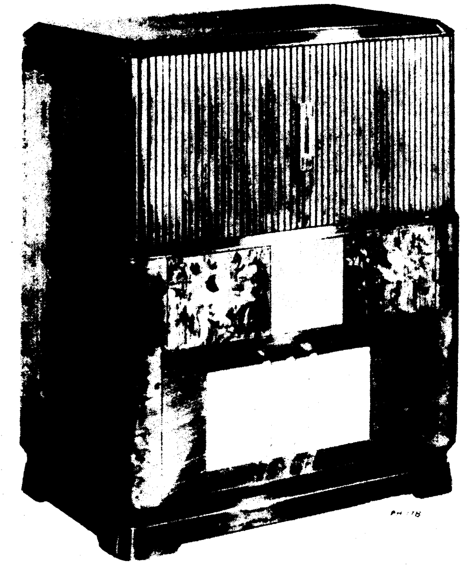

Model 648PTK

RCA VICTOR

PROJECTION TELEVISION, AM-FM RADIO, COMBINATION

MODEL 648PTK

Chassis Nos. KCS 24-1, KRS 20-1, KRS 21-1 KRK 1-1, RK-121A and RS-123A

Mfr. No. 274

SERVICE DATA

- 1947 No. T2 -

RADIO CORPORATION OF AMERICA
RCA VICTOR DIVISION
CAMDEN, N. J., U. S. A.

GENERAL DESCRIPTION

Model 648PTK is a forty-eight tube Projection Television, AM-FM Radio, console combination. The television receiver employs four chassis with a total of thirty-five tubes and a five-inch projection kinescope. A Reflective Optical System provides a 15" x 20" picture on the screen.

Features of the television unit are full thirteen channel coverage; FM sound system; improved picture brilliance; picture A-G-C; A-F-C horizontal hold; stabilized vertical hold; two stages of video amplification; noise saturation circuits; three-stage sync separator and clipper; four mc band width for picture channel and reduced hazard high voltage supply.

The radio receiver employs an eight-tube tuner unit and a four-tube audio-amplifier, power-supply unit.

The radio chassis is provided with a Phono input jack to permit the use of an external record player.

ELECTRICAL AND MECHANICAL SPECIFICATIONS

RADIO TUNING RANGE

Broadcast	540-1,600 kc
Short Wave	9.2-16 mc
Frequency Modulation	88-108 mc
Intermediate Frequency—AM	455 kc
Intermediate Frequency—FM	10.7 mc

PICTURE SIZE .... 15" x 20"

TELEVISION R-F FREQUENCY RANGES

Television Channel Number	Channel Freq. Mc.	Picture Carrier Freq. Mc.	Sound Carrier Freq. Mc.	Tel. Rec. R-F Osc. Freq. Mc.
1	44-50	45.25	49.75	71
2	54-60	55.25	59.75	81
3	60-66	61.25	65.75	87
4	66-72	67.25	71.75	93
5	76-82	77.25	81.75	103
6	82-88	83.25	87.75	109
7	174-180	175.25	179.75	201
8	180-186	181.25	185.75	207
9	186-192	187.25	191.75	213
10	192-198	193.25	197.75	219
11	198-204	199.25	203.75	225
12	204-210	205.25	209.75	231
13	210-216	211.25	215.75	237

TELEVISION FINE TUNING RANGE

Plus and minus approximately 800 kc on channel 1, and plus and minus approximately 1.9 mc on channel 13.

RECEIVER ANTENNA INPUT IMPEDANCE..300 ohms balanced

POWER SUPPLY RATING

Television Operation	115 volts, 60 cycles, 530 watts
Radio Operation	115 volts, 60 cycles, 145 watts

AUDIO POWER OUTPUT RATING

Undistorted Power Output	10 watts
Maximum Power Output	11 watts

CHASSIS DESIGNATIONS

Television R-F, I-F Chassis	KCS24-1
Horizontal Deflection Chassis	KRS20-1
Television Power Supply Chassis	KRS21-1
Optical Barrel	KRK1-1
Radio Chassis	RK121A
Audio Amplifier	RS123A

LOUDSPEAKER (92567-2)

Type	12-inch Electrodynamic
Voice Coil Impedance	2.2 ohms at 400 cycles

WEIGHT

Chassis with Tubes in Cabinet	295 lbs.
Shipping Weight	360 lbs.

DIMENSIONS (inches)	Width	Height	Depth
Cabinet (outside)	36¼	47½	22¾
KCS24-1 (overall)	17	8½	13¼
KRS20-1 (overall)	18⅛	11	9¾
KRS21-1 (overall)	12¼	7¾	6½
RK121A (overall)	17	5¾	8½
RS123A (overall)	13¼	5¾	4¾

Specifications continued on page 3

First Edition

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HIGH VOLTAGE WARNING

OPERATION OF THIS RECEIVER OUTSIDE THE CABINET OR WITH THE COVERS REMOVED, INVOLVES A SHOCK HAZARD FROM THE RECEIVER POWER SUPPLIES. WORK ON THE RECEIVER SHOULD NOT BE ATTEMPTED BY ANYONE WHO IS NOT THOROUGHLY FAMILIAR WITH THE PRECAUTIONS NECESSARY WHEN WORKING ON HIGH VOLTAGE EQUIPMENT. DO NOT OPERATE THE TELEVISION RECEIVER WITH THE HIGH VOLTAGE COMPARTMENT SHIELD REMOVED.

KINESCOPE HANDLING PRECAUTIONS

DO NOT OPEN THE KINESCOPE SHIPPING CARTON, INSTALL, REMOVE OR HANDLE THE KINESCOPE IN ANY MANNER UNLESS SHATTERPROOF GOGGLES AND HEAVY GLOVES ARE WORN. PEOPLE NOT SO EQUIPPED SHOULD BE KEPT AWAY WHILE HANDLING KINESCOPES. KEEP THE KINESCOPE AWAY FROM THE BODY WHILE HANDLING.

The kinescope bulb encloses a high vacuum and, due to its large surface area, is subjected to considerable air pressure. For these reasons, kinescopes must be handled with more care than ordinary receiving tubes.

The large end of the kinescope bulb—particularly that part at the rim of the viewing surface—must not be struck, scratched or subjected to more than moderate pressure at any time. In installation, if the tube sticks or fails to slip smoothly into its socket, or deflecting yoke, investigate and remove the cause of the trouble. Do not force the tube. Refer to the receiver Installation Instructions section for detailed instructions on kinescope installation. All RCA kinescopes are shipped in special cartons and should be left in the cartons until ready for installation in the receiver. Keep the carton for possible future use.

TELEVISION CHASSIS DATA

PICTURE I-F FREQUENCIES

Picture Carrier Frequency .... 25.75 mc
Adjacent Channel Sound Trap .... 27.25 mc
Accompanying Sound Traps .... 21.25 mc
Adjacent Channel Picture Carrier Trap .... 19.75 mc

SOUND I-F FREQUENCIES

Sound Carrier Frequency .... 21.25 mc
Sound Discriminator Band Width (between peaks) .... 350 kc

VIDEO RESPONSE .... To 4 mc

FOCUS .... Electrostatic

SWEEP DEFLECTION .... Magnetic

SCANNING .... Interlaced, 525 line

HORIZONTAL SCANNING FREQUENCY .... 15,750 cps

VERTICAL SCANNING FREQUENCY .... 60 cps

FRAME FREQUENCY (Picture Repetition Rate) .... 30 cps

OPERATING CONTROLS (front panel)

Channel Selector / Fine Tuning .... Dual Control Knobs
Picture / Brightness .... Dual Control Knobs
Picture Horizontal Hold / Picture Vertical Hold .... Dual Control Knobs

NON-OPERATING CONTROLS (not including r-f and i-f adjustments)

Horizontal Centering .. Horizontal Deflection chassis adjustment
Vertical Centering .... R-F, I-F chassis rear adjustment
Height .... R-F, I-F chassis rear adjustment
Vertical Linearity .... R-F, I-F chassis rear adjustment
Width .... Horizontal Deflection chassis screwdriver adjustment
Horizontal Linearity ....Horizontal Deflection chassis adjustment
Horizontal Drive .... Horizontal Deflection chassis adjustment
Horizontal Oscillator Frequency — Horizontal Deflection chassis adjustment
Horizontal Oscillator Phase — Horizontal Deflection chassis adjustment
Focus (Electrical) .. Horizontal Deflection chassis rear adjustment
Focus (Mechanical) .... Optical Barrel adjustment
Deflection Coil .... Optical Barrel adjustment
Video Peaking Switch .... R-F, I-F chassis rear switch
Horizontal Optical Centering .... Optical Barrel adjustment
Lateral Optical Centering .... Optical Barrel adjustment

RCA TUBE COMPLEMENT

KCS24-1 R-F, I-F CHASSIS

	Tube Used	Function
(1)	RCA-6J6	R-F Amplifier
(2)	RCA-6J6	R-F Oscillator
(3)	RCA-6J6	Converter
(4)	RCA-6BA6	1st Sound I-F Amplifier
(5)	RCA-6BA6	2nd Sound I-F Amplifier
(6)	RCA-6AU6	3rd Sound I-F Amplifier
(7)	RCA-6AL5	Sound Discriminator
(8)	RCA-6AT6	A-G-C Amplifier
(9)	RCA-6AL5	A-G-C Diode and D-C Restorer
(10)	RCA-6AG5	1st Picture I-F Amplifier
(11)	RCA-6AG5	2nd Picture I-F Amplifier
(12)	RCA-6AG5	3rd Picture I-F Amplifier
(13)	RCA-6AG5	4th Picture I-F Amplifier
(14)	RCA-6AL5	Picture 2nd Detector and A-G-C Detector
(15)	RCA-6AU6	1st Video Amplifier
(16)	RCA-6V6GT	2nd Video Amplifier
(17)	RCA-6SK7	1st Sync Amplifier
(18)	RCA-6SH7	2nd Sync Amplifier
(19)	RCA-6J5	3rd Sync Amplifier
(20)	RCA-6J5	Vertical Sweep Oscillator and Discharge
(21)	RCA-6K6GT	Vertical Sweep Output

KRS20-1 HORIZONTAL DEFLECTION CHASSIS

	Tube Used	Function
(1)	RCA-6H6	Horizontal Sync Discriminator
(2)	RCA-6K6GT	Horizontal Sweep Oscillator
(3)	RCA-6J5	Horizontal Discharge
(4)	RCA-6AC7	Horizontal Sweep Oscillator Control
(5)	RCA-6BG6G	Horizontal Sweep Output (2 tubes)
(6)	RCA-5V4G	Horizontal Damper
(7)	RCA-6AS7G	Horizontal Damper
(8)	RCA-1B3-GT/8016	High Voltage Rectifier (3 tubes)
(9)	RCA-5TP4	Projection Kinescope

KRS21-1 TELEVISION POWER SUPPLY CHASSIS

	Tube Used	Function
(1)	RCA-5U4G	Rectifier (3 tubes)

RK121A RADIO CHASSIS

	Tube Used	Function
(1)	RCA-6BA6	R-F Amplifier
(2)	RCA-6BE6	Oscillator
(3)	RCA-6BA6	Mixer
(4)	RCA-6BA6	1st I-F Amplifier
(5)	RCA-6AU6	2nd I-F and Phono Amplifier
(6)	RCA-6AU6	Driver
(7)	RCA-6AL5	Ratio Detector
(8)	RCA-6AT6	AM Detector, AVC and Audio Amplifier

RS123A AUDIO AMPLIFIER

	Tube Used	Function
(1)	RCA-5U4G	Rectifier
(2)	RCA-6J5	Phase Inverter
(3)	RCA-6F6G	Power Output (2 tubes)

TELEVISION OPERATION

The following adjustments are necessary when turning the receiver on for the first time.

1. Turn the radio FUNCTION switch to Tel.

2. Turn the receiver "ON" and advance the SOUND VOLUME control to approximately mid-position.

3. Set the STATION SELECTOR to the desired channel.

4. Turn the PICTURE control fully counter-clockwise.

5. Turn the BRIGHTNESS control clockwise, until a glow appears on the screen, then counter-clockwise until the glow just disappears.

6. Turn the PICTURE control clockwise until a glow or pattern appears on the screen.

7. Adjust the FINE TUNING control for best sound fidelity and SOUND VOLUME for suitable volume.

8. Adjust the VERTICAL hold control until the pattern stops vertical measurement.

9. Adjust the HORIZONTAL hold control until a picture is obtained and centered.

10. Adjust the PICTURE control for suitable picture contrast.

11. After the receiver has been on for some time, it may be necessary to readjust the FINE TUNING control slightly for improved sound fidelity.

12. In switching from one station to another, it may be necessary to repeat steps number 7 and 10.

13. When the set is turned on again after an idle period, it should not be necessary to repeat the adjustments if the positions of the controls have not been changed. If any adjustment is necessary, step number 7 is generally sufficient.

14. If the position of the controls have been changed, it may be necessary to repeat steps number 2 through 10.

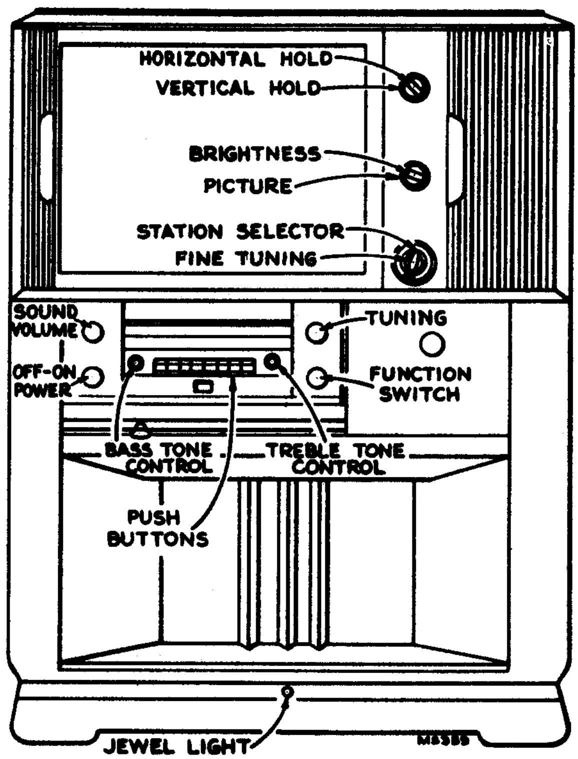


Figure 1—Receiver Operating Controls

RADIO OPERATION

1. Turn the radio FUNCTION switch to the desired band (BC, SW or FM).

2. Tune in the desired station with the TUNING control.

PUSH BUTTON OPERATION

1. Turn the radio FUNCTION switch to the desired band (BC, SW or FM).

2. Push the appropriate push button to receive the desired station.

PHONOGRAPH OPERATION

1. Turn the radio FUNCTION switch to the phono position.

2. Connect phono attachment to phono input jack and operate conventionally.

The 648PTK is shipped complete except for the 5TP4 Kinescope. The shipping carton is a plywood box put together with nails. Open the box by removal of the front side. If the front of the carton is removed by prying, do not permit the prying tool to enter the box as the front of the cabinet may become scratched. Remove 2 wood screws on each side of the box and slip the cabinet out of the carton. Lift the shipping frame off over the top of the cabinet.

A flat skid is attached to the bottom of the receiver cabinet which will permit the cabinet to be moved about without danger of breaking a cabinet leg or stressing the cabinet joints. This skid should be left on the cabinet until the receiver is placed on display or installed in the home. To remove the skid, take off the cabinet back and remove two nuts on the inside as shown in Figure 2. With a man at each end of the cabinet, lift the cabinet off the skid.

The radio panel is held in the closed position by two wood screws in a bracket attached to the radio chassis. Remove the screws shown at Detail B in Figure 2 and take out the two red brackets.

Remove the tapes holding the television compartment doors.

The radio and television control knobs, the deflection yoke, the kinescope anode clip and the kinescope holder ball head screws are packed in a carton taped to the cabinet upper back cross member. Remove the knobs and install them on their control shafts.

Remove the shipping material as shown in Figure 2. Make sure that all tubes are firmly seated in their sockets. Access to the front tubes in the r-f, i-f chassis may be had through the front of the cabinet by raising the door stop as shown in Detail A of Figure 2 and then sliding the right television door all the way back. When this check is completed, close the door to its normal position and drop the door stop back in place.

Untie the canvas dust cover for the optical barrel and tie it off to one side.

Caution: Handle the corrector lens with care. This lens is made of a plastic material, is soft and can be easily scratched by improper handling or even by rubbing with a cloth. Do not use cleaning fluid on the lens as it may be attacked by some of the chemicals used in such solutions. In short, the lens should be given the care due any precision optical equipment.

Although the high voltage filter capacitors of a new receiver are not likely to be charged, it is a good idea to form the habit of discharging the optical barrel before making any internal adjustments. Take a clip lead, fasten the clip end to the barrel and discharge the unit by making repeated contacts to the kinescope holder shown in Figure 3.

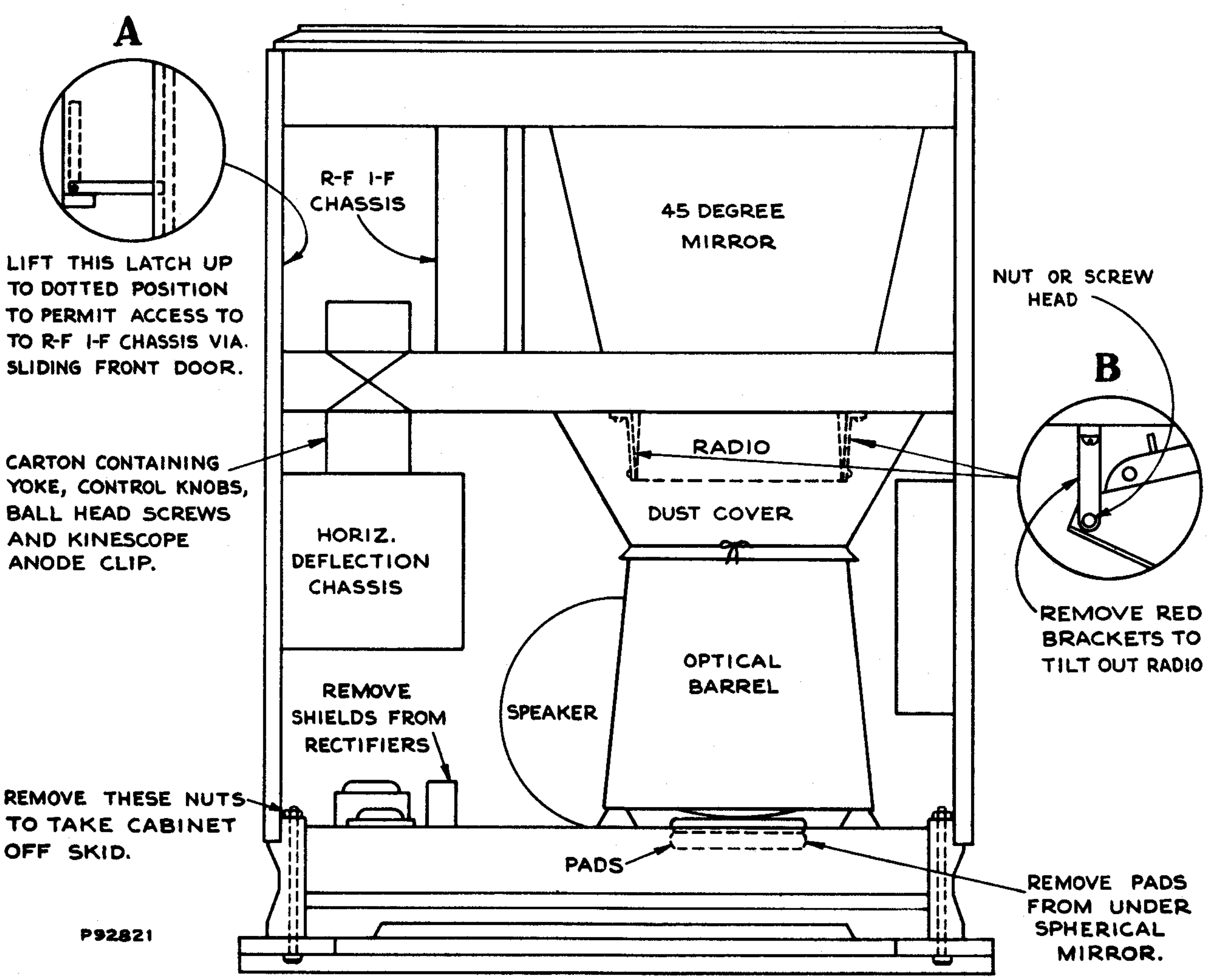


Figure 2—Removal of Shipping Material

Remove the corrector lens from the top of the optical barrel by loosening the three screws holding the clamp springs as shown in Figure 4. Caution: Do not loosen the three screws holdinq the corrector lens mounting plate.

Clean the back of the screen, the front of the 45° mirror and the optical barrel spherical mirror by "sweeping" the surface with a small camel's hair brush. Any dust on the spherical mirror should be swept into the black center portion where it can be picked up with a piece of scotch tape. Caution: Do not touch the silvered portion of the mirrors. The mirrors are surface silvered and can be damaged by contact with the moist hand. If the screen or mirrors require cleaning, a solution of "Dreft" and water should be employed.

Insert the ball head screws from the carton with the knobs in the kinescope holder as shown in Figure 3.

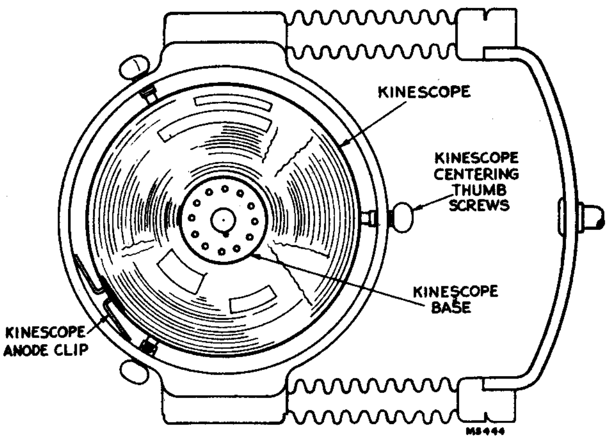


Figure 3—Kinescope Holder

Place a Stock No. 53440 test lamp in the kinescope holder and adjust the ball screws to center the lamp in the holder. Connect the lamp cord into a 110-volt power outlet and turn the lamp on. Replace the corrector lens, taking care that the arrow on the edge of the lens points to the rear of the cabinet. Rotate the lamp so as to produce a picture on the screen in the proper aspect. Cover the center hole in the corrector lens with a piece of black cardboard in order to prevent light from this source from lowering the resolution. Pull the dust cover down around the barrel.

Observe the raster on the screen by use of a mirror placed in front of the set. A chrome-plated photographic ferrotype tin is excellent for this purpose.

Loosen the optical focus adjustment lock screws and adjust the optical focus adjustment for the best overall definition on the screen. The optical system should show at least 900 line resolution over all the screen. If the system shows less definition, it will be necessary to make the adjustments under "Alignment of Optical Barrel."

ALIGNMENT OF OPTICAL BARREL—With the test lamp in place as described above, turn the optical focus adjustment until the vertical and horizontal lines become double. When the test lamp is properly centered, the lines are parallel. If the lines are not parallel, the Horizontal or Lateral optical centering controls require readjustment.

Lateral Optical Adjustment—If the vertical lines are not parallel, loosen the lateral adjustment set screws and turn the lateral adjustment until the vertical lines are parallel. Tighten the adjustment set screws.

Horizontal Optical Adjustment—If the horizontal lines are not parallel, loosen the optical horizontal centering lock screws and turn the optical horizontal centering adjustment until the lines are parallel. Tighten the adjustment lock screws.

Corrector Lens Centering—Turn the focus adjustment until a halo appears around the dot in the center of the test lamp. If the halo is not symmetrical around the dot, loosen the three corrector lens lock screws and the three corrector lens mounting clip screws and shift the lens until the halo is symmetrical. Tighten the lens centering lock screws with the lens in this position.

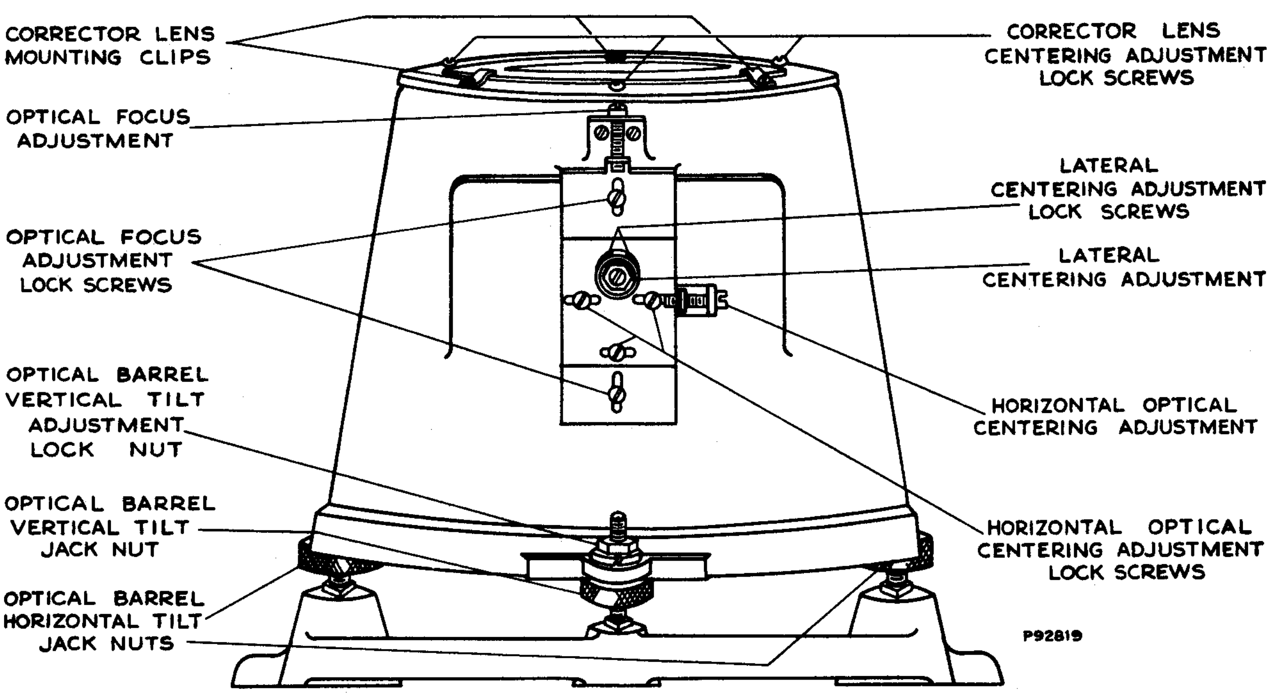


Figure 4—Optical Barrel Adjustments

Check of Optical Barrel Tilt—Adjust the optical focus control to and through the focus range. The picture should go through focus all over at the same time. This does not mean that the definition will be equal over all the picture, but it should be the best definition obtainable. If this is not the case, the optical barrel is not in alignment with the cabinet and requires adjustment as outlined in the following paragraph.

Optical Barrel Tilt Alignment—Turn the optical focus adjustment counterclockwise until the picture is out of focus then clockwise until the picture begins to come in focus. If one side comes into focus before the rest of the picture, it indicates that that side of the optical barrel should be raised. Loosen the lock nuts and turn the inner jack nuts, shown in Figure 4, to raise that side of the barrel and the other jack nut down to lower the other side of the barrel, until both sides of the picture come into focus at the same time.

If the top of the picture comes into focus first as the optical focus adjustment is turned clockwise, it indicates that the outer jack nut (nearest the focus controls) should be adjusted to lower the back of the optical barrel, until top and bottom come into focus at the same time.

When the barrel is properly adjusted, the entire picture will come into best focus all over at the same time as the focus control is rocked through the focus point. At this point the pattern should be in the center of the screen. When this condition of alignment is obtained, tighten the lock nuts being careful not to disturb the adjustments.

If the optical barrel tilt adjustments are made, it will be necessary to recheck the adjustments under Horizontal Optical Adjustments and Lateral Optical Adjustments.

Loosen all the kinescope mounting wing screws equally and just sufficiently to permit removal of the test lamp.

KINESCOPE HANDLING PRECAUTION—Do not open the kinescope shipping carton, install, remove, or handle the kinescope in any manner, unless shatterproof goggles and heavy gloves are worn. People not so equipped should be kept away while handling the kinescope. Keep the kinescope away from the body while handling. The shipping carton should be kept for use in case of future moves.

Open the kinescope shipping carton and remove the tube. Handle this tube by the neck. Do not cover the envelope of the tube with fingermarks as it will produce leakage paths between the high voltage rim near the screen and the grounded coating on the neck. If this portion of the tube has inadvertently been handled, wipe it clean with a soft cloth moistened with "dry" carbon tetrachloride, which is obtainable at most drug stores.

Wipe the kinescope screen clean of all dust or finger marks with a soft cloth moistened with the Drackett Co.'s "Windex" or similar cleaning agent.

INSTALLATION OF KINESCOPE—The kinescope second anode contact is a recessed metal well in the side of the bulb. A small brass clip (from the carton containing the deflection yoke and front panel control knobs) must be placed in the kinescope anode connector and the tube inserted in the holder as shown in Figure 3. The tube must be installed so that the socket key on the base of the tube is pointed towards the television chassis. Make sure that the anode clip is horizontal so that it cannot protrude out of the holder.

Tighten the three ball screws equally to center the tube in the support. Caution: Do not apply too much pressure in tightening the ball screws as the tube can be cracked by so doing.

Wipe the corrector lens clean with a piece of lens tissue and replace making sure that the arrow on the lens points to the rear of the cabinet as before. Turn the lens mounting clips in place and tighten the clip screws.

Turn the deflection yoke so that the slotted end of the bakelite center tube is up and slide the yoke down over the neck of the kinescope. Connect the kinescope socket to the base of the tube. Turn the yoke so that the leads come out towards the rear of the cabinet.

Slip the yoke cables out through the cable sleeve in the optical barrel dust cover. The three-prong plug on the unshielded yoke cable should be plugged into the television r-f, i-f chassis as shown in Figure 5. The two-prong plug on the shielded yoke cable should be plugged into the horizontal deflection chassis. The shield braid extension from this cable should be grounded to the chassis by means of the screw provided for this purpose.

Caution—Do not turn the television receiver on with the deflection yoke cables disconnected. To do so may cause the destruction of the kinescope screen.

Check all chassis interconnecting cables to make sure that all are plugged into the proper sockets as shown in Figure 5. It is possible to insert the receiver antenna and ground plug backwards. The ground wire should go to the middle connector at the radio chassis as shown.

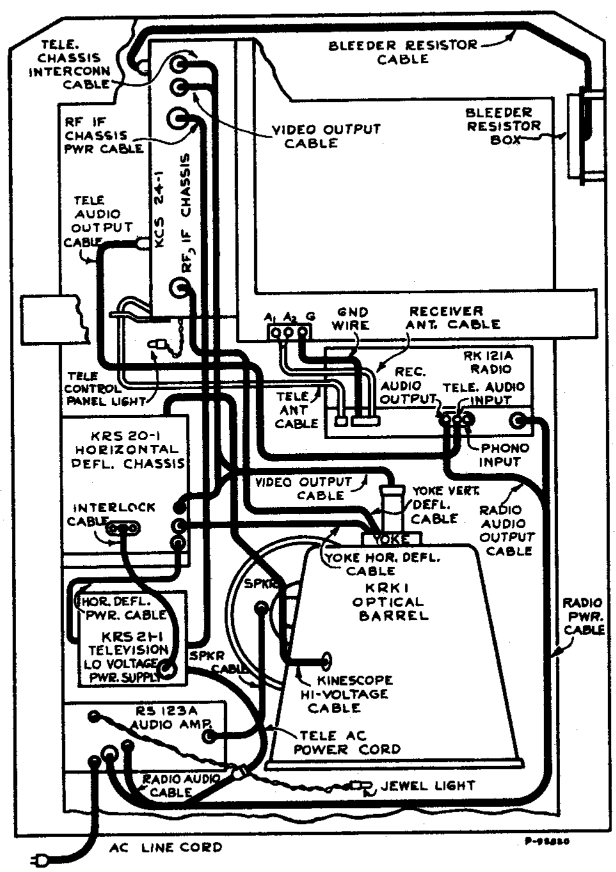


Figure 5—Chassis Interconnecting Cables

Remove the cover from the horizontal deflection chassis and take out the strings holding the high voltage filter capacitors in the clips during shipment. Replace the chassis cover.

The antenna and power connections should now be made. Turn the power switch to the "on" position, the function switch to television, the picture control counterclockwise and the brightness control clockwise until a glow appears on the screen.

Adjust the electrical focus control R331 on the horizontal deflection chassis until the raster lines are in sharpest focus as seen when looking down into the barrel. If necessary, reduce the brilliance control setting, and readjust the focus control. Pull the dust cover down around the optical barrel.

Adjust the optical focus adjustment until the raster lines are in focus on the screen. Turn the deflection yoke until the raster lines are horizontal on the screen and tighten the yoke clamp in this position.

Picture Adjustments—It will now be necessary to obtain a test pattern picture in order to make further adjustments. See step 3 through step 10 of the receiver operating instructions on page 4.

CHECK OF HORIZONTAL OSCILLATOR ALIGNMENT—The sync link (see Figure 7) must be in the normal position (2 to 3). Turn the horizontal hold control to the extreme counterclockwise position. The picture should remain in horizontal sync. Momentarily remove the signal by turning the picture control fully counterclockwise and then returning it to the operating position. Normally the picture will pull into sync.

Turn the horizontal hold control to the extreme clockwise position. The picture should remain in sync. Momentarily remove the signal. Again the picture should normally pull into sync.

If the receiver passes the above checks and the picture is normal and stable, the horizontal oscillator is properly aligned. Skip "Alignment of Horizontal Oscillator" and proceed with HEIGHT AND VERTICAL LINEARITY ADJUSTMENTS.

ALIGNMENT OF HORIZONTAL OSCILLATOR—If in the above check the receiver failed to hold sync with the hold control at either extreme or failed to pull into sync after momentary removals of the signal, make the adjustments under "Slight Retouching Adjustments." If, after making these retouching adjustments, the receiver fails to pass the above checks or if the horizontal oscillator is completely out of adjustment, then make the adjustments under "Complete Realignment."

Slight Retouching Adjustments—Tune in a Television Station and adjust the fine tuning control for best sound quality. Sync the picture and adjust the picture control for slightly less than normal contrast. Turn the horizontal hold control to the extreme position in which the oscillator fails to hold or to pull in. Momentarily remove the signal. Turn the T301 frequency adjustment on the chassis rear apron until the oscillator pulls into sync. Check hold and pull-in for the other extreme position of the hold control.

Complete Realignment—Tune in a Television Station and adjust the fine tuning control for best sound quality.

With the sync link in the normal position (2-3), turn the T301 frequency adjustment (on rear apron), until the picture is synchronized. (If the picture is not synchronized vertically, adjust the vertical hold.) Adjust the picture control so that the picture is somewhat below average contrast level.

Turn the T301 phase adjustment screw (under chassis, see Figure 23) until the blanking bar, which may appear in the picture, moves to the right and off the raster. The range of this adjustment is such that it is possible to hit an unstable condition (ripples in the raster). The screw must be turned clockwise from the unstable position. The length of stud beyond the bushing in its correct position is usually about ½ inch.

Turn horizontal hold to extreme counterclockwise position. Turn T301 frequency adjustment clockwise until the picture falls out of sync. Then turn it slowly counterclockwise to the point where the picture falls in sync again.

Readjust T301 phase adjustment so that the left side of the picture is close to the left side of the raster, but does not begin to fold over.

Turn horizontal hold to extreme clockwise. The right side of the picture should be close to the right side of the raster, but should not begin to fold over. If it does, readjust the phase.

Momentarily remove the signal. When the signal is restored, the picture should fall in sync. If it doesn't, turn T301 frequency adjustment counterclockwise until the picture falls in sync.

Turn horizontal hold to extreme counterclockwise position. Remove the signal momentarily. When signal is restored, the picture should fall in sync.

NOTE: If the picture does not pull in sync after momentary removals of signal in both extreme positions of horizontal hold, the pull-in range may be inadequate, though not necessarily. A pull-in through ¾ of the hold control range may still be satisfactory.

There is a difference between the pull-in range and hold-in range of frequencies. Once in sync, the circuit will hold about 50% to 100% more variation in frequency than it can pull in. The range of the horizontal hold control is only approximately equal to the pull-in range, considerable variation may be found due to variations in the cut-off characteristic of the horizontal oscillator control tubes, V303.

Excessive pull-in is objectionable because the higher sensitivity of the control circuits means also greater susceptibility to noise, and to the vertical sync and equalizing pulses which tend to cause a bend in the upper part of the raster. This effect is more noticeable when the sync link is in the 1-2 position.

Now that a picture has been obtained we may proceed with the picture adjustments.

Adjust the electrical and optical focusing adjustments for maximum definition in the vertical wedge of the test pattern.

HEIGHT AND VERTICAL LINEARITY ADJUSTMENTS—Adjust the height control (R149 on r-f, i-f chassis rear apron) until the picture fills the screen vertically. Adjust vertical linearity (R175 on rear apron), until the test pattern is symmetrical from top to bottom. Adjustment of either control will require a readjustment of the other. Adjust vertical centering to align the picture with the mask. In some cases it may be necessary to shift the position of the kinescope in the holder (see Figure 3) in order to obtain proper centering of the picture.

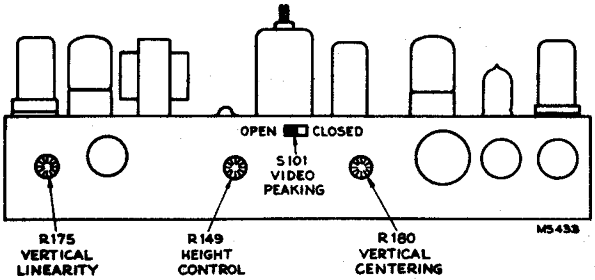


Figure 6—R-F, I-F Rear Chassis Adjustments

WIDTH AND HORIZONTAL LINEARITY ADJUSTMENTS—Turn the horizontal drive (R340 on rear apron) clockwise as far as possible without causing crowding of the right of the picture. This position provides maximum high voltage to the kinescope second anode. Adjust the horizontal linearity control R351 (see Figure 7) until the test pattern is symmetrical left to right. A slight readjustment of the horizontal drive control may be necessary when the linearity control is used. Adjust the width control (L302 on rear chassis) until the picture just fills the screen horizontally. Adjust horizontal centering to align the picture with the mask. In some cases it may be necessary to shift the position of the kinescope in the holder in order to obtain proper centering of the picture.

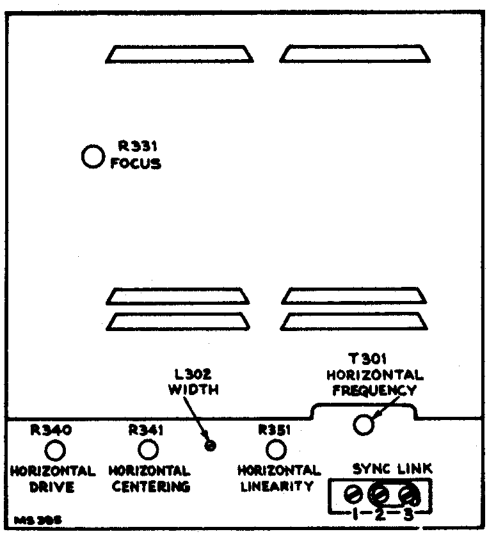


Figure 7—Horizontal Deflection Chassis Adjustments

Pull the dust cover down around the top of the optical barrel and tie it securely and tightly in place as shown in Figure 2. Tie the cable sleeve tight around the leads to prevent the entry of dust. These precautions are very important for if dust is permitted to enter and settle on the corrector lens, the optical efficiency of the system will be greatly impaired, resulting in a dim picture with poor definition.

FOCUS—Adjust the focus control for maximum definition in the test pattern vertical "wedge." Adjust the optical focus adjustment for best overall focus on the screen.

Check to see that all yoke and optical barrel lock screws are tight.

CHECK OF R-F OSCILLATOR ADJUSTMENTS—With a crystal calibrated test oscillator or heterodyne frequency meter, check to see if the receiver r-f oscillator is adjusted to the proper frequency on all channels. If adjustments are required, these should be made by the method outlined in the alignment procedure on page 22. The adjustments for channels 1 through 5 and 7 through 12 are available from the front of the cabinet by removing the station selector escutcheon as shown in Figure 8. Adjustments for channels 6 and 13 are under the chassis. See Figure 27 for their locations.

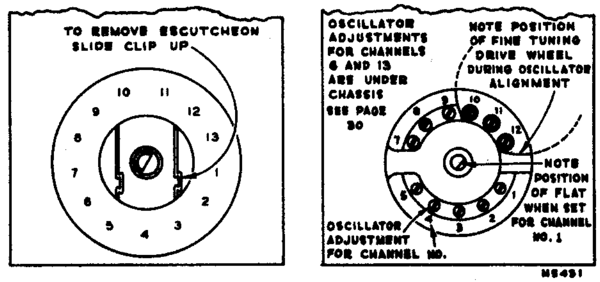


Figure 8—R-F Oscillator Adjustments

Tune in all available Television Stations. Observe the picture for detail, for proper interlacing and for the presence of interference or reflections. If these are encountered, see the section on antennas on page 11.

VIDEO PEAKING SWITCH—A video peaking switch is provided (see Figure 6) to permit changing the video response. See page 15 for an explanation of the effect. Normally the switch should be left open. However, if the pictures from the majority of stations look better with the switch closed, then the switch should be placed in that position. However, if transients are produced on high contrast pictures then the switch should be left open.

RADIO OPERATION—Turn the receiver function switch to AM and FM positions and check the radio for proper operation. In switching from radio to television or from television to radio, approximately 30 seconds warm-up time is required.

PUSH-BUTTON ADJUSTMENT—To adjust the radio push buttons, set the function switch to the broadcast band position, tune the receiver to the desired station. Adjust the push buttons as instructed on page 47.

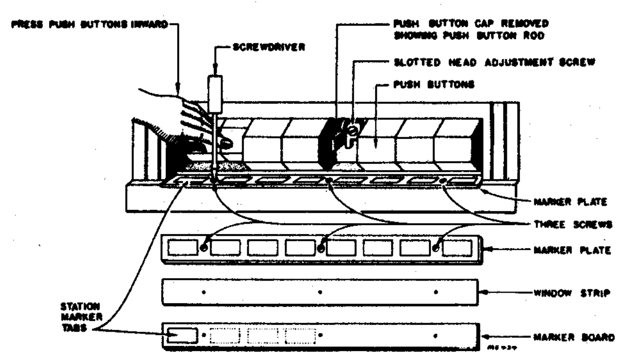


Figure 9—Push-Button Adjustments

Select the proper station call letter tab, moisten the back of the tab and insert in the appropriate recess in the push button bezel. Place the tab cellophane cover in the recess over the tab.

Replace the television receiver metal back grill. Make sure the screws which hold the back grill in place are tight, otherwise the back may rattle or buzz when the receiver is operating at high volume.

Advise the customer to keep all packing cartons and hardware for use in case of future moves.

INSTALLATION INSTRUCTION TABLE

The following table is provided as a check-off list for use when installing the receivers.

Step No.	Proceed as Indicated
1	Remove front of shipping carton.
2	Slide cabinet out of carton.
3	Remove cabinet back.
4	Take off two nuts inside cabinet and remove cabinet from skid.
5	Unpack yokes, knobs, anode clip, and kinescope holder ball head screws.
6	Remove shipping materials.
7	Remove radio brackets.
8	Remove shipping tapes.
9	Install control knobs.
10	Make sure all tubes are firmly seated in their sockets.
11	Remove optical barrel dust cover.
12	Remove corrector lens and warning label.
13	Clean screen and mirrors.
14	Insert test lamp in kinescope holder.
15	Replace corrector lens, cover center hole.
16	Misadjust optical focus.
17	Check optical, horizontal and lateral centering.
18	Adjust centering if necessary.
19	Adjust corrector lens centering if necessary.
20	Refocus.
21	If focus is uneven, adjust optical barrel tilt.
22	Repeat steps 17 through 21 if necessary to obtain proper resolution.
23	Remove corrector lens.
24	Remove test lamp.
25	Unpack and clean kinescope.
26	Insert kinescope in kinescope holder.
27	Clean and replace corrector lens.

Step No.	Proceed as Indicated
28	Install deflection yoke, connect cables and kinescope socket.
29	Check all chassis interconnecting cables.
30	Remove high voltage capacitors shipping strings.
31	Connect receiver to an a-c line and antenna.
32	Turn receiver on, function switch to Tel.
33	Tune in station per Operating Instructions, steps 3 through 10.
34	Adjust electrical and optical focus control.
35	Check horizontal oscillator for hold and pull-in with horizontal hold control at each extreme.
36	Align horizontal oscillator (T301) if necessary.
37	Rotate yoke for horizontal pattern, tighten.
38	Adjust height and vertical linearity and vertical centering controls.
39	Adjust width, horizontal drive, linearity and horizontal centering controls.
40	Adjust focus control R331 for max definition of vertical wedge and optical focus adjustment for best overall focus.
41	MAKE SURE ALL OPTICAL ADJUSTMENT LOCKS ARE TIGHT.
42	Replace optical barrel dust cover.
43	Check r-f oscillator frequency on all channels.
44	Observe picture from all available stations.
45	Set video peaking switch S101.
46	Check radio for operation on BC, SW, and FM bands.
47	Set push buttons.
48	Insert station call letter tabs in push button escutcheon.
49	Replace cabinet back.
50	Wipe cabinet

RECEIVER LOCATION—The owner should be advised of the importance of placing the receiver in the proper location in the room.

The location should be chosen—

—Away from bright windows and so that no bright light will fall directly on the screen. (Some illumination in the room is desirable, however.)

—To give easy access for operation and comfortable viewing.

—To permit convenient connection to the antenna.

—Convenient to an electrical outlet.

—To allow adequate ventilation.

VENTILATION CAUTION—The receiver is provided with adequate ventilation holes in the bottom and back of the cabinet. Care should be taken not to allow these holes to be covered or ventilation to be impeded in any way.

If the receiver is to be operated with the back of the cabinet near a wall, at least a two-inch clearance should be maintained between cabinet and wall.

ANTENNAS—The finest television receiver built may be said to be only as good as the antenna design and installation. It is therefore important to use a correctly designed antenna, and to use care in its installation.

RCA Television Antennas, stock #225 and #226 are designed for reception on all thirteen television channels. These antennas use the 300-ohm RCA "Bright Picture" television transmission line. Installation personnel are cautioned not to make any changes in the antenna or substitute other types of transmission line as such changes may result in unsatisfactory picture reproduction.

The stock #226 antenna is bi-directional on channels one through six (44 to 88 Mc). When used on these channels, the maximum signal is obtained when the antenna rods are broadside toward the transmitting antenna.

The stock #225 antenna with reflector is uni-directional on channels one through six. When used on these channels, the maximum signal is obtained when the antenna rods are broadside toward the transmitting antenna, with the antenna element beween the reflector and the transmitting antenna.

When operated on channels seven through thirteen, (174 to 216 Mc), both types of antennas have side lobes. On these channels, the maximum signal will be obtained when the antenna is rotated approximately 35 degrees in either direction from its broadside position toward the transmitting antenna.

In general, the stock #225 antenna should be used if reflections are encountered, if the signal strength is weak, or if the receiving location is noisy. If these conditions are not encountered, the stock #226 antenna will probably be satisfactory.

In most cases, the antenna should not be installed permanently until the quality of the picture reception has been observed on a television receiver. A temporary transmission line can be run between receiver and the antenna, allowing sufficient slack to permit moving the antenna Then, with a telephone system connecting an observer at the receiver and an assistant at the antenna, the antenna can be positioned to give the most satisfactory results on the received signal. A shift of direction or a few feet in antenna position may effect a tremendous difference in picture reception.

REFLECTIONS—Multiple images, sometimes known as echoes or ghosts, are caused by the signal arriving at the antenna by two or more routes. The second or subsequent image occurs when a signal arrives at the antenna after being reflected off a building, a hill or other object. In severe cases of reflections, even the sound may be distorted. In less severe cases, reflections may occur that are not noticeable as reflections but that will instead cause a loss of definition in the picture.

Depending upon the circumstances, it may be possible to eliminate the reflections by rotating the antenna or by moving it to a new location. In extreme cases, it may be impossible to eliminate the reflection.

Under certain extremely unusual conditions, it may be possible to rotate or position the antenna so it receives the cleanest picture over a reflected path. If such is the case, the antenna should be so positioned. However, such a position may give variable results as the nature of reflecting surfaces may vary with weather conditions. Wet surfaces have been known to have different reflecting characteristics than dry surfaces.

INTERFERENCE—Auto ignition, street cars, electrical machinery and diathermy apparatus may cause interference which spoils the picture. Whenever possible, the antenna location should be removed as far as possible from highways, hospitals, doctors' offices and similar sources of interference. In mounting the antenna, care must be taken to keep the antenna rods at least ¼ wave length (at least 6 feet) away from other antennas, metal roofs, gutters or other metal objects.

Short-wave radio transmitting and receiving equipment may cause interference in the picture in the form of moving ripples. In some instances it may be possible to eliminate the interference by the use of a trap in the antenna transmission line. However, if the interfering signal is on the same frequency as the television station, a trap will provide no improvement.

WEAK PICTURE—When the installation is near the limit of the area served by the transmitting station, the picture may be speckled, having a "snow" effect, and may not hold steady on the screen. This condition is due to lack of signal strength from the transmitter.

LIGHTNING ARRESTOR—The lightning arrestor contained in the antenna kit should be installed in accordance with the instructions. The mast used to mount the antenna should be provided with a direct ground.

INFORMATION REFERENCES—In short, a television receiving antenna and its installation must conform to much higher standards than an antenna for reception of International Short Wave and Standard Broadcast signals. For further information on antennas and antenna installation see the RCA Booklet entitled "Practical Television by RCA," and also the specific instructions accompanying the RCA Television Antenna.

It is advisable that the reader be familiar with a recent standard textbook of television principles in order to understand the receiver circuits and their functions. Such knowledge is assumed for the purpose of this publication. The discussions which follow will not dwell on the operation of conventional circuits used which have been used in previous receivers and which should be well known. In generdl, the circuits discussed will be only those that are new to the field.

For ease of understanding the basic operation of the television receiver, a 14 unit block diagram of it is shown in Figure 10. The circuit description will follow the numerical order of these blocks in order to follow a signal through the set in a logical manner.

R-F UNIT (block #1)—The r-f unit is a separate subchassis of the receiver. On this subchassis are the r-f amplifier, converter, oscillator, fine tuning control, channel switch, converter transformer, r-f, converter and oscillator coils and all their tuning adjustments. The unit provides operation on all thirteen of the present television channels. It functions to select the desired picture and sound carriers, amplifies and converts to provide at the converter plate, a picture i-f carrier frequency of 25.75 mc. and a sound i-f carrier of 21.25 mc.

R-F Amplifier—Referring to the schematic diagram (page 59), T1 is a center tapped coil used for the short circuiting of low frequency signals picked up by the antenna which would otherwise be directly applied to the control grids of the 6J6 r-f amplifier, V1. C1 and C2 are antenna isolating capacitors. The d-c return for the grids of V1 is through R3 and R13 which also serve to terminate the 300 ohm antenna transmission line. C3 and C4 are neutralizing capacitors necessary to counteract the grid to plate capacitance of the triode r-f amplifier.

In the plate circuit of the r-f amplifier are a series of inductances L1 to L25 and L2 to L26 inclusive. These inductances may be considered as a quarter wave section of a balanced transmission line which can be tuned over a band of frequencies by moving a shorting bar along the parallel conductors.

Adjustable coils 25 and L26 provide the correct length of line for the thirteenth channel, 210—216 mc. L13 to L23 and L14 to L24 are fixed sections of line which are added to L25 and L26 as the shorting bar is moved progressively down the line. The physical construction of each one of these inductances is a small non-adjustable silver strap between the switch contacts. Each strap is cut to represent a six-megacycle change in frequency. In order to make the jump between the lowest high frequency channel (174-180 mc) and the highest low frequency channel (82-88 mc), adjustable coils L11 and L12 are inserted. To provide for the remaining five low frequency channels, L1 to L9 and L2 to L10 are progressively switched in to add the necessary additional inductance.

Coils L1 to L9 and L2 to L10 are unusual in that they are wound in figure 8 fashion on fingers protruding from the switch wafer. This winding form produces a relatively noncritical coil since the coupling between turns is minimized. A maximum amount of wire is used for the small inductance which is required, thus permitting greater accuracy in manufacturing.

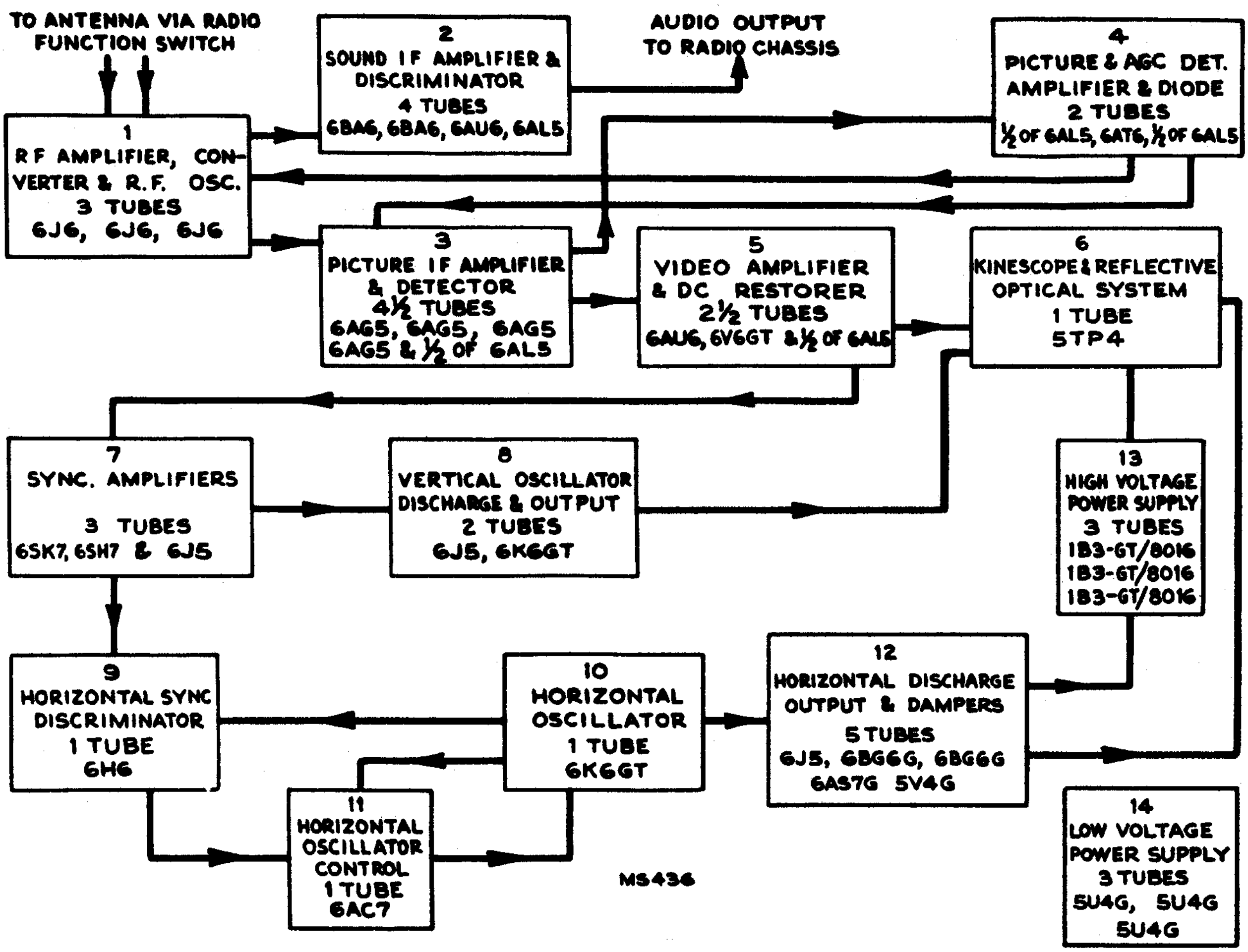


Figure 10—Television Receiver Block Diagram

Converter—The converter grid line operates in a similar manner and is so arranged on the switch to provide coupling between it and the r-f line. C10, C12, C13 and a link, provide additional coupling which is arranged to produce at least a 4.5 megacycle band pass on each of the channels.

L80 and C14 form a series resonant circuit used to prevent i-f feedback in the converter by grounding its grids for i-f frequency. They also act as a trap to reject short-wave signals of i-f frequency which arrive at the converter grids in a push push manner.

A 6J6 twin triode is used as converter. Since the grids are fed in push pull by both the signal and the oscillator, the heterodyne products (i-f signals) are in phase on the converter plates so the two plates are connected in parallel. Unwanted signals of i-f frequency that arrive at the converter grid in a push pull manner are out of phase on the converter plates. Since the plates are tied together, these signals tend to cancel thus reducing the possibility of interference from this source.

R-F Oscillator—The oscillator line is similar except that trimmer adjustments are provided for each channel and the low frequency coils are not figure 8 windings. For tuning each channel, brass screws are used in close proximity to the high frequency tuning straps L66 to L76, and adjustable brass cores are provided for coils L54 to L62. It is obvious that the high frequency adjustments should be made before each lower frequency one.

C15 is a fine tuning adjustment which provides approximately plus or minus 800 kc. variation of oscillator frequency on channel 1 and approximately plus or minus 1.9 mc. on channel 13.

The physical location of the oscillator line with respect to the converter grid line is such as to provide some coupling to the converter grids. This coupling is augmented by the link shown on the schematic and provides a reasonably uniform oscillator voltage at the converter grids over the entire tuning range of the unit.

The converter transformer T2 is a combination picture i-f transformer, sound trap, and sound i-f transformer. The converter plate coil is assembled within the structure of a high Q resonant circuit tuned to the sound i-f frequency. This high Q coil absorbs the sound i-f component from the primary. Thus on the T2 primary (from which the picture i-f is fed), the sound carrier is attenuated with relation to the picture channel.

SOUND I-F AMPLIFIER AND DISCRIMINATOR (block #2)—A portion of the energy absorbed by the T2 trap circuit is fed to the first sound i-f amplifier. Three stages of amplification are used to provide adequate sensitivity. A conventional discriminator is used to demodulate the signal. The discriminator band width is approximately 350 kc. between peaks.

The output from the discriminator is fed into the radio audio system and is controlled by the radio volume and tone controls.

PICTURE I-F AMPLIFIER AND DETECTOR (block #3)—The picture i-f amplifier departs considerably from the conventional coupled system. To obtain the necessary wide band characteristic with adequate gain, four stages of i-f amplification are employed. The converter plate and each successive i-f transformer utilize one tuned circuit each and each is tuned to a different frequency. The effective Q of each coil is fixed by the shunt plate load or grid resistor so that the response product of the total number of stages produces the desired overall responsive curve. Figure 11 shows the relative gains and selectivities of each coil and the shape of the curve of the quintuple combination.

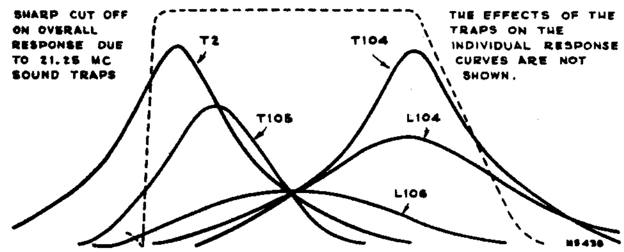


Figure 11—Stagger Tuned I-F Response

In order to obtain this band pass characteristic, the picture i-f transformers are tuned as follows:

Converter transformer	21.8 mc.	(T2 primary)
First pix i-f transformer	25.3 mc.	(T104 primary)
Second pix i-f transformer	22.3 mc.	(T105 primary)
Third pix i-f coil	25.2 mc.	(L104)
Fourth pix i-f coil	23.4 mc.	(L106)

In such a stagger tuned system variations of individual i-f amplifier tube gain do not affect the shape of the overall i-f response curve if the Q's and center frequencies of the stages remain unchanged. This means that the i-f amplifier tubes are non-critical in replacement because variations in Gm do not affect the response curve.

To align the i-f system, the transformers are peaked to the specified frequencies with a signal generator. The overall i-f response is then observed by use of a sweep generator and oscilloscope. Slight deviations from design center circuit Q are compensated for with slight shifts in tuned-circuit center frequency until the desired response curve is obtained. If this response cannot be obtained, the difficulty is likely to be in a component that affects either the frequency or Q of one or more of the i-f coils.

The response curve does shift slightly as the picture control is varied due to the Miller effect. This effect is the change in tube input capacitance as its gain is varied by grid bias changes. The change of input capacitance causes a slight detuning of the preceding i-f coil and a small shift in response curve shape. This effect is slight, however, and when the receiver is aligned with the specified grid bias, no difficulty from this source should be encountered.

For familiarization with the frequencies which are important in the receiver's operation, Figure 12 shows the relative position of the picture and sound carriers for channels 2, 3 and 4. If a station on channel 3 is transmitting a picture with video frequencies up to 4 mc., the picture carrier will have upper side band frequencies up to 65.25 mc. The lower side bands are suppressed at the transmitter.

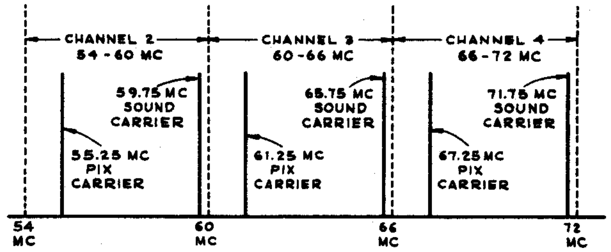


Figure 12—Television Channel Frequencies

With the receiver r-f oscillator operating at a higher frequency than the received channel, the i-f frequency relation of picture to sound carrier is reversed as shown in Figure 13.

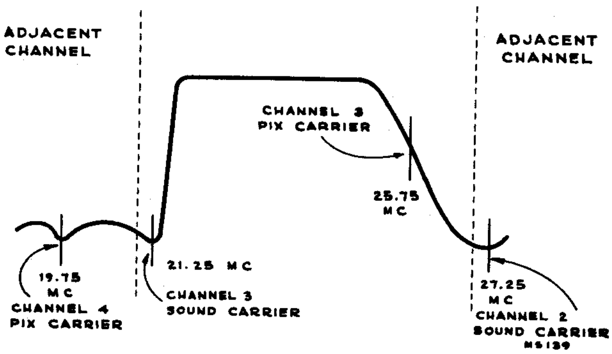


Figure 13—Overall Picture I-F Response

Traps—Since it is necessary for the picture i-f to pass frequencies quite close to the sound carrier frequency, the sound carrier would produce interference in the picture. In order to prevent this interference, traps must be added to the picture i-f amplifier to attenuate the sound carrier. If the receiver should be operating on channel 3, it is possible that interference would be experienced from the channel 2 sound carrier and the channel 4 picture carrier. The adjacent channel traps are provided to attenuate these unwanted frequencies.

The first three traps are absorption circuits. The first trap (T2 secondary) is tuned to the accompanying sound i-f frequency. The second trap (T104 secondary) is tuned to the adjacent channel sound frequency. The third trap (T105 secondary) is tuned to the adjacent channel picture carrier frequency. The fourth trap (T106 secondary) is in the cathode circuit of the fourth picture i-f amplifier V111 and is tuned to the accompanying sound carrier i-f frequency. The primary of T106 in series with C137 forms a series resonant circuit at the frequency to which L106 is tuned (23.4 mc.). This provides a low impedance in the cathode circuit at this frequency and permits the tube to operate with a gain. However, at the resonant frequency of the secondary (21.25 mc.), a high impedance is reflected into the cathode circuit, and the gain of the tube for this frequency is reduced by degeneration. The rejection at 21.25 mc. with this circuit is limited to the gain of the tube.

Picture Second Detector—The detector is a conventional half wave rectifier connected to produce a video signal of the proper polarity.

PICTURE A-G-C DETECTOR, AMPLIFIER AND DIODE (block #4)—An automatic gain control circuit is employed in connection with the picture i-f system to hold the output from the i-f's substantially constant over a wide range of signal inputs.

The a-g-c system of the picture i-f amplifier (shown in Figure 14) differs considerably from the a-v-c system used in broadcast receivers. In broadcast receivers, it is customary to use the filtered d-c drop across the diode resistor as the source of the a-v-c voltage. This is satisfactory, because the d-c voltage thus obtained is directly proportional to the average carrier amplitude at the diode. If it maintains the average carrier amplitude substantially constant, then the a-v-c operates as it should.

In the transmission of television pictures, however, the average carrier amplitude varies greatly with picture content, and an a-g-c system operating on the principle of maintaining a substantially uniform average carrier amplitude therefore is not suitable.

The RMA Standard Television Signal calls for a transmission system known as d-c negative transmission. Under this system, the carrier always reaches a uniform maximum amplitude during the periods when synchronizing pulses are being transmitted, and a white portion of the scene is represented by minimum or zero carrier condition. Thus, if there is no fading, the peaks of the synchronizing pulses will always represent some constant amplitude, and they, therefore, form a convenient reference for operating a satisfactory picture a-g-c system.

A portion of the output from the fourth i-f amplifier is fed into V105A, the a-g-c detector. Since the time constant of the diode load resistor and filter (R145 and C153) is somewhat greater than one horizontal line, the detector is essentially a peak reading voltmeter at sync frequency (15,750 cps). The d-c voltage that appears on the cathode of V105A is therefore proportional to the peak strength of the received signal and substantially independent of the picture content.

Such a system will also tend to read the peak of noise pulses. To prevent this, R151 and the diodes of V106 are used as a two-stage clipper or noise-limiting network. For further protection against noise, the d-c output is fed through an integrating network (R157 and C158) which tends to remove the effects due to random noise.

The d-c output from the integrator is less than that required to control the gain, and since it increases in the positive direction with increases in signal strength, it is necessary to amplify and "invert." To accomplish this, the output from the integrator is d-c coupled to the V106 a-g-c amplifier grid.

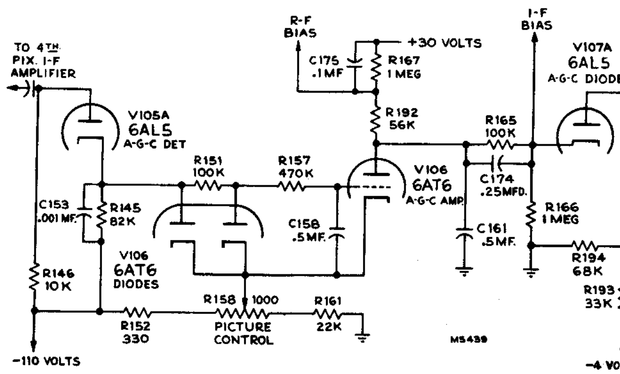


Figure 14—Picture A-G-C Circuit

V106 is operated with approximately minus one hundred and ten volts on the cathode and the plate at or slightly below ground potential. The voltage available from the plate is suitable for use as a control bias.

With a weak signal input, the bias on V106 (obtained across R152 and R158) is sufficient to cause the V106 plate current to be nearly cut off. The V106 plate is at approximately ground potential, no bias is applied to the r-f and i-f grids and the receiver operates at maximum gain. When a strong signal is applied to the receiver, the d-c output from the a-g-c detector opposes the fixed bias on V106 and causes more plate current to flow. As a consequence, the plate goes negative with respect to ground and this negative voltage is applied to the r-f and i-f grids reducing gain and maintaining constant output from the i-f system.

Since the grid control characteristic of the pentode i-f amplifiers is different from that of the triode r-f amplifier, different bias voltages are required and must be taken from different points in the system.

Also, in order to obtain the maximum signal to noise ratio from the receiver, it is desirable to allow the r-f amplifier to run essentially at full gain on any signal which will not cause overloading of the first i-f stage. The circuit arrangement of Figure 14 including the a-g-c diode (V107A) permits maximum use of r-f gain on weak signals and prevents overloading of the i-f amplifier on strong signals.

With an input signal of 1000 microvolts (and the picture control set for normal contrast) the V106 plate is at approx. −2 volts. Since the a-g-c diode plate is placed at approx. a −2.5 volt tap on the dividers R193 and R194, the diode does not conduct and the −2 volts on the V106 plate is applied to the i-f grids. With a signal of 10,000 microvolts, the a-g-c amplifier plate is at approx. −5 volts. Under this condition, the a-g-c diode conducts and due to the drop in R165, prevents the i-f bias from rising appreciably above approx. −3 volts. The r-f bias, however, is not limited and can therefore rise above the i-f bias.

This high value of bias on the r-f amplifier is necessary to reduce the triode nearly to cut-off. Although triodes are not generally considered to be remote cut-off tubes, sufficient curvature is present in the grid control characteristic to provide approximately a ten to one reduction in gain when the bias approaches the plate current cut-off point.

Figure 15 shows a graph of the r-f and i-f bias versus signal input.

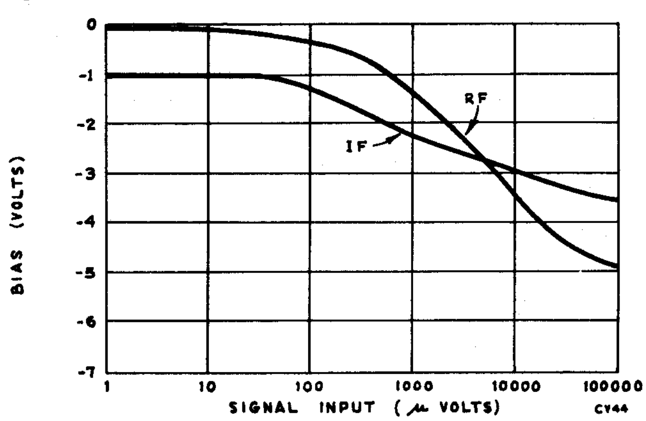


Figure 15—Bias versus Signal Input

Picture Control—A manual gain control is also provided since it is necessary to vary the picture contrast because of variations in room lighting, transmitting technique and to suit personal preference in picture balance. The control varies the i-f gain by varying the initial bias on the a-g-c amplifier which in turn varies the r-f and i-f bias.

VIDEO AMPLIFIER AND D-C RESTORER (block #5)—The function of this section of the receiver is to amplify the video output of the second detector. Two amplifier stages are employed. The gain from the first video grid to output plate is 30X and the frequency response extends to 4 mc.

The 648PTK is aligned to give a normal test pattern when receiving a signal from a station employing standard RMA vestigal side band transmission. If the station deviates from this transmission characteristic, then a properly aligned receiver may produce an output with an excessive amount of low frequency video causing the picture to smear.

The 648PTK provides a back panel Video Peaking Switch S101 to modify the video response to compensate for the above mentioned transmitter characteristic. S101 switches a 680 mmf. capacitor across the V113 cathode resistor, R176. This reduces the cathode degeneration for high frequencies and thus increases the high video response. Closing the switch for operation of the receiver on such a station will generally improve the good picture. However, if the receiver is then tuned to a station with proper side band suppression, transients may be produced on high contrast pictures such as test patterns. Therefore, it must be determined at the time of installation, if the video peaking switch S101 is to be open or closed

Noise Saturation Circuit—Since the synchronizing pulse is "blacker than black" and "black" information must drive the kinescope grid toward cut-off, the video signal polarity must be such that the sync is negative when applied to the kinescope grid. It is obvious that for the two-stage video amplifier used, the sync pulse from the second detector must also be negative at the first video amplifier grid. The first stage is designed so that with a normal signal input level at its grid, the tube will be working over most of its operating range. Any large noise signal above sync will drive the grid to cut-off and the noise will be limited. In effect, the signal to noise ratio is thus improved.

D-C Restorer—Since the video amplifier is an a-c amplifier, the d-c component of the video signal that represents the average illumination of the original scene will not be passed.

Unless this d-c component is restored, difficulty will be experienced in maintaining proper scene illumination For any given scene, this average illumination could be set properly by the brightness control. However, a change of scene would probably necessitate resetting this control. The d-c restorer accomplishes this setting automatically thus assuring proper picture illumination at all times. For a detailed explanation of the operation of the d-c restorer, see "Practical Television by RCA."

KINESCOPE AND REFLECTIVE OPTICAL SYSTEM (block #6) —The picture tube employed is a 5TP4, a five inch projection kinescope. The tube operates at approximately 27 kv and employs magnetic deflection and electrostatic focusing. The kinescope screen is backed by a microscopic aluminum film. This coating is porous to the electron stream. However, it is opaque to light and prevents radiation at the back of the screen from reducing picture contrast by illuminating dark areas of the picture. Instead, this light is reflected out the front of the screen thus increasing the picture brilliance by approximately two to one. The aluminum film also prevents a negative charge from building up on the screen. Such a charge tends to repel the electron beam thus reducing the velocity with which the beam strikes the screen with consequent reduction of light output. The aluminum coating provides some protection against screen burns produced by ions in the electron stream. The thick screen employed in high voltage kinescopes also prevents a burn on the back of the screen from being visible on the outer surface of the screen.

The reflective optical system is employed to project the image from the kinescope on to a large screen. The system consists of the kinescope mounted above and facing a spherical mirror. The spherical mirror reflects the light up through the corrector lens to a forty-five degree plane mirror which in turn reflects the image on to the back of a translucent screen, as shown in Figure 16.

The center section of the spherical mirror is painted black so that the illumination which falls on this sector will not be reflected back on to the face of the kinescope to reduce the picture contrast by illuminating dark areas of the picture.

Since a large spherical mirror by itself will not produce an in focus image, the corrector lens must be employed to bring the image to focus at all points on the screen. The spherical mirror and the forty-five degree mirror are front surfaced mirrors to prevent ghosts which would occur from reflections at the surface of the glass of a rear surfaced mirror.

The screen is composed of two lucite sheets with a partial diffusing layer between them. The back sheet has a fresnel lens molded into its rear surface. The front sheet has vertical ribs molded into its outer surface. The fresnel lens functions to concentrate the light into a narrow viewing angle. The vertical ribs act to increase the horizontal viewing angle above that obtained with a flat surface. The diffusing layer is employed to eliminate interference patterns between the fresnel lens and the vertical ribs. The screen and lens combination give a gain of approximately five over that which would be obtained from a ground glass type screen. This gain is obtained at the expense of the illumination at extreme side, upper or lower viewing angles. Since such extreme angles are impractical due to foreshortening of the picture, no disadvantage is achieved and the brilliance from practical viewing angles is increased.

The leads from the deflection yoke and the kinescope socket pass through the optical path directly above the corrector lens. However, due to the fact that the light from any given point on the kinescope passes through all points on the corrector lens, as shown in Figure 16, the leads do not cast a shadow on the picture, but instead reduce the optical efficiency of the system by a very slight amount proportional to the percentage of the corrector lens area blocked by the leads.

This reflective optical system has a resolution of approximately 1500 lines and an efficiency equivalent to an F.8 lens. Conventional projection optics of this speed for this size kinescope and screen would be prohibitive from the standpoint of cost and size.

The inside and outside of the flaring portion of the kinescope bulb are given a metallic coating. The inner coating, which is the second anode, is connected to the high voltage supply. The outer coating is grounded by means of two small springs on the deflection yoke support. The capacity between the two coatings is used as a high voltage filter capacitor.

The vertical axis of the optical barrel is approximately 7 degrees off vertical and the 45 degree mirror is in reality approximately 48 degrees from the horizontal as shown in Figure 16. This arrangement is employed in order to permit placing the barrel slightly forward of the mirror thus making the optical system as compact as possible.

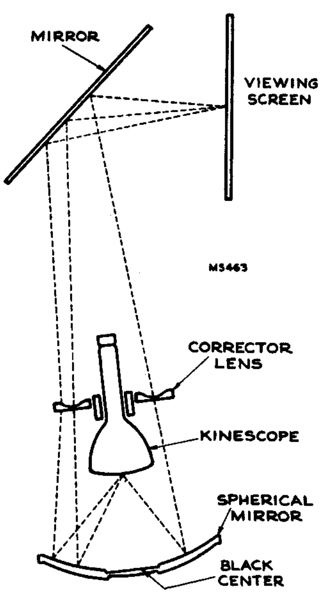


Figure 16—Reflective Optical System

SYNC AMPLIFIERS (block #7)—The function of this system is to amplify the sync signal and effect the separation of sync from the video.

First Sync Amplifier—The first sync amplifier V114 is a 6SK7 which has a remote cut-off characteristic. The signal from the d-c restorer is fed into this amplifier with the polarity such that the sync is in the negative direction. Noise pulses above sync that remain after the limiting action of the first video grid are thus further compressed and the sync to noise ratio is again improved.

Second Sync Amplifier—The sync at the grid of V115, the second sync amplifier grid is positive in polarity. The operating voltages applied to the grid, screen and plate, are such that the negative portion of the applied signal is cut off. Thus, the video and blanking pulses are removed and only the sync pulses appear at the plate.

Third Sync Amplifier—The sync pulses appearing at the third sync amplifier (V116), grid are negative in polarity and must be inverted before they can be injected into the sweep oscillators. The signal at the V116 grid is sufficient to drive the tube beyond cut-off and the signal is again clipped. This final clipping removes all amplitude variations between sync pulses due to noise, hum, etc., and it appears with the correct polarity at the plate.

Integrating Network—The purpose of this network is to separate the horizontal from the vertical sync and to pass the vertical to the vertical oscillator.

Since the horizontal sync pulse is of short duration (5 microseconds) and the vertical pulse is of much longer duration (190 microseconds), they can be separated by an r-c filter which is responsive to wave shape. The integrating network which is such a filter is composed of R142, R143, R144, C148, C149 and C150. In operation it can be considered to be a low-pass filter which by-passes the narrow or high frequency horizontal sync but passes the broad or low frequency vertical sync.

VERTICAL OSCILLATOR DISCHARGE AND OUTPUT (block #8)—The function of these circuits is to provide a sawtooth of current of the proper frequency and phase to perform the vertical scanning for the kinescope. To produce such a current in the vertical deflection coil, a somewhat differently shaped voltage wave is required.

Since the vertical trace is slow, requiring approximately 16,000 microseconds, and the vertical deflection coil inductance is small, approximately 50 millihenries, the majority of the voltage across the coil during trace is across its resistive component. In order to produce a linear change of current through a resistance, a linear change of voltage is necessary. Retrace, however, must be accomplished within the 666 microsecond vertical blanking time and therefore requires a much faster rate of change of current through the coil. During this time, the effect of the inductance of the coil becomes appreciable because of the required fast rate of change of current. It is therefore necessary to apply a large pulse of voltage across the coil in order to obtain rapid retrace. The composite waveform required to produce a sawtooth of current in the coil is a sawtooth of voltage with a sharp pulse as shown in Figure 17D. V117 and V118 supply such a voltage.

Vertical Oscillator and Discharge—A single 6J5 triode, V117, with its associated components form a blocking oscillator and discharge circuit. The wave form of the voltage at the control grid of this tube with respect to time, is a small, positive surge followed by a large negative drop which returns to the positive condition at a relatively slow rate as shown in Figure 17A. During the negative part of the cycle, the grid is beyond cut-off and the discharge capacitor, C160, charges through resistors R148 and R149. When the grid reaches a voltage that permits plate to cathode conduction, C160 discharges through T107 secondary and V117. The discharge current of C160 builds up a magnetic field in T107 that in turn induces a positive voltage at the grid of V117. This positive voltage on the V117 grid lowers the plate resistance of the tube and allows C160 to discharge more rapidly. This process builds up very rapidly until C160 is nearly discharged. The magnetic field in T107 then collapses and drives the V117 grid negative. The charge placed on C155 due to grid conduction during the positive pulse now holds the grid negative. As the charge on C155 leaks off through R155 and R156, the grid slowly becomes less negative and approaches the point which will allow plate to cathode conduction. Just before the conduction point is reached, the 60 cycle vertical synchronizing pulse from the integrating network is applied to the V117 grid. This pulse is sufficient to drive the tube to conduction and the process is repeated. In this manner, the incoming sync maintains control of vertical scanning.

On the plate of V117, a sawtooth of voltage appears due to the slow charging and rapid discharging of C160. A sharp negative pulse also occurs during the discharge period. See Figure 17B. This pulse appears because of the action of R164 and C160, an action which is known as peaking. When V117 is conducting, the plate voltage drops nearly to cathode potential. C160 discharges during this time. However, since the conduction time is short, C160 cannot be completely discharged due to the time constant of R164 in series with C160. When V117 becomes non-conducting, the plate voltage does not have to rise slowly from cathode potential but instead rises immediately to an appreciable value due to the charge that remains on C160. The plate voltage then slowly rises from this value as C160 charges through R148 and R149. Adjustment of the height control R149 varies the amplitude of the sawtooth voltage on V117 plate by controlling the rate at which C160 can charge.

The voltage present on the V117 plate is of the shape required to produce a sawtooth of current in the vertical deflection coil. It is now necessary to amplify it in a tube capable of supplying a sufficient amount of power.

Vertical Output—A 6K6GT is connected as a triode for the output stage, V118. The vertical output transformer T108 matches the resistance of the vertical deflection coils to the plate impedance of the 6K6GT.

Vertical Linearity Control—R175 is provided as a vertical sweep linearity control. Since the grid-voltage, plate-current curve of V118 is not a straight line over its entire range, the effect of adjustments of R175 is to produce slight variations in the shape of the sawtooth by shifting the operating point of the tube to different points along the curve.

Since the slope of the curve varies at these different points and thus varies the effective gain of the tube, it is apparent that adjustments of linearity affect picture height and that such adjustments must be accompanied by readjustments of the height control R149. Adjustments of the height control affect the shape of the sawtooth voltage on the V117 plate so that adjustments of height must be accompanied by readjustments of linearity.

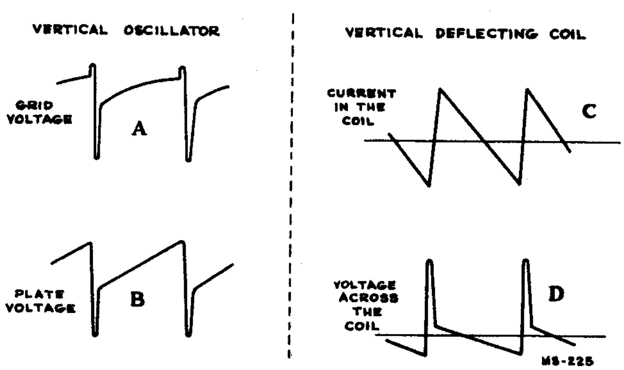


Figure 17—Vertical Sweep Waveforms

HORIZONTAL SYNC DISCRIMINATOR, HORIZONTAL OSCILLATOR AND OSCILLATOR CONTROL (block #9, 10 and 11) —These circuits are a radical departure from the conventional systems used for framing the picture in the horizontal direction. Their features are ease of operation, stability and good noise immunity.

HORIZONTAL OSCILLATOR (block #10)—The horizontal oscillator is an extremely stable Hartley oscillator operating at the scanning frequency 15,750 cps. The primary of T301 (terminals A, B and C) is the oscillator coil. This coil is closely coupled to the secondary winding (terminals D, E and F) and thus feeds a sine wave voltage to V301.

HORIZONTAL SYNC DISCRIMINATOR (block #9)—The sync discriminator, V301, is a 6H6 dual diode in a circuit which produces a d-c output voltage proportional to the phase displacement between the incoming sync pulses and the sine wave horizontal oscillator voltage.

The sine wave oscillator voltages applied to the plates of V301 are equal in amplitude and opposite in phase. The synchronizing pulses from the third sync amplifier are fed through a small capacitor (C301) to attenuate the vertical sync and then applied to the center tap of T301. The horizontal sync pulses thus appear in phase and of equal amplitude on the diode plates as shown in Figure 18. When the pulse and sine wave from the oscillator are properly phased as in (A), both diodes will produce equal voltage across their load resistances, R301 and R303. However, these voltages are of opposing polarity and therefore the sum of the voltages across these two load resistors will be zero If the phase of the sine wave changes with respect to the pulse as in (B), the top diode will produce more voltage across R301 than the bottom diode produces across R303. Thus, the voltage across the two will be positive. In (C) the reverse condition exists. It is obvious that the output of the discriminator can swing from positive through zero to negative dependent upon the phase relation of the synchronizing signal and the oscillator. This d-c output is applied to the grid of V303.

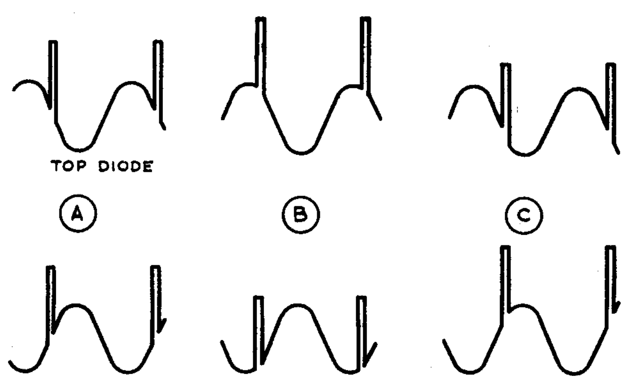


Figure 18—Sync Discriminator Waveforms

HORIZONTAL OSCILLATOR CONTROL (block #11)—V303 the oscillator control is a 6AC7 connected as a reactance tube across the V302 oscillator coil. A change in the d-c output of the sync discriminator produces a change in Gm of V303 which in turn changes the frequency of the oscillator. If the phase of the oscillator shifts with respect to the synchronizing pulse, the corresponding change in d-c from the sync discriminator causes the oscillator to be brought back into correct phase.

C304 and C306 form a voltage divider to attenuate rapid changes in d-c from the sync discriminator such as are produced by the vertical sync or bursts of noise.

Sync Link—If any phase modulation is present in the transmitted sync, a condition which unfortunately still exists in some transmitters to date, a faster response to fluctuations in the sync phase is needed than is provided by the ratio of C304 to C306.

The sync discriminator will demodulate sync phase variation quite faithfully, however, the filter resistor R305 together with the capacity attenuator, C304 and C306 is just as effective in removing this information as it is with respect to the noise disturbances for which it is intended. The removal of this information will produce a horizontal displacement of portions of the picture.

It may be necessary in some instances to sacrifice some noise immunity to compensate for phase modulation in the transmitted sync. By switching the link provided for this purpose, C303 is added across C304 and the speed of response is increased by several times. Therefore, the link of J304 should be connected between terminals 1 and 2 whenever this condition exists.

Before making this change, however, it should first be definitely determined that distortion of the raster is due to phase modulation of the sync. Horizontal "jitter" and distortion of the raster can be caused by operating the picture control at too great a gain setting considering the r-f signal input. Such a setting produces an excessive video signal at the first video amplifier grid. This stage is designed to limit an excessive input in order to improve the signal to noise ratio. If the video input is excessive, the sync is limited and thus removed. At the same time picture information may be introduced into the sync circuits. With extreme excesses of video level, both horizontal and vertical sync may be lost. If the receiver operating instructions on page 4 are followed, no difficulty should be experienced with the picture control setting.

HORIZONTAL DISCHARGE, OUTPUT AND DAMPERS (block #12)—The purpose of these circuits is to produce a sawtooth of current in the deflection coils to provide horizontal scanning for the kinescope.

Horizontal Discharge—A 6J5 is employed for the discharge tube V304. The function of this stage is to produce a sawtooth voltage for use in the horizontal sweep circuits.

The oscillation in V302 takes place between screen-grid and cathode. Since the peak to peak voltage on its grid is approximately 100 volts, a square wave of voltage is produced on its plate. This wave is differentiated by C312 and R314, and the pulse so obtained is applied to the grid of the discharge tube V304.

The discharge tube is normally cut off due to bias produced by grid rectification of these incoming pulses. The pulse from V302 overcomes this bias and drives the tube into heavy momentary conduction. During this period the plate voltage falls nearly to cathode potential and C318 discharges rapidly. Then when V304 again becomes non-conducting, the plate voltage rises slowly and approximately linearly as C318 charges through R316 and C315.

Horizontal Output and Dampers—The operation of these two circuits is so interconnected that it will be necessary to discuss them simultaneously. The function of the output tubes V305 and V306 is to supply sufficient current of the proper wave form to the horizontal deflection coils in order to provide horizontal scanning for the kinescope. The function of the damper tubes V310 and V311 is to stop oscillation of certain components at certain times and thus help provide a linear trace.

Other functions of these circuits include the utilization of energy stored in the horizontal-deflection coil to furnish retrace and kinescope high voltage. The damper circuit also recovers some of the energy from the yoke kickback and uses it to help supply the plate power requirements of the output tubes.

In operation, the visible portion of the horizontal trace is approximately 53 microseconds in duration. Although the inductance of the horizontal deflection coil is in the order of 8 millihenries, at the horizontal scanning frequency, the reactance of the coil predominates over its resistance. This is a different case than that encountered in the vertical deflection system and so a different method of operation must be employed.

Horizontal blanking is approximately 10 microseconds in duration. During this time, the kinescope beam must be returned to the left side of the tube, the trace started and made linear. To accomplish all this within the horizontal blanking time, only 7 microseconds can be allowed for the return trace. In order to obtain such rapid retrace, the horizontal deflection coil, output transformer and associated circuits are designed to resonate at a frequency such that one-half cycle of oscillation at this frequency will occur in the 7 microseconds retrace time limit. This represents a frequency of approximately 71 kc.

During the latter part of the horizontal trace, the output tubes conduct very heavily and build up a strong magnetic field in the deflection coil and output transformer. When the negative pulse from the horizontal discharge tube is applied to the output tube grids, their plate currents are suddenly cut off and the magnetic field in the transformer and deflection coil begins to collapse at a rate determined by the resonant frequency of the system. Actually the system is shock excited into oscillation. Since the output tubes are cut off and since the voltage generated by the collapsing field is negative on the damper tube plates so that they are non-conductive, there is essentially no load on the circuit and it oscillates vigorously for one-half cycle. If the damper tubes were not present, the circuit would continue to oscillate as shown in Figure 19 (C), curve 1. This condition however is not permitted. One-half cycle of oscillation is permitted because at the end of such a time the current in the deflection coil has reached a maximum in the opposite direction to which it was flowing at the end of the trace period. This reversal of the direction of flow of current is the requirement for retrace and it is accomplished in the allotted 7 microseconds.

Now that retrace has been completed, it is necessary to start the next trace. The energy which was placed in the deflection coil by the output tubes in the latter part of the last trace has not been dissipated. During the one-half cycle of oscillation, retrace was accomplished with very little loss of energy. The field in the coil was merely reversed in polarity. So at this point, a strong field exists in the deflection coil.

As mentioned previously if the coil were not damped, it would continue to oscillate at its natural frequency as shown in Figure 19 (C), curve 1. To prevent such an oscillation the damper tubes are brought into action. These tubes are effectively connected across the deflecting coil.

In the oscillating circuit, the current in the deflection coil lags the voltage by approximately 90 degrees (one-quarter cycle at oscillation frequency) and when the current has reached its maximum negative value, the voltage across the coil being 90 degrees ahead, has begun to swing positive. When the voltage on the damper plates becomes positive with respect to their cathodes, they begin to conduct heavily. This places such a load across the deflection coil that it cannot oscillate. Instead the field begins to decay at a rate permitted by the load which the damper tubes placed on the coil. The circuit constants are such that this decay is linear and at a rate suitable for the visible trace.

If no additional energy were fed into the coil the field would fall to zero and the kinescope beam would come to rest in the center of the tube. In such an r-l circuit, as the current approaches its final value, it does not do so linearly but asymptotically as indicated in Figure 19 (C), curve 2. It is therefore necessary to have the output tubes begin to supply power to the deflection coil before the energy in the coil is completely dissipated. Figure 19 (C), curve 3 shows the shape of the current supplied by the output tubes. Although the currents supplied by the output tubes and by the decaying field are curved at the cross over point, together they produce a coil current that is linear.

By the time the beam has reached the right side of the kinescope, the output tubes are conducting heavily and have built up a strong field in the transformer and coil. At this point, the output tubes are again suddenly cut off and the process is repeated.

The 6BG6G plate voltage is supplied through the 5V4G which is conducting over the major portion of the trace. Capacitor C324A is charged during this period and this charge is sufficient to supply the 6BG6G plates when the 5V4G is not conducting.

The charge is placed on this capacitor by the receiver d-c supply and by the current from the collapse of the field in the horizontal deflecting coil. The a-c axis of the sweep voltage is 475 volts above ground since the T302 secondary is connected to the receiver 475 volt bus. The charge placed on this capacitor by the coil kick-back is therefore in addition to that from the d-c supply and thus the capacitor is charged to a voltage greater than the d-c supply. This permits operation of the output tubes at a higher voltage than is obtainable from the receiver power supply and produces an increase in the system efficiency by salvaging energy that would otherwise have been wasted.

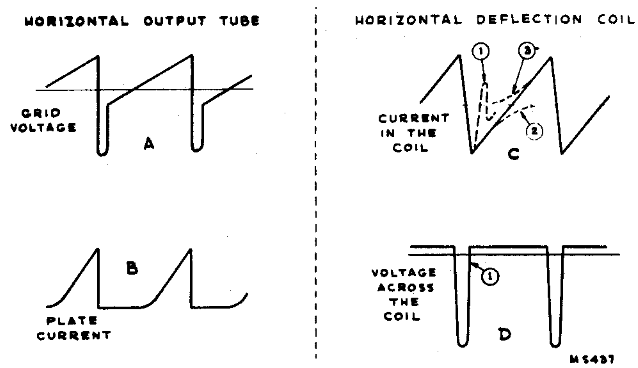


Figure 19—Horizontal Sweep Waveforms

Width Control—L302 is provided to vary the output and hence the picture width by shunting a portion of the T302 secondary winding. Clockwise rotation of the adjustment increases the picture width and causes the right side of the picture to stretch slightly.

Horizontal Drive Control—The horizontal drive control R340 varies the amount of high peaking on the grid of the horizontal output tubes and thus affects the point on the trace at which the tubes conduct. The negative pulse is applied to the sawtooth by feeding back a portion of the pulse from the secondary of the horizontal output transformer. Clockwise rotation of the control increases picture width, crowds the right side of the picture and stretches the left side.

Horizontal Linearity Control—In order to describe the action of the linearity control, some additional facts about damper circuits must be presented.

When two horizontal output tubes are employed as in the 648PTK, proper damping cannot be obtained by a single damper tube due to the heavy damping action required during the first quarter of the trace. V311 a 5V4G provides damping action over the entire trace. V310 a dual triode is employed to provide the extra damping action required during the first portion of the trace. When the voltage on the damper plate swings positive at the start of the trace, the differentiating network (C331, R350, and R351) in the grid circuit of V310 produces a positive pulse on the damper grid due to the steep wave front of the sweep voltage (shown in Figure 19 (D) at point 1. This positive pulse lowers the plate resistance of the triodes and permits heavy damping current to flow. Then due to the short time constant of the grid network, the positive pulse decays and the bias due to grid rectification of the pulses cuts the triode damper off, leaving the 5V4G to provide the damping for the remainder of the trace.

The horizontal linearity control R351 changes the time constant of the differentiation network in the 6AS7G grid circuit and determines the portion of the trace over which the tube conducts, thus controlling linearity on the left side of the picture. Counterclockwise rotation of the control causes the left side of the picture to stretch.

HIGH VOLTAGE POWER SUPPLY (block #13)—The kinescope high voltage supply is unusual in that the power is obtained from the energy stored in the deflection inductances during each horizontal scan. When the 6BG6G plate currents are cut off by the incoming signal, a positive pulse appears on the T302 primary due to the collapsing field in the deflection coil. This pulse of voltage is stepped up by the auto transformer action of T302 and applied to the plate of the high voltage rectifiers. At the same time, a negative pulse is applied to the cathodes of the rectifiers.

Three type 8016 tubes are employed in a voltage trippler circuit which produces approximately 27kv d-c for operation of the kinescope. The pulses are first rectified by V307 and charge capacitor C326 to near peak-to-peak voltage applied between the plate and cathode. Since the cathode of V307 is connected to the plate of V308 by resistors R342 and R343, capacitor C327 will charge to the same voltage as C326. The charge on C327 is thus added to the incoming pulse and V308 rectifies the sum of these voltages thus charging C328 to double the pulse voltage. The cathode of V308 is connected to the plate of V309 through R344 and R345 charging C329 to the same voltage as C328. The charge on C329 is added to the incoming pulse. V309 rectifies the incoming pulse and the d-c charge on C229 to charge C330 to three times pulse voltage.

In practice, due to a slight loss between stages and a small phase shift between the positive and negative pulses, the d-c output is approximately 2.8 rather than 3 times the applied pulse.

Since the frequency of the supply voltage is high (15,750 cps), relatively little filter capacity is necessary Since the filter capacity is small, the stored energy is small, and the high voltage supply is made less dangerous.

Corona rings are employed on the rectifier tube sockets, the high voltage capacitor lugs and on nearby sharp edges in order to prevent carona discharge.

LOW VOLTAGE POWER SUPPLY (block #15)—The low voltage power supply chassis contains two separate power supplies. One supply provides the filament and plate voltages for the r-f, i-f chassis and the other supply provides for the horizontal deflection chassis. This latter supply employs an interlock cable to the horizontal deflection chassis and a fuse in the power transformer primary to protect the supply in case of short circuits in the horizontal deflection chassis.

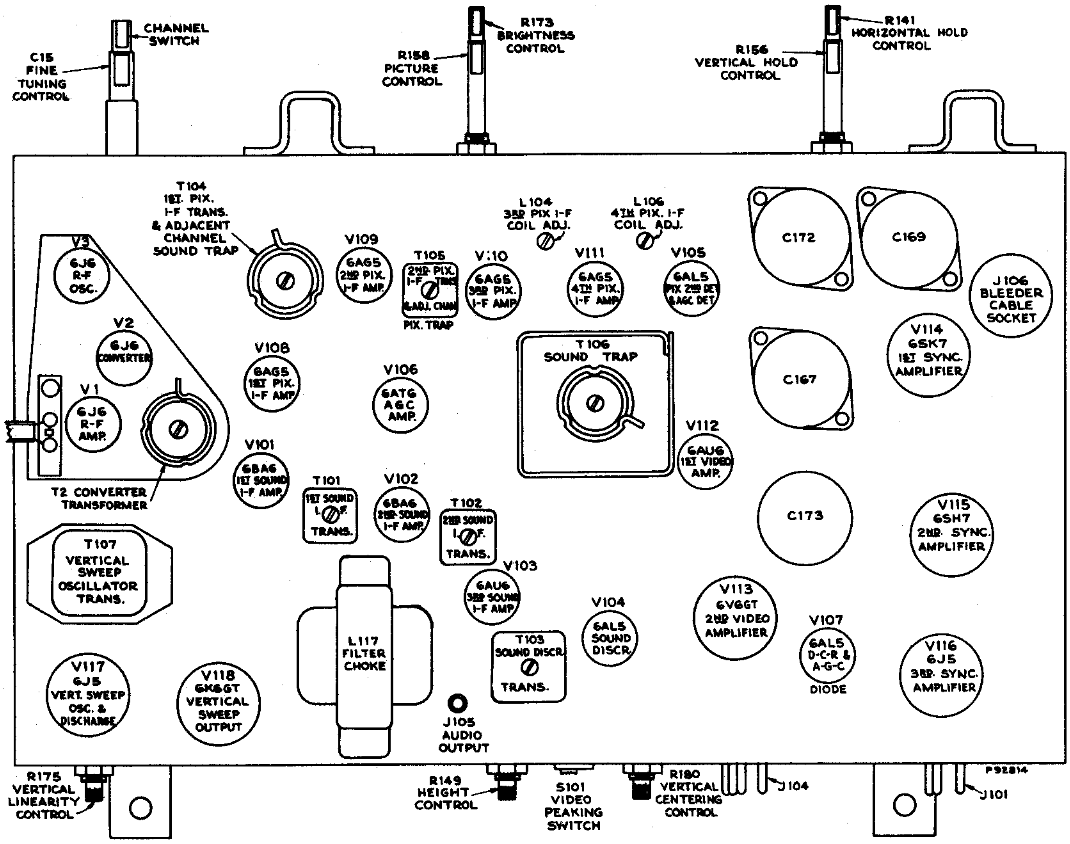


Figure 20—R-F, I-F Chassis Top View

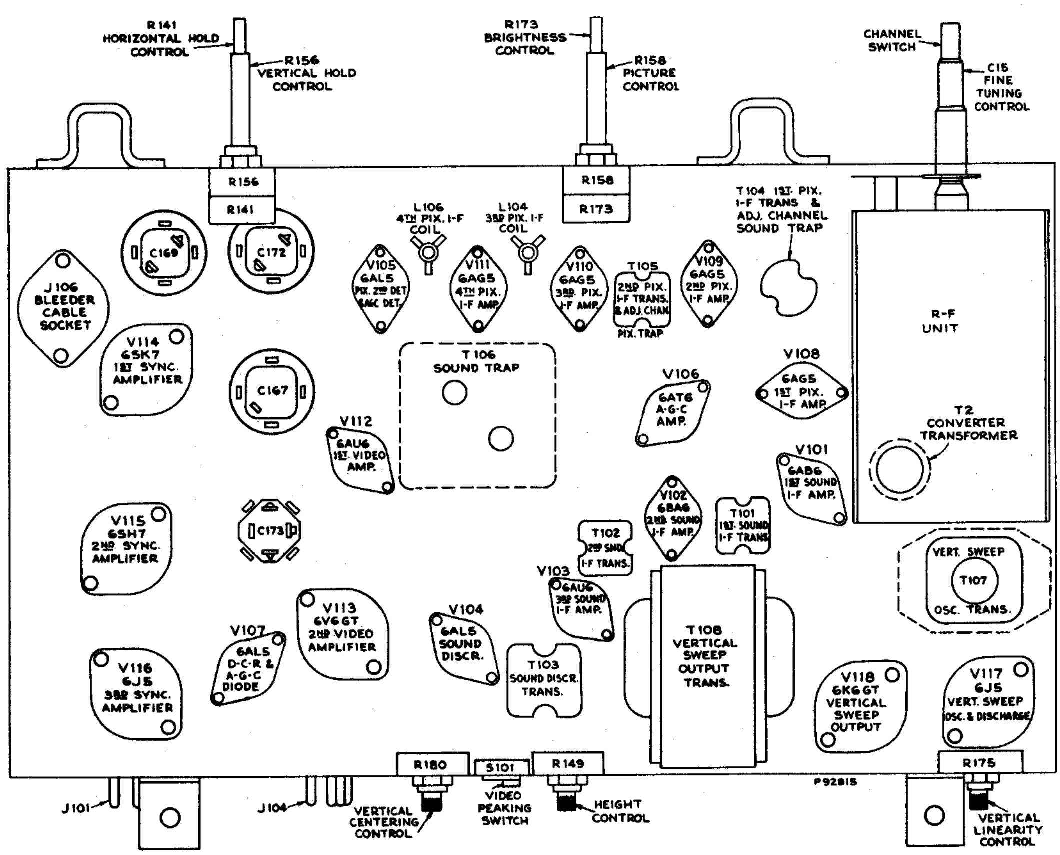


Figure 21—R-F, I-F Chassis Bottom View

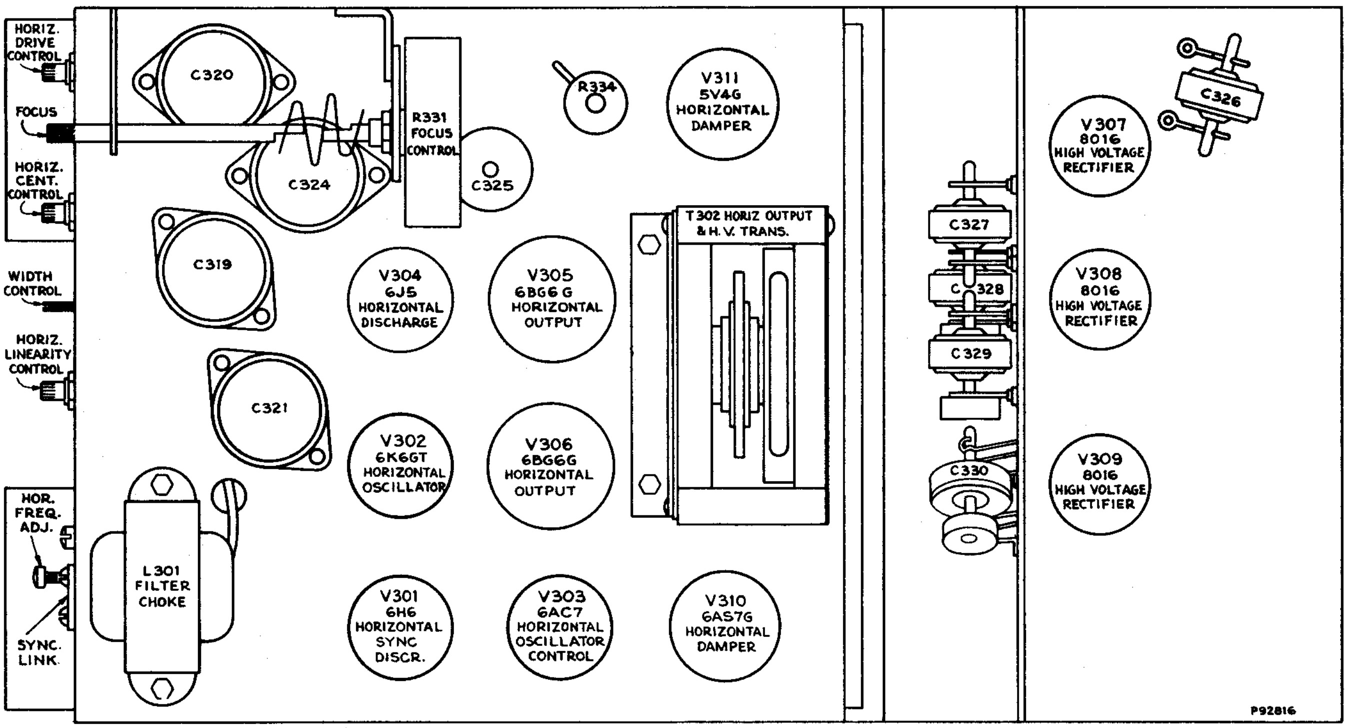


Figure 22—Horizontal Deflection Chassis Top View

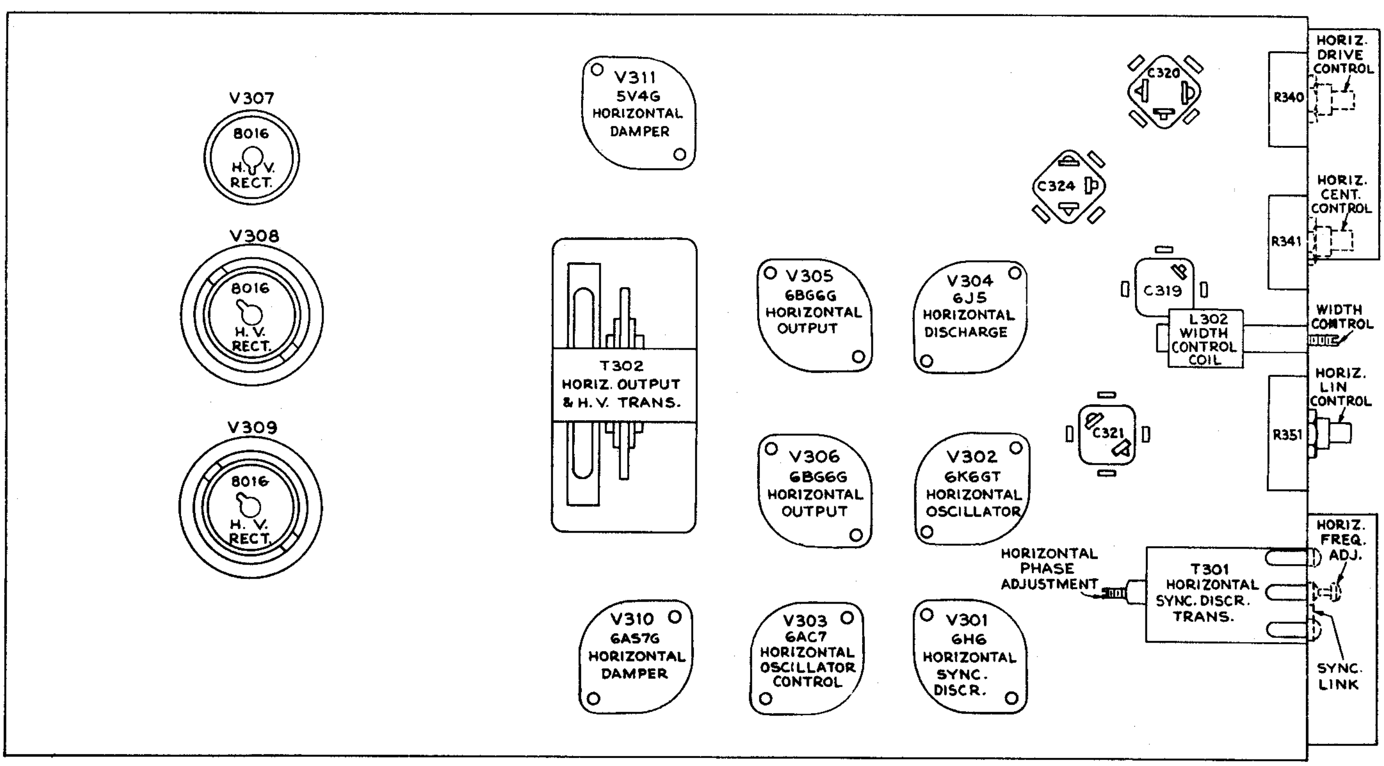


Figure 23—Horizontal Deflection Chassis Bottom View

TEST EQUIPMENT—To properly service the television chassis of this receiver, it is recommended that the following test equipment be available:

R-F Sweep Generator meeting the following requirements:

(a) Frequency Ranges

18 to 30 mc., 1 mc. sweep width
40 to 90 mc., 10 mc. sweep width
170 to 225 mc., 10 mc. sweep width

(b) Output adjustable with at least 1 volt maximum.

(c) Output constant on all ranges.

(d) "Flat" output on all attenuator positions.

Cathode-ray Oscilloscope, preferably one with a wide band vertical deflection, an input calibrating source, and a low capacity probe.

Signal Generator to provide the following frequencies.

(a) I-F frequencies

19.75 mc. adjacent channel picture trap
21.25 mc. sound i-f and sound traps
21.8 mc. converter transformer
22.3 mc. second picture i-f transformer
23.4 mc. fourth picture i-f coil
25.2 mc. third picture i-f coil
25.3 mc. first picture i-f transformer
25.75 mc. picture carrier
27.25 mc. adjacent channel sound trap

(b) R-F frequencies

Channel Number	Picture Carrier Freq. Mc.	Sound Carrier Freq. Mc.
1	45.25	49.75
2	55.25	59.75
3	61.25	65.75
4	67.25	71.75
5	77.25	81.75
6	83.25	87.75
7	175.25	179.75
8	181.25	185.75
9	187.25	191.75
10	193.25	197.75
11	199.25	203.75
12	205.25	209.75
13	211.25	215.75

(c) Output on these ranges should be adjustable and at least 1 volt maximum.

Heterodyne Frequency Meter with crystal calibrator if the signal generator is not crystal controlled.

Electronic Voltmeter of Junior "VoltOhmyst" type and a high voltage multiplier probe for use with this meter to permit measurements up to 30 kv.

NOTE: Since separate power supplies are used for the r-f, i-f chassis and the horizontal deflection chassis, it is possible to operate the r-f, i-f chassis with the horizontal deflection chassis disconnected and without materially affecting the d-c supply voltage. It is therefore possible to align the r-f, i-f chassis by connecting it alone to the power supply chassis. The vertical oscillator and vertical output tubes are inoperative under such conditions, however the operation of these tubes is unnecessary for alignment purposes.

By turning the chassis on end, all adjustments will be made conveniently available.

Adjustments Required—Normally, only the r-f oscillator line will require the attention of the service technician. All other circuits are either broad or very stable and hence will seldom require readjustment.

Due to the high frequencies at which the receiver operates the r-f oscillator line adjustment is critical and may be affected by a tube change. The line can be adjusted to proper frequency on channel 13 with practically any 6J6 tube in the oscillator socket. However, it may not then be possible to adjust the line to frequency on all of channels 7, 8, 9, 10, 11 and 12. To be satisfactory as an oscillator tube, it should be possible to adjust the line to proper frequency with the fine tuning control in the middle third of its range. It may therefore be necessary to select a tube for the oscillator socket. In replacing, if the old tube can be matched for frequency by trying several new ones, this practice is recommended. At best, however, it will probably be necessary to completely realign the oscillator line when changing the tube.

Tubes which cannot be used as oscillator will work satisfactorily as r-f amplifier or converter.

The detailed alignment procedure which follows is intended primarily as a discussion of the method used, precautions to be taken and the reasons for these precautions. Then, for more convenient reference during alignment, a tabulation of the method is given. All the information necessary for alignment is given in the table, however, alignment by the table should not be attempted before reading the detailed instructions.

ORDER OF ALIGNMENT—When a complete receiver alignment is necessary, it can be most conveniently performed in the following order:—

- Sound discriminator
- Sound i-f transformers
- Picture i-f traps
- Picture i-f transformers
- R-F and converter lines
- R-F oscillator line
- Converter grid trap
- Retouch picture i-f transformers
- Sensitivity check

SOUND DISCRIMINATOR ALIGNMENT—

Set the signal generator for approximately 1 volt output at 21.25 mc. and connect it to the third sound i-f grid.

Detune T103 secondary (bottom).

Set the "VoltOhmyst" on the 10 volt scale.

Connect the meter in series with a one megohm resistor to the junction of diode resistors R135 and R136. Keep the junction end lead of the resistor as short as possible and dress the test lead away from the i-f section in order to prevent oscillation.

Adjust the primary of T103 (top) for maximum output on the meter.

Connect the "VoltOhmyst" to the junction of R135 and C146.

Adjust T103 secondary (bottom). It will be found that it is possible to produce a positive or negative voltage on the meter dependent upon this adjustment. Obviously to pass from a positive to a negative voltage, the voltage must go through zero. T103 (bottom) should be adjusted so that the meter indicates zero output as the voltage swings from positive to negative. This point will be called discriminator zero output.

Connect the sweep oscillator to the grid of the third sound i-f amplifier.

Adjust the sweep band width to approximately 1 mc. with the center frequency at approximately 21.25 and with an output of approximately 1 volt.

Connect the oscilloscope to the junction of R135 and C146.

The pattern obtained should be similar to that shown in Figure 30A. If it is not, adjust the T103 (top) until the wave form is symmetrical.

The peak to peak bandwidth of the discriminator should be approximately 350 kc. and should be linear from 21.175 mc. to 21.325 mc.

SOUND I-F ALIGNMENT—

Connect the sweep oscillator to the second sound i-f amplifier grid.

Connect the oscilloscope to the third sound i-f grid return (terminal A T102) in series with a 33,000 ohm isolating resistor.

Insert a 21.25 mc. marker signal from the signal generator into the second sound i-f grid.

Adjust T102 (top and bottom) for maximum gain and symmetry about the 21.25 mc. marker. The pattern obtained should be similar to that shown in Figure 30B.

The output level from the sweep should be set to produce approximately .3 volt peak-to-peak at the third sound i-f grid return when the final touches on the above adjustment are made. It is necessary that the sweep output voltage should not exceed the specified values otherwise the response curve will be broadened, permitting slight misadjustment to pass unnoticed and possibly causing distortion on weak signals.

Connect the sweep and signal generator to the top end of the trap winding of T2 (on top of the chassis). Adjust T101 (top and bottom), for maximum gain and symmetry at 21.25 mc.

Reduce the sweep output for the final adjustments so that approximately .3 volt peak-to-peak is present at the third sound i-f grid return.

The band width at 70% response from the first sound i-f grid to the third i-f grid should be approximately 200 kc.

PICTURE I-F TRAP ADJUSTMENT—

Turn the receiver picture control fully clockwise.

Remove the 6AT6 a-g-c amplifier, V106.

Construct a bias box by shunting a 10,000 ohm potentiometer across a 4½ volt battery. Connect the positive terminal of the battery to the receiver chassis. Connect the arm of the potentiometer to pin 1 of V107. Adjust the potentiometer to provide –3 volts at its arm.

Set the channel switch to channel 13.

Connect the "VoltOhmyst" across the picture second detector load resistor R154.

Connect the output of the signal generator to the junction of L80 and R6. This connection is available on a terminal lug through a hole in the side apron of the chassis, beside the r-f unit. This hole is normally down when the chassis is in the recommended position. Connection can be easily made, however, by allowing the receiver to hang over the edge of the test bench by a few inches.

Set the generator to each of the following frequencies and tune the specified adjustment for minimum indication on the "VoltOhmyst." In each instance the generator should be checked against a crystal calibrator to insure that the generator is exactly on frequency.

21.25 mc.—T106 (top)
21.25 mc.—T2 (top)
27.25 mc.—T104 (top)
19.75 mc.—T105 (top)

PICTURE I-F TRANSFORMER ADJUSTMENTS—

Set the signal generator to each of the following frequencies and peak the specified adjustment for maximum indication on the "VoltOhmyst."

21.8 mc.—T2 (bottom)
25.3 mc.—T104 (bottom)
22.3 mc.—T105 (bottom)
25.2 mc.—L104 (top of chassis)
23.4 mc.—L106 (top of chassis)

If T105 (bottom) required adjustment, it will be necessary to reset T105 (top) for minimum response at 19.75 mc.

Picture I-F Oscillation—**If the receiver is badly misaligned and two or more of the i-f transformers are tuned to the same frequency, the receiver may fall into i-f oscillation. I-F oscillation shows up as a d-c voltage in excess of 3 volts at the picture detector load resistor. This voltage is unaffected by r-f signal input and sometimes is independent of picture control setting.**

If such a condition is encountered, it is sometimes possible to stop oscillation by adjusting the transformers approximately to frequency by setting the adjustment stud extensions of T2, T104, T105, T106, L104, and L106 to be approximately equal to those of another receiver known to be in proper alignment. If this does not have the desired effect, it may now be possible to stop oscillation by increasing the grid bias. If so, it should then be possible to align the transformers by the usual method. Once aligned in this manner, the i-f should be stable with reduced bias.

If the oscillation cannot be stopped in the above manner, shunt the grids of the first three i-f amplifiers to ground with 1000 mmf. capacitors.

Connect the signal generator to the fourth i-f grid and adjust L106 to frequency.

Remove the shunting capacitor from the third i-f grid, connect the signal generator to this grid and align L104.

Remove the shunting capacitor from the second i-f grid, connect the signal generator and align T105.

Remove the shunt from the first i-f grid, connect the signal generator and align T104 to frequency.

Connect the signal generator to the junction of L80 and R6 and align T2 to frequency.

If this does not stop the oscillation, the difficulty is not due to i-f misalignment as the i-f section is very stable when properly aligned. Check all i-f by-pass condensers, transformer shunting resistors, tubes, socket voltages, etc.

R-F AND CONVERTER LINE ADJUSTMENT—

Connect the r-f sweep oscillator to the receiver antenna terminals. If the sweep oscillator has a 50 ohm single-ended output, it will be necessary to obtain balanced output by connecting as shown in Figure 24.

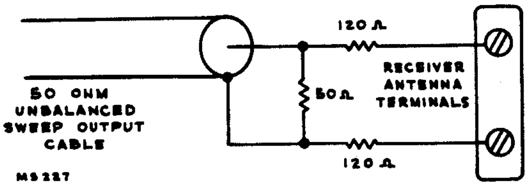


Figure 24—Unbalanced Sweep Cable Termination

Connect the oscilloscope to the junction of L80 and R6 (in the r-f tuning unit) through a 10,000 ohm resistor.

By-pass the first picture i-f grid to ground through a 1000 mmfd. capacitor. **Keep the leads to this by-pass as short as possible. If this is not done, lead resonance may fall in the r-f range and cause an incorrect picture of the r-f response.**

Turn the picture control fully clockwise. Connect the positive terminal of the bias box to the receiver chassis and the arm to pin 1 of V107. Set the potentiometer for –3 volts at its arm.

Connect the signal generator loosely to the receiver antenna terminals.

In most receivers C14 is fixed. However, if C14 is variable, set the C14 adjustment screw to its approximate normal operating position, 1½ turns out from maximum capacity. If the C14 capacity is less than this it may produce a resonance in channel 1, 2 or 3. During r-f alignment, such a resonance may show up as a "suck out" in the response curve of one of these channels. Under such conditions it will be impossible to obtain the proper response. With C14 set as specified or in receivers in which C14 is fixed, no such difficulty should be experienced.

Since channel 7 has the narrowest response of any of the high frequency channels, it should be adjusted first.

Set the receiver channel switch to channel 7 (see Figure 29 for switch shaft flat location versus channel).

Set the sweep oscillator to cover channel 7.

Insert markers of channel 7 picture carrier and sound carrier 175.25 mc. and 179.75 mc.

Adjust L25, L26, L51 and L52 (see Figure 31) for an approximately flat topped response curve located symmetrically between the markers. Normally this curve appears somewhat overcoupled or double humped with a 10 or 15% peak to valley excursion and the markers occur at approximately 90% response. See Figure 31, channel 7. In making these adjustments, the stud extension of all cores should be kept approximately equal.

Check the response of channels 8 through 13 by switching the receiver channel switch, sweep oscillator and marker oscillator to each of these channels and observe the response obtained. See Figure 31 for typical response curves. It should be found that all these channels have the proper shaped response with the markers above 70% response. If the markers do not fall within this requirement on one or more high frequency channels, since there are no individual channel adjustments, it will be necessary to readjust L25, L26, L51 and L52, and possibly compromise some channel slightly in order to get the markers up on other channels. Normally however, no difficulty of this type should be experienced since the higher frequency channels become comparatively broad and the markers easily fall within the required range.

Channel 6 is next aligned in the same manner.

Set the receiver to channel 6.

Set the sweep oscillator to cover channel 6.

Set the marker oscillator to channel 6 picture and sound carrier frequencies.

Adjust L11, L12, L37 and L38, for an approximately flat-topped response curve located symmetrically between the markers.

Check channels 5 down through channel 1 by switching the receiver, sweep oscillator and marker oscillator to each channel and observing the response obtained. In all cases, the markers should be above the 70% response point. If this is not the case, L11, L12, L37 and L38 should be retouched. On final adjustment, all channels must be within the 70% specification.

Coupling between r-f and converter lines is augmented by a link between L12 and L37. This link is adjusted in the factory and should not require adjustment in the field. On channel 6 with the link in the minimum coupling position, the response is slightly overcoupled with approximately a 10% excursion from peak-to-valley. With the coupling at maximum, the response is somewhat broader and the peak-to-valley excursion is approximately 40%. The amount of coupling permissible is limited by the peak-to-valley excursion which should not be greater than 30% on any channel.

R-F OSCILLATOR LINE ADJUSTMENT—

The r-f oscillator line may be aligned by adjusting it to beat with a crystal calibrated heterodyne frequency meter, or by feeding a signal into the receiver at the r-f sound carrier frequency and adjusting the oscillator for zero output from the sound discriminator. In this latter case the sound discriminator must first have been aligned to exact frequency. Either method of adjustment will produce the same results. The method used will depend upon the type of test equipment available.

The heterodyne frequency meter is the more universal method since it is applicable to all types of receivers. However, it requires a great many calibration points since receivers with different i-f frequencies employ different oscillator frequencies and hence different calibration points on the frequency meter. This may result in confusion and errors in adjustment.

Since all sets must receive the same stations, the r-f sound carrier frequencies remain the same, regardless of i-f frequency. By use of this method, only one set of calibrating points is necessary. If these frequencies are crystal controlled, this method of alignment becomes very fast and with a minimum chance for error. However, this method is applicable only on receivers that use a sound discriminator, or other type of sound detector that has a definite and measurable characteristic at center frequency. This method cannot be easily employed on receivers that employ a slope type detector.

Regardless of which method of oscillator alignment is used, the frequency standard must be crystal controlled or calibrated.

If the receiver oscillator is to be adjusted by the heterodyne frequency meter method, the following calibration points must be established for the 648PTK.

Channel Number	Receiver R-F Osc. Freq. Mc.
1	71
2	81
3	87
4	93
5	103
6	109
7	201
8	207
9	213
10	219
11	225
12	231
13	237

If the receiver oscillator is adjusted by feeding in the r-f sound carrier frequency, the following signals must be available.

Channel Number	R-F Sound Carrier Freq. Mc.
1	49.75
2	59.75
3	65.75
4	71.75
5	81.75
6	87.75
7	179.75
8	185.75
9	191.75
10	197.75
11	203.75
12	209.75
13	215.75

If the heterodyne frequency meter method is used, couple the meter probe loosely to the receiver oscillator.

If the r-f sound carrier method is used, connect the "Volt-Ohmyst" to the sound discriminator output (junction of R135 and C146).

Connect the signal generator to the receiver antenna terminals.

The order of alignment remains the same regardless of which method is used.

Since lower frequencies are obtained by adding steps of inductance, it is necessary to align channel 13 first and continue in reverse numerical order.

Set the receiver channel switch to channel 13.

Adjust the frequency standard to the correct frequency (237 mc. for heterodyne frequency meter or 215.75 mc. for the signal generator).

Set the fine tuning control to the middle of its range while making the adjustment.

Adjust L77 and L78 for an audible beat on the heterodyne frequency meter or zero voltage from sound discriminator. The core stud extensions should be maintained equal by visual inspection except as discussed in the following paragraph entitled Oscillator Pulling.

Switch the receiver to channel 12.

Set the frequency standard to the proper frequency as listed in the alignment table.

Adjust L76 for indications as above.

Adjust the oscillator to frequency on all channels by switching the receiver and the frequency standard to each channel and adjusting the appropriate oscillator trimmer for the specified indication. It should be possible to adjust the oscillator to the correct frequency on all channels with the fine tuning control in the middle third of its range.

After the oscillator has been set on all channels, start back at channel 13 and recheck to make sure that all adjustments are correct.

Oscillator Pulling—If in setting the low frequency channels, the high frequency channels are pulled noticeably off frequency, or if it is impossible to set channels 10, 11 or 12 within the range of their respective trimmers, it may be due to interaction between sections of the line. A quick check can be made to determine if this is the case.

The shorting section of the r-f oscillator channel switch, (rotor), should be at ground r-f potential. If this is not the case due to dissymmetry in the circuit, the shorting section may be somewhat above ground. Since at these high frequencies, even the length of the shorting bar represents an appreciable portion of a wave length, the lower frequency section is effectively tapped up on the high frequency section and reflects reactance into it. This reactance varies with low frequency channel oscillator adjustments thus causing a shift in oscillator frequency on the upper channels. One way to cure this difficulty is to adjust the shorting switch to ground potential. This can be accomplished by staggering L77 and L78 until this condition is achieved.

To find if dissymmetry exists, remove the bottom cover from the r-f unit.

Set the channel switch to channel 10.

Disconnect any input from the receiver.

Connect the "VoltOhmyst" to R6 through the hole in the side of chassis, and measure the oscillator injection into the converter grid.

Take an insulated metal prod and touch the center of the oscillator rotor shorting bar. If the meter reading changes, it indicates that the bar is not at r-f ground.

To balance the line, switch to channel 13 and stagger the cores for one or more turns (usually L78 out and L77 in). The final adjustment must leave the oscillator on correct channel 13 frequency.

Switch back to channel 10 and touch the switch rotor as before. As before, meter movement indicates unbalance.

For fine balancing touch the switch contacts for channel 10. When balanced, the meter will show equal reduction for both contacts. Continue staggering the cores until balance is obtained.

Repeat the oscillator adjustments for all channels.

In later production receivers, several r-f oscillator coil changes were made and a capacitor C19 was added to minimize the oscillator pulling effect. In receivers in which C19 is present the staggering of cores should not be necessary.

CONVERTER GRID TRAP ADJUSTMENT—

Connect the sweep generator to the receiver antenna terminals. Observe the precaution for single-ended output generators mentioned in the r-f alignment section.

Connect the oscilloscope to R6 through 10,000 ohms.

Shunt the first picture i-f grid to ground with a 1,000 mmf. capacitor, keeping the leads as short as possible.

Couple the signal generator loosely to the receiver antenna terminals.

Switch the channel switch and signal generator through the low frequency channels and observe the response on each range.

Select a channel which is essentially flat over the operating range with the sound and picture carrier markers at 90% or higher on the response curve.

Remove the capacitor from the first picture i-f grid and shunt it from the second picture i-f grid to ground.

Adjust C14 for an r-f response curve similar to the one obtained with the first picture i-f grid shunted. See Figure 32.

In most receivers, C14 is fixed and obviously this adjustment cannot be made on those sets. In such receivers, this step should be followed as a check to assure that proper converter operation is obtained.

RETOUCHING OF PICTURE I-F ADJUSTMENTS—

The picture i-f response curve varies somewhat with change of bias and for this reason it should be aligned with approximately the same signal input as it will receive in operation.

If the receiver is located at the edge of the service area, it should be aligned with approximately −1 volt i-f grid bias. However, for normal conditions, (signals of 1000 microvolts or greater), it is recommended that the picture i-f be aligned with a grid bias of −3 volts.

Connect the r-f sweep generator to the receiver antenna terminals.

Connect the signal generator to the antenna terminals and feed in the 25.75 mc i-f picture carrier marker and a 22.3 mc. marker.

Connect the oscilloscope across the picture detector load resistor.

Remove the shunting capacitor from the second picture i-f grid.

Turn the picture control fully clockwise. Connect the bias box and set the potentiometer for −3 volts at its arm.

Set the sweep output to produce approximately .3 volt peak-to-peak across the picture detector load resistor.

Observe and analyze the response curve obtained. The response will not be ideal and the i-f adjustments must be retouched in order to obtain the desired curve. See Figure 33.

If for example as in Figure 33A the response is peaked in the middle, and the picture carrier is low on the response curve slope, then the high Q transformer T104, (which is peaked at 25.3 mc.—near the picture carrier 25.75 mc.), should be retouched to bring the picture carrier response up to approximately 40%.

It will then probably be found that the response is generally high on the low frequency end of the curve as in Figure 33B. If this is the case, adjust L104, (25.2 mc. and fairly broad), to bring the high frequency end response up and the low frequency response down. The picture carrier is thus brought still further up the slope and an approximately flat topped response curve is obtained as in Figure 33C.

If T105 (bottom) required any adjustment, it will be necessary to reset T105 (top) for minimum response at 19.75 mc.

On final adjustment the picture carrier marker must be at approximately 50% response. The curve must be approximately flat topped and with the 22.3 mc. marker at approximately 100% response.

The most important consideration in making the i-f adjustments is to get the picture carrier at the 50% response point.

If the picture carrier operates too low on the response curve, loss of low frequency video response, of picture brilliance, of blanking, and of sync may occur. If the picture carrier operates too high on the response curve, the picture definition is impaired by loss of high frequency video response.

The above example is used to show the line of reasoning involved in making the retouching adjustments. Since there are five tuned circuits each aligned to a different frequency, it is obvious that many different conditions can exist, however, similar reasoning will apply to each case. With some experience in making these adjustments, it will be found that the desired response can be readily obtained. In making these adjustments, care should be taken that no two transformers are tuned to the same frequency as i-f oscillation may result.

Replace the 6AT6 a-g-c amplifier, V106.

SENSITIVITY CHECK—A comparative sensitivity check can be made by operating the receiver on a weak signal from a television station and comparing the picture and sound obtained to that obtained on other receivers under the same conditions.

This weak signal can be obtained by connecting the shop antenna to the receiver through an attenuator pad of the type shown in Figure 25. The number of stages in the pad depends upon the signal strength available at the antenna. A sufficient number of stages should be inserted so that a somewhat less than normal contrast picture is obtained when the picture control is at the maximum clockwise position.

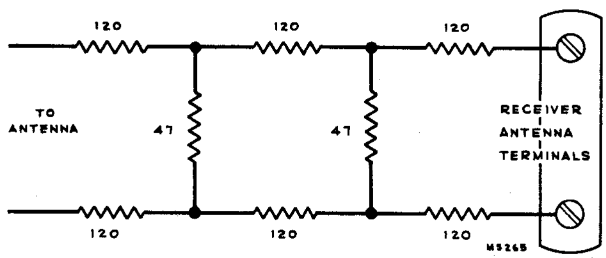


Figure 25—Attenuator Pad

Only carbon type resistors should be used to construct the attenuator pad. Since many of the low value moulded resistors generally available are of wire wound construction, it is advisable to break and examine one of each type of resistor used in order to determine its construction.

RESPONSE CURVES—The response curves shown on page 30 and referred to throughout the alignment procedure were taken from a production set. Although these curves are typical, some variations can be expected. Channel 2 response (not shown) is similar to that of channel 3.

The response curves are shown in the classical manner of presentation, that is with "response up" and low frequency to the left. The manner in which they will be seen in a given test set-up will depend upon the characteristics of the oscilloscope and the sweep generator. The curves may be seen inverted and/or switched from left to right depending on the deflection polarity of the oscilloscope and the phasing of the sweep generator.

ALIGNMENT TABLE—Both methods of oscillator alignment are presented in the alignment table. The service technician may thereby choose the method to suit his test equipment. If it is found that the dual listing is confusing, the unwanted listing can be easily erased.

TELEVISION ALIGNMENT TABLE

THE DETAILED ALIGNMENT PROCEDURE BEGINNING ON PAGE 22 SHOULD BE READ BEFORE ALIGNMENT BY USE OF THE TABLE IS ATTEMPTED.

STEP No.	CONNECT SIGNAL GENERATOR TO	SIGNAL GEN. FREQ. MC.	CONNECT SWEEP GENERATOR TO	SWEEP GEN. FREQ. MC.	CONNECT OSCILLOSCOPE TO	CONNECT "VOLTOHMYST" TO	MISCELLANEOUS CONNECTIONS AND INSTRUCTIONS	ADJUST	REFER TO
DISCRIMINATOR AND SOUND I-F ALIGNMENT									
1	3rd sound i-f grid (pin 1, V103)	21.25 1 volt output	Not used		Not used	In series with 1 meg. to junction of R135 & R136		Detune T103 (bottom). Adjust T103 (top) for max. on meter	Fig. 28 Fig. 27 Fig. 26
2	"	"	"		"	Junct of R135 & C146	Meter on 3 volt scale	T103 (bottom) for zero on meter	Fig. 28 Fig. 27
3	"	"	3rd sound i-f grid (pin 1, V103)	21.25 center 1 mc. wide 1 v. out	Junct of R135 & C146	Not used	Check for symmetrical response waveform (positive & negative). If not equal adjust T103 (top) until they are equal		Fig. 28 Fig. 30 A
4	2nd sound i-f grid (pin 1, V102)	21.25 reduced output	2nd sound i-f grid	21.25 reduced output	Terminal A, T102 in series with 33,000 ohms	"	Sweep output reduced to provide .3 volt p-to-p on scope	T102 (top & bottom) for max. gain and symmetry at 21.25 mc.	Fig. 28 Fig. 26 Fig. 27 Fig. 30 B
5	Trap winding on T2 (top of chassis)	21.25 reduced output	Trap winding on T2	21.25 reduced output	"	"	"	T101 (top & bottom) for max. gain and symmetry at 21.25 mc.	Fig. 26 Fig. 27 Fig. 28 Fig. 30 B
PICTURE I-F AND TRAP ADJUSTMENT									
6	Not used		Not used		Not used	Pin 1 V107	Remove V106. Connect bias box + to gnd − to Pin 1 V107 socket.	Picture control max, Bias box −3 volts.	Fig. 28
7	Junction L80 and R6	21.25	"		"	Junction of L109 & R154	Meter on 3 volt scale. Receiver on channel 13	T106 (top) for min. on meter	Fig. 26
8	"	21.25	"		"	"	"	T2 (top) for min.	Fig. 28 Fig. 26
9	"	27.25	"		"	"	"	T104 (top) for min.	"
10	"	19.75	"		"	"	"	T105 (top) for min.	Fig. 26
11	"	21.8	"		"	"	"	T2 (bottom) for max.	Fig. 27
12	"	25.3	"		"	"	"	T104 (bottom) for max.	"
13	"	22.3	"		"	"	"	T105 (bottom) for max.	"
14	"	25.2	"		"	"	"	L104 (top chassis) for max.	Fig. 26
15	"	23.4	"		"	"	"	L106 (top chassis) for max.	"
16	If T105 (bottom) required adjustment in step 13, repeat step 10.								
R-F AND CONVERTER LINE ALIGNMENT									
17	Not used		Not used		Not used		Set C14 1½ turns out from max. cap.	Picture control max, Bias box −3 volts.	Fig. 28 Fig. 27
18	Antenna terminal (loosely)	175.25 & 179.75	Antenna terminals (see text for precaution)	Sweeping channel 7	Junction L80 and R6 through 10,000 ohm series resistor	Not used	1st i-f grid bypass to gnd. with 1000 mmf. Receiver on channel 7	L25, L26, L51 & L52 for approx. flat top response between markers. Markers above 70%	Fig. 28 Fig. 27 Fig. 31 (7)
19	"	181.25 185.75	"	channel 8	"	"	Receiver on channel 8	Check to see that response is as above	Fig. 31 (8)
20	"	187.25 191.75	"	channel 9	"	"	Receiver on channel 9	"	Fig. 31 (9)
21	"	193.25 197.75	"	channel 10	"	"	Receiver on channel 10	"	Fig. 31 (10)
22	"	199.25 203.75	"	channel 11	"	"	Receiver on channel 11	"	Fig. 31 (11)
23	"	205.25 209.75	"	channel 12	"	"	Receiver on channel 12	"	Fig. 31 (12)
24	"	211.25 215.75	"	channel 13	"	"	Receiver on channel 13	"	Fig. 31 (13)
25	If the response on any channel (steps 19 through 24) is below 70% at either marker, switch to that channel and adjust L25, L26, L51 & L52 to pull response up on that channel. Then recheck steps 18 through 24.								

STEP No.	CONNECT SIGNAL GENERATOR TO	SIGNAL GEN. FREQ. MC.	CONNECT SWEEP GENERATOR TO	SWEEP GEN. FREQ. MC.	CONNECT OSCILLOSCOPE TO	CONNECT "VOLTOHMYST" TO	MISCELLANEOUS CONNECTIONS AND INSTRUCTIONS	ADJUST	REFER TO
					R-F AND CONVERTER LINE ALIGNMENT (Cont'd)				
26	Antenna terminal (loosely)	83.25 87.75	Antenna terminals (see text for precaution)	Sweeping channel 6	Junction L80 and R6 through 10,000 ohm series resistor	Not used	Receiver on channel 6	L11, L12, L37 & L38 for response as above	Fig. 31 (6)
27	"	77.25 81.75	"	channel 5	"	"	Receiver on channel 5	Check to see that response is as above	Fig. 31 (5)
28	"	67.25 71.75	"	channel 4	"	"	Receiver on channel 4	"	Fig. 31 (4)
29	"	61.25 65.75	"	channel 3	"	"	Receiver on channel 3	"	Fig. 31 (3)
30	"	55.25 59.75	"	channel 2	"	"	Receiver on channel 2	"	
31	"	45.25 49.75	"	channel 1	"	"	Receiver on channel 1	"	Fig. 31 (1)
32	If the response on any channel (steps 27 through 31) is below 70% at either marker, switch to that channel and adjust L11, L12, L37 & L38 to pull response up on that channel. Then recheck steps 26 through 31.								

R-F OSCILLATOR ALIGNMENT

STEP No.	CONNECT SIGNAL GENERATOR TO	SIGNAL GEN. FREQ. MC.	CONNECT HETERODYNE FREQ. METER TO	HET. METER FREQ. MC.	CONNECT OSCILLOSCOPE TO	CONNECT "VOLTOHMYST" TO	MISCELLANEOUS CONNECTIONS AND INSTRUCTIONS	ADJUST	REFER TO
33	Antenna terminals	215.75	Loosely coupled to r-f osc.	237	Not used	Junction of R135 & C146 for sig. gen. method only	Fine tuning centered for all adjustments Receiver on channel 13	L77 & L78 for zero on meter or beat on het. freq. meter	Fig. 28, Fig. 27
34	"	209.75	"	231	"	"	Receiver on channel 12	L76 as above	Fig. 29
35	"	203.75	"	225	"	"	Receiver on channel 11	L74 as above	"
36	"	197.75	"	219	"	"	Receiver on channel 10	L72 as above	"
37	"	191.75	"	213	"	"	Receiver on channel 9	L70 as above	"
38	"	185.75	"	207	"	"	Receiver on channel 8	L68 as above	"
39	"	179.75	"	201	"	"	Receiver on channel 7	L66 as above	"
40	"	87.75	"	109	"	"	Receiver on channel 6	L63 & L64 as above	Fig. 27
41	"	81.75	"	103	"	"	Receiver on channel 5	L62 as above	Fig. 29
42	"	71.75	"	93	"	"	Receiver on channel 4	L60 as above	"
43	"	65.75	"	87	"	"	Receiver on channel 3	L58 as above	"
44	"	59.75	"	81	"	"	Receiver on channel 2	L56 as above	"
45	"	49.75	"	71	"	"	Receiver on channel 1	L54 as above	"
46	Repeat steps 33 through 45 as a check.								
					CONVERTER GRID TRAP ADJUSTMENT				
47	Antenna terminal (loosely)	Sound and Pix Carrier of Selected Channel	Not used		Junction L80 and R6 (in r-f unit) through 10,000 ohm series resistor	Not used	Connect sweep to ant. terms. 1st pix i-f grid bypassed to gnd. with 1000 mmf.	Switch through channels 1 through 6. Select channel with flat response and markers above 80%	Fig. 28 Fig. 32 (A)
48	"	"	"		"	"	Move 1000 mmf. bypass from 1st pix i-f grid to 2nd i-f grid	Adjust C14 for response curve similar to that obtained above	Fig. 28 Fig. 32 (B)
					RETOUCHING PICTURE I-F TRANSFORMERS				
49			Not used		Not used		Receiver & sweep on same channel as above. Remove i-f grid bypass	Picture control max. Bias box −3 volts.	Fig. 28
50	Antenna terminals (loosely)	22.3 25.75	"		Junction L109 and R154	Not used	Retouch pix i-f adjustments (T2, T104, T105 bottoms L104 & L106) as necessary to provide proper response		Fig. 28 Fig. 27 Fig. 33
51	If T105 (bottom) was adjusted in step 50, repeat step 10 and step 50. Replace V106 upon completion.								
					SENSITIVITY CHECK				
52	Connect antenna to receiver through attenuator pad to provide weak signal. Compare picture and sound obtained to that obtained on other receivers under the same conditions.								

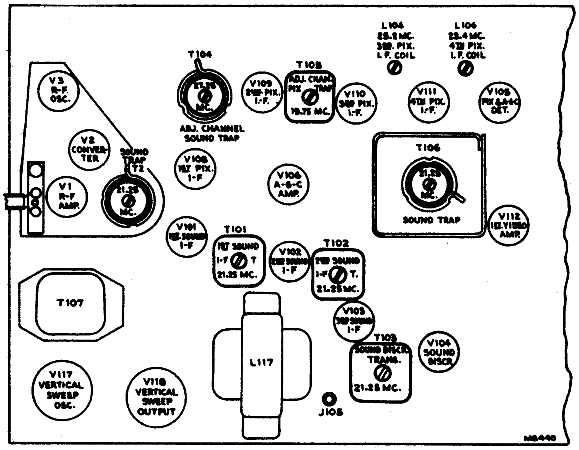


Figure 26—Top Chassis Adjustments

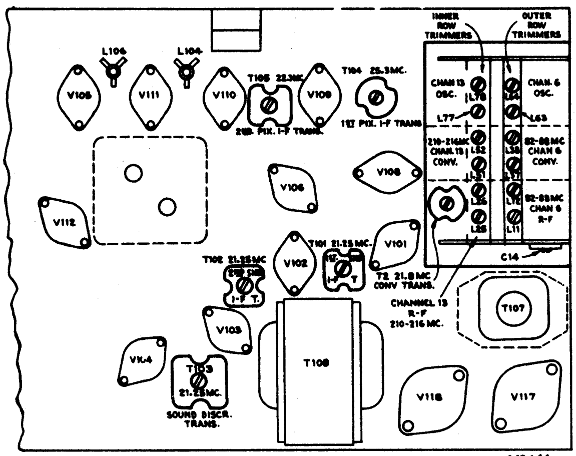


Figure 27—Bottom Chassis Adjustments

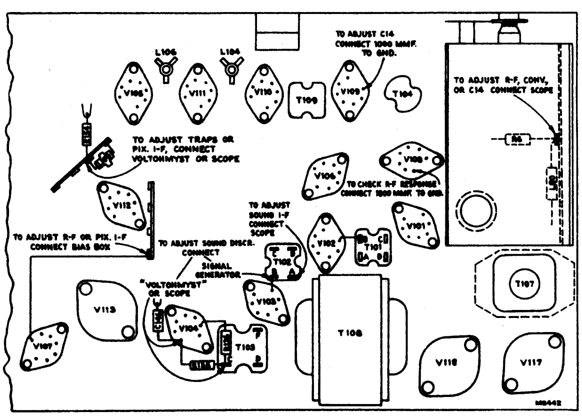
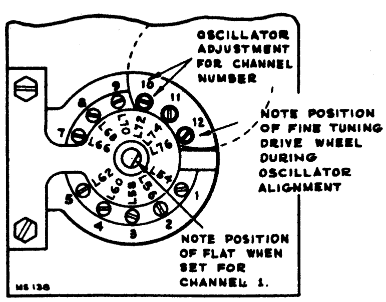


Figure 28—Test Connection Points



OSCILLATOR ADJUSTMENTS FOR CHANNELS 6 AND 13 ARE ON SIDE OF R.F. UNIT

Figure 29—R-F Oscillator Adjustments

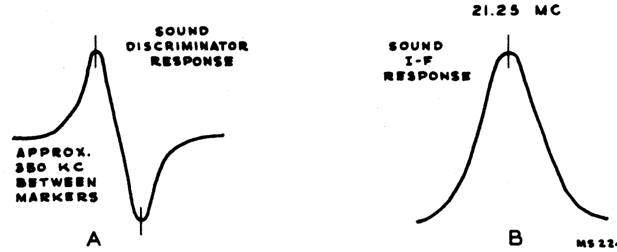


Figure 30—Sound Discriminator and I-F Response

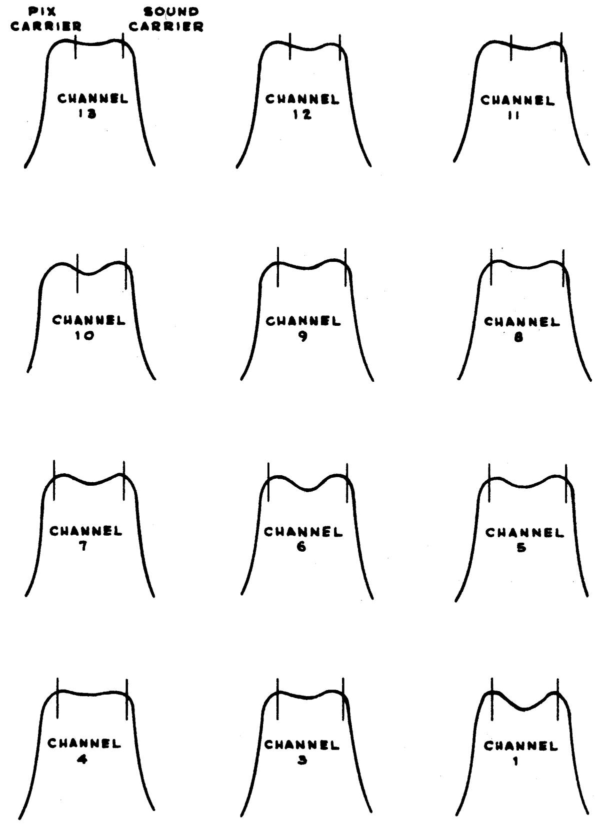


Figure 31—R-F Response

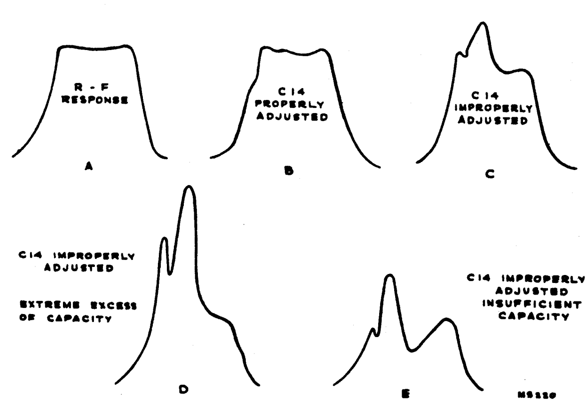


Figure 32—Effects of C14 Adjustments

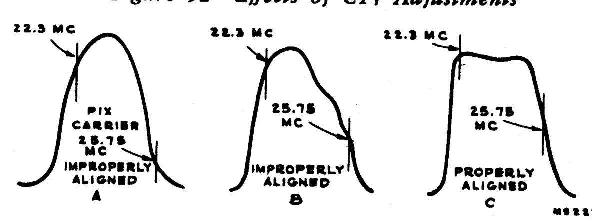


Figure 33—Overall Response

Following is a list of symptoms of possible failures and an indication of some of the possible faults.

NO RASTER ON SCREEN:

(1) P303 or kinescope socket disconnected.

(2) No high voltage due to failure of power supply. P401 or interlock disconnected. Fuse in power supply blown or defective. V401 and V402 defective—filter capacitor or choke shorted or filter choke open.

(3) No high voltage—If horizontal deflection is operating as evidenced by the correct waveform on terminal 4 of horizontal output transformer, the trouble can be isolated to the 8016 circuits. Either the T302 high voltage winding is open, (points 2 to 3), the 8016 tubes are defective, the 8016 filament circuits are open or one or more of the following capacitors are open or shorted: C326, C327, C328, C329, and C330.

(4) V302 and V304 circuits inoperative—check for sine wave on V302 grid, pulse on V304 grid, and sawtooth on V305 grid. Refer to schematic and wave form chart.

(5) Damper tubes V310 or V311 inoperative.

(6) Defective Kinescope.

(7) R162 defective, R173 open, (terminal 3 to ground).

NO VERTICAL DEFLECTION:

(1) P101 disconnected or cable defective.

(2) P301 disconnected or cable defective.

(3) V117 or V118 inoperative. Check voltage and wave forms on grids and plates.

(4) T108 open.

(5) Vertical deflection coils open.

NO HORIZONTAL DEFLECTION:

(1) P401 disconnected or cable defective.

(2) Interlock cable disconnected or defective.

(3) P302 disconnected or cable defective.

(4) V302, V304, V305, V306, V310 or V311 inoperative—check voltage and wave forms on grids and plate.

(5) T302 open.

(6) Horizontal deflection coil open.

SMALL RASTER:

(1) Low Plus B or low line voltage.

POOR VERTICAL LINEARITY:

(1) If adjustments cannot correct, change V118.

(2) Vertical output transformer (T108) defective.

(3) V117 inoperative—check voltage and wave forms on grid and plate.

(4) R164, C160, C165-B or C172-C defective.

(5) Low bias or plate voltage—check rectifiers and capacitors in supply circuits.

POOR HORIZONTAL LINEARITY:

(1) If adjustments do not correct, change V305, V306, V310 or V311.

(2) T302 or L302 defective.

(3) R346, R348, R350, R351, C331 or C332 defective.

(4) R332, R340 or C318 defective.

(5) R316 defective.

WRINKLES ON LEFT SIDE OF RASTER:

(1) R184, R186 or C334 defective.

(2) Defective yoke.

PICTURE OUT OF PHASE HORIZONTALLY:

(1) T301 winding D to F incorrectly tuned or connected in reverse.

(2) R312 or R314 defective.

TRAPEZOIDAL OR NON-SYMMETRICAL RASTER:

(1) C334 defective.

(2) Defective yoke.

RASTER & SIGNAL ON SCREEN BUT NO SOUND:

(1) R-F oscillator off frequency.

(2) Sound i-f or discriminator inoperative—check V101, V102, V103, V104 and their socket voltages.

(3) Radio audio system inoperative.

(4) Speaker defective.

SIGNAL ON SCREEN BUT NO SYNC:

(1) Picture control advanced too far.

(2) V107-B, V114, V115, or V116 inoperative. Check voltage and waveforms at their grids and plates.

(3) C171 defective.

SIGNAL ON SCREEN BUT NO VERTICAL SYNC:

(1) Check V117 and associated circuit—C155, T107, etc.

(2) Integrating network inoperative—check C143, C148, C149, C150, R140, R142, R143 and R144.

SIGNAL ON SCREEN BUT NO HORIZONTAL SYNC:

(1) T301 misadjusted—readjust as instructed on page 8.

(2) V301 or V303 inoperative—check socket voltages and waveforms.

(3) T301 defective.

(4) C301, C303, C304, C306 or R306 defective.

(5) If horizontal speed is completely off and cannot be adjusted check C302, C304, C305, C308, C313, C145, R304, R309 and R141.

SOUND & RASTER BUT NO PICTURE OR SYNC:

(1) Picture i-f, detector or video amplifier inoperative—check V108, V109, V110, V111, V105, V112 and V113—check socket voltages.

(2) Bad contact to kinescope grid.

PICTURE STABLE BUT POOR RESOLUTION:

(1) Make sure that the focus control operates on both sides of proper focus.

(2) Optical barrel adjustments misadjusted.

(3) V105, V112 or V113 defective.

(4) Peaking coils defective—check for specified resistance.

(5) C157, C164, C168 or C171 defective.

(6) R-F and I-F circuits misaligned.

PICTURE SMEAR:

(1) Video amplifier overloaded by excessive input—reduce picture control setting.

(2) Close switch S101.

(3) Insufficient bias on V112 and V113 resulting in grid current on video signal. Check bias and possible grid current.

(4) Defective coupling condenser or grid load resistor—check C157, C164, C168, C173-B, R160, R177, R185, R189, etc.

(5) This trouble can originate at the transmitter—check on another station.

PICTURE JITTER:

(1) Picture control operated at excessive level.

(2) If regular sections at the left picture are displaced change V305 and V306.

(3) Vertical instability may be due to loose connections or noise.

(4) Horizontal instability may be due to unstable transmitted sync. Connect sync link to terminal 1 and 2.

(5) C304, R306 or V303 defective.

RASTER BUT NO SOUND, PICTURE OR SYNC.

(1) Defective antenna or transmission line.

(2) R-F oscillator off frequency.

(3) R-F unit inoperative—check V1, V2, V3 and their socket voltages.

DARK VERTICAL LINE ON LEFT OF PICTURE:

(1) Reduce horizontal drive and readjust width and horizontal linearity.

(2) Replace V305 and V306.

LIGHT VERTICAL LINE ON LEFT OF PICTURE:

(1) C334 defective.

(2) V310 or V311 defective.

CRITICAL LEAD DRESS:

(1) Dress spaghetti-covered leads from A and B on discriminator transformer T301 to pin 3 and 5 on V301 tube socket approximately 3/16" above chassis.

(2) Dress video capacitors C157, C164 and C168 up and away from chassis.

(3) Dress video peaking coils L108, L109, L110, L111, L112, L113 and L114 up and away from chassis.

(4) Contact between the r-f oscillator frequency adjustment screws and the oscillator coils or channel switch eyelets must be avoided.

(5) Dress T302 winding leads as shown in Figure 34.

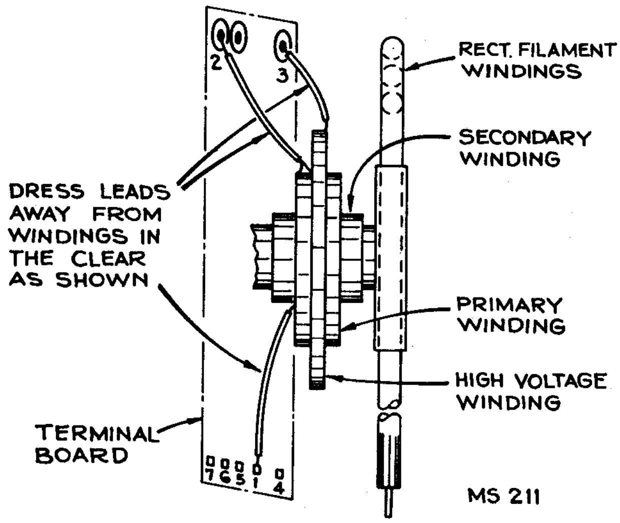


Figure 34—T302 Lead Dress

PICTURE I-F RESPONSE—At times it may be desirable to observe the individual i-f stage response. This can be achieved by the following method.

Select a channel with a flat r-f response as outlined in the converter grid trap adjustment section of the alignment procedure.

Shunt all i-f transformers and coils with a 330 ohm carbon resistor except the one whose response is to be observed.

Connect the oscilloscope across the picture detector load resistor and observe the overall response. The response obtained will be essentially that of the unshunted stage. The effects of the various traps are also visible on the stage response.

Figures 35 through 39 show the response of the various stages obtained in the above manner. The curves shown are typical although some variation between receivers can be expected. Relative stage gain is not shown.

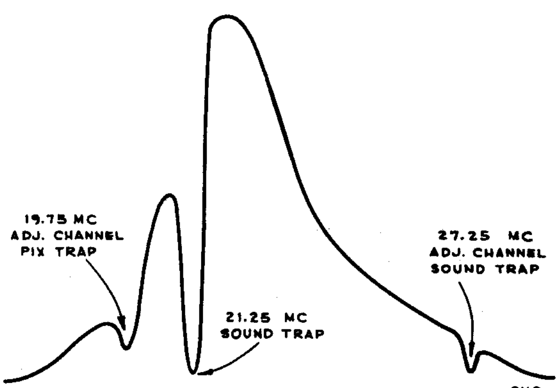


Figure 35—T2 Response

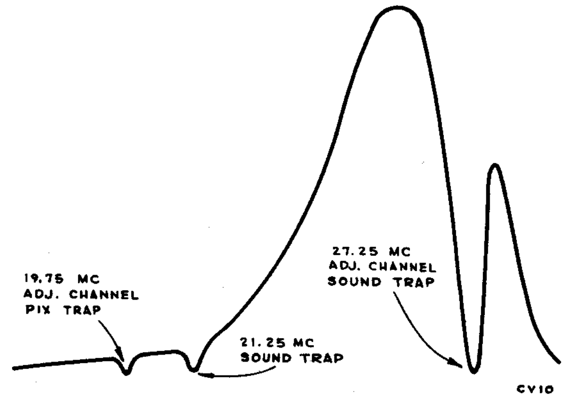


Figure 36—T104 Response

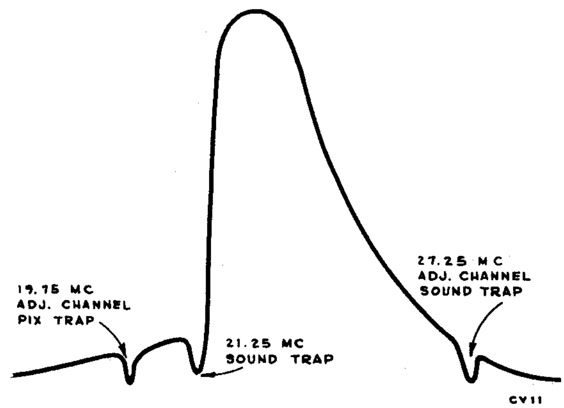


Figure 37—T105 Response

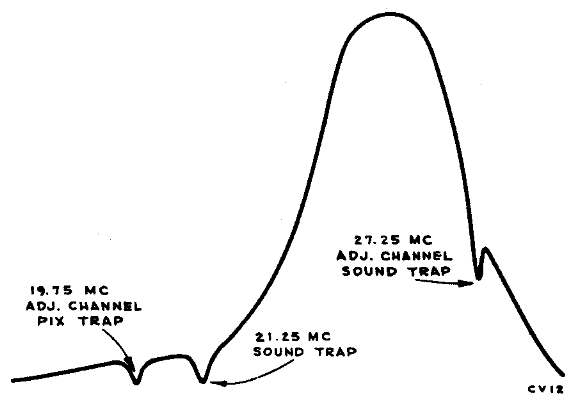


Figure 38—L104 Response

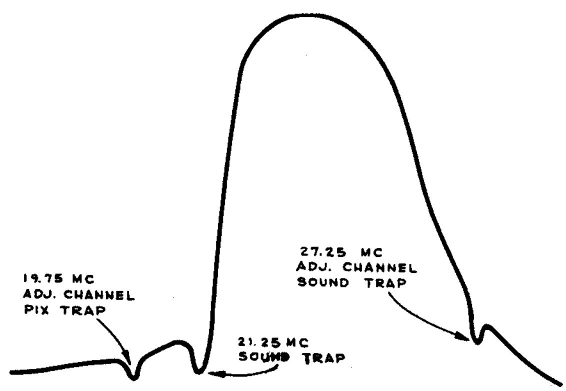
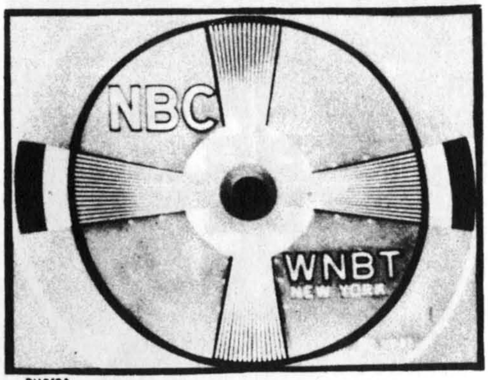


Figure 39—L106 Response



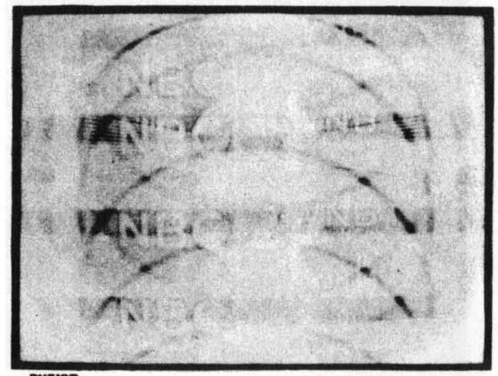
PH210A

Figure 40—Normal Picture

←

Figure 41—Vertical Hold Control Misadjusted

→


PH210B

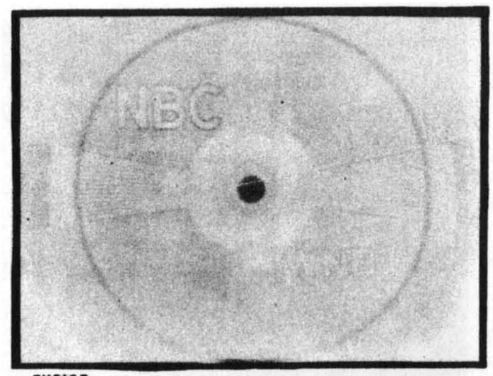
PH210C

Figure 42—Picture Control Misadjusted

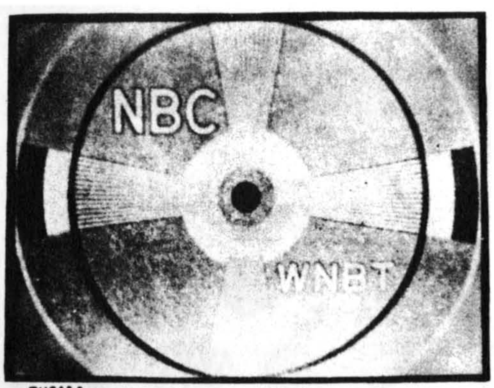
←

Figure 43—Brightness Control Misadjusted

→



PH210D



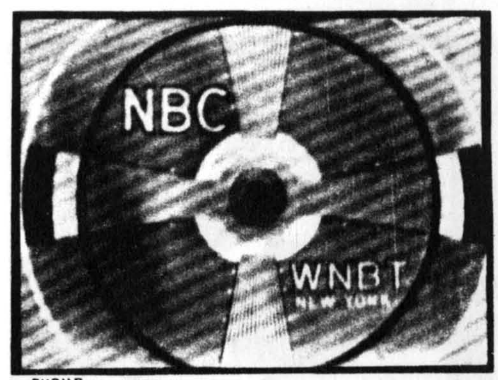
PH211A

Figure 44—Weak Signal

←

Figure 45—Interference from Another Signal

→



PH211B

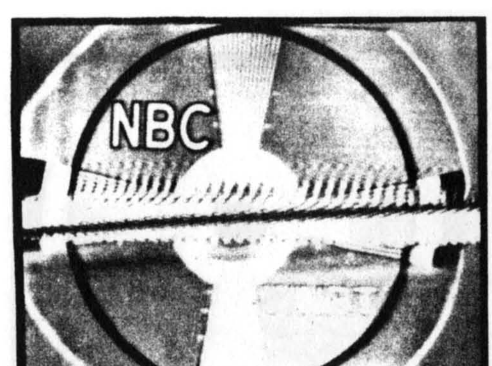

PH211C

Figure 46—Sound in the Picture

←

Figure 47—Interference, Diathermy, etc.

→



PH211D

TEST PATTERN PHOTOGRAPHS

PH220

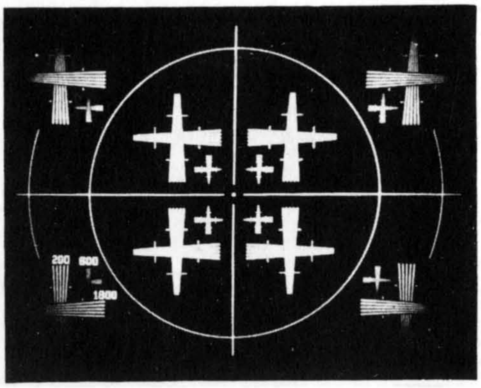


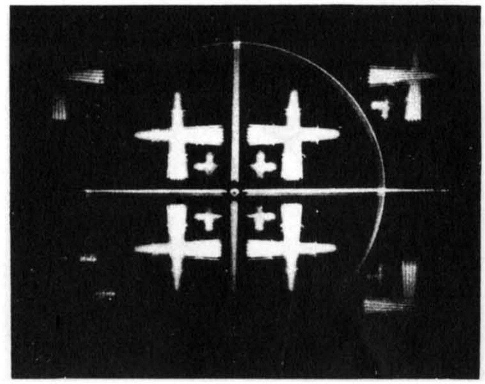
Figure 48—Correct Picture of Optical Test Lamp Pattern

←

Figure 49—Optical Barrel Focus Adjustment Misadjusted

→

PH221



PH222

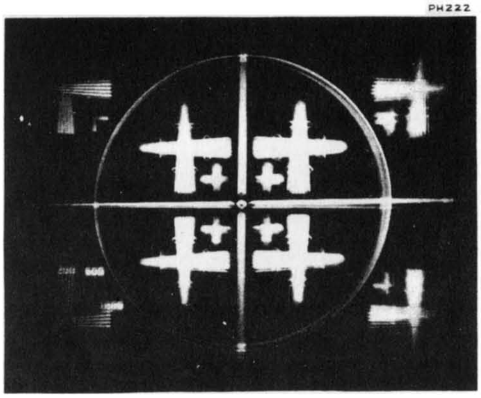


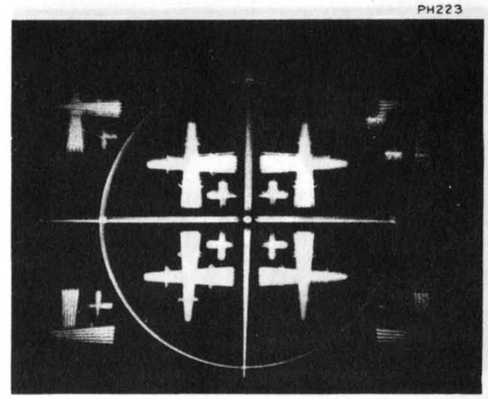
Figure 50—Optical Barrel Horizontal Centering Adjustment Misadjusted

←

Figure 51—Optical Barrel Lateral Centering Adjustment Misadjusted

→

PH223



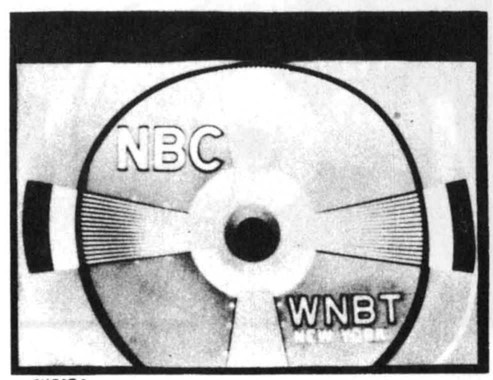
PH212D

Figure 52—Electrical Horizontal Centering Control Misadjusted

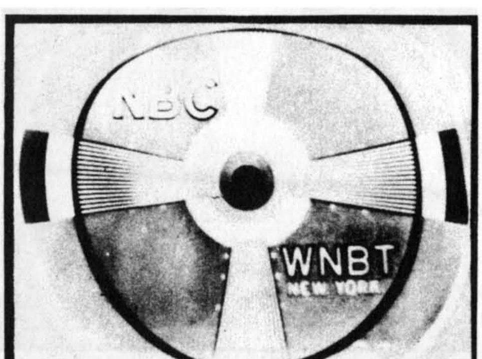
←

Figure 53—Electrical Vertical Centering Control Misadjusted

→



PH213A



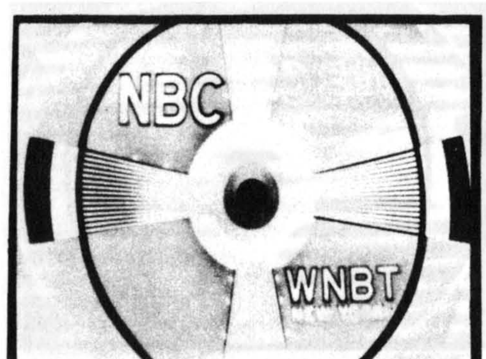
PH213C

Figure 54—Vertical Linearity Control Misadjusted

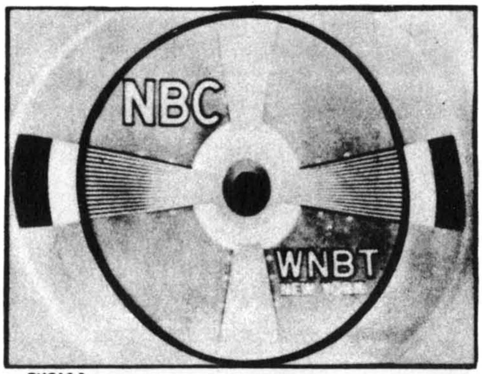
←

Figure 55—Height Control Misadjusted

→



PH213D



PH214A

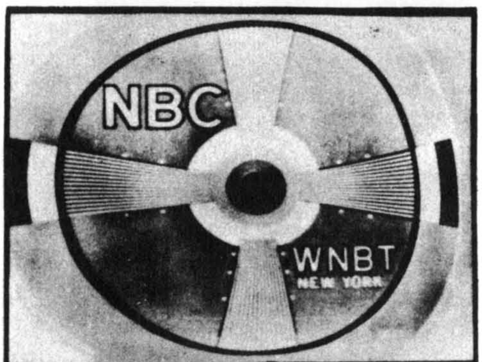
Figure 56—Horizontal Linearity Control Misadjusted (Picture Cramped in Middle)

←

Figure 57—Width Control Misadjusted

→

PH214B



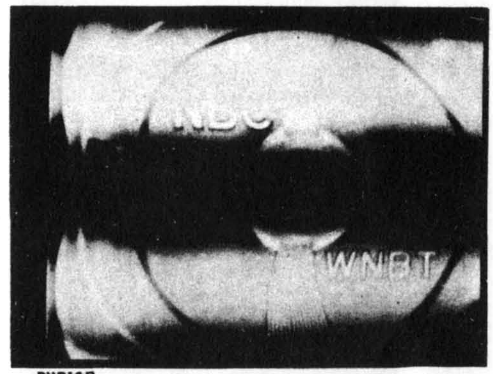
PH214C

Figure 58—Horizontal Drive Control Misadjusted

←

Figure 59—Hum in Video and Sync (Picture Off Center to Show Edge of Raster)

→


PH214D

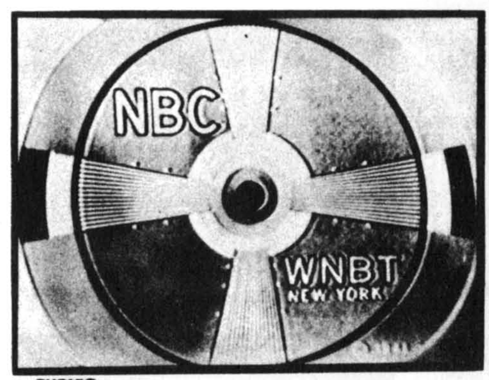

PH215A

Figure 60—Reflections

←

Figure 61—Transients (Check position of S101)

→



PH215B

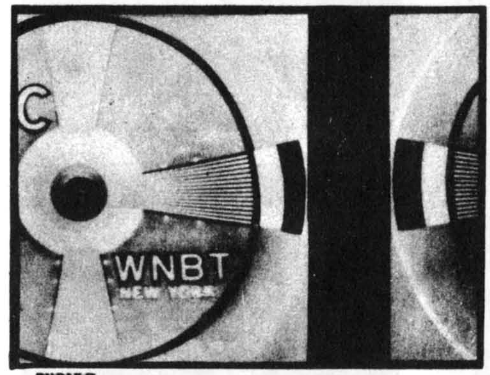

PH215C

Figure 62—Horizontal Sync Discriminator Transformer Frequency Adjustment Misadjusted

←

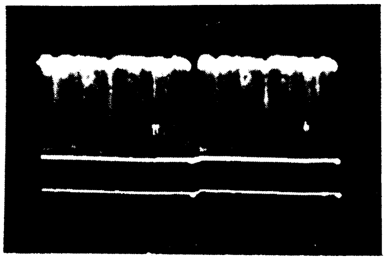
Figure 63—Horizontal Sync Discriminator Transformer Phase Adjustment Misadjusted

→



PH215D

WAVEFORM PHOTOGRAPHS

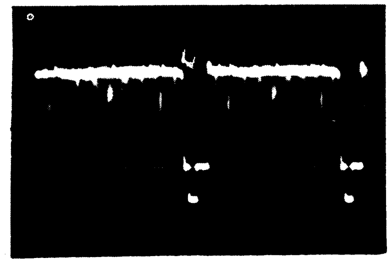


CV16B

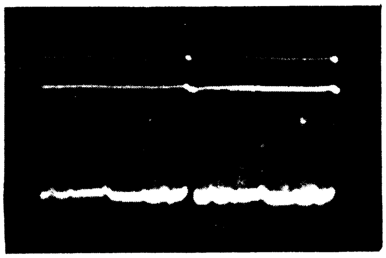
Video Signal Input to 1st Video Amplifier (Junction of L108 and C157)

Figure 64—Vertical (Oscilloscope Synced to ½ of Vertical Sweep Rate) (1.8 Volts PP)
←

Figure 65—Horizontal (Oscilloscope Synced to ½ of Horizontal Sweep Rate) (1.8 Volts PP)
→



CV16A

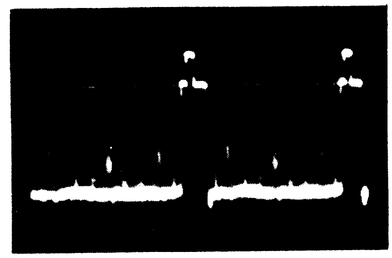


CV16D

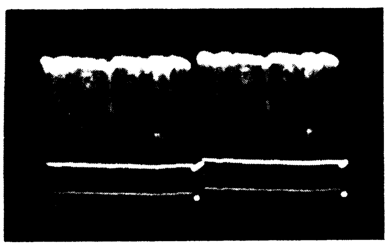
Output of 1st Video Amplifier (Junction of L110 and C164)

Figure 66—Vertical (18 Volts PP)
←

Figure 67—Horizontal (18 Volts PP)
→



CV16C

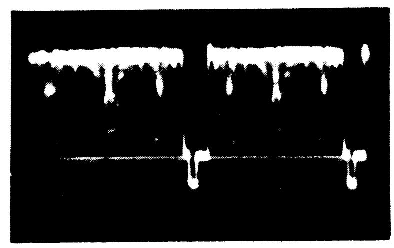


CV16F

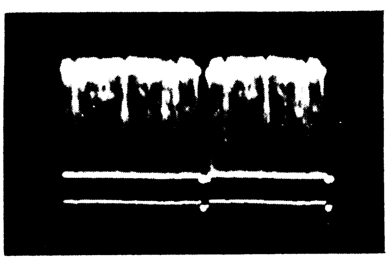
Input to Kinescope Grid (S101 open)

Figure 68—Vertical (60 Volts PP)
←

Figure 69—Horizontal (60 Volts PP)
→



CV16E

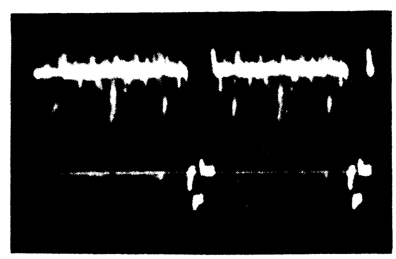


CV17B

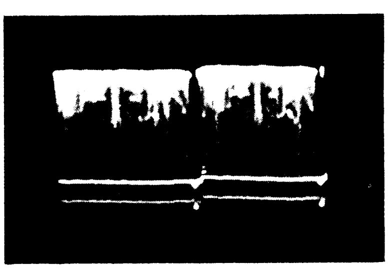
Input to Kinescope Grid (S101 closed)

Figure 70—Vertical (60 Volts PP)
←

Figure 71—Horizontal (60 Volts PP)
→



CV17A

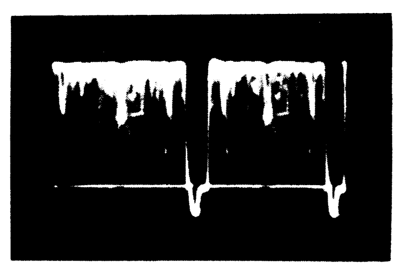


CV17D

Cathode of D-C Restorer (Pin 5 of V107-B) (6AL5)

Figure 72—Vertical (58 Volts PP)
←

Figure 73—Horizontal (58 Volts PP)
→



CV17C

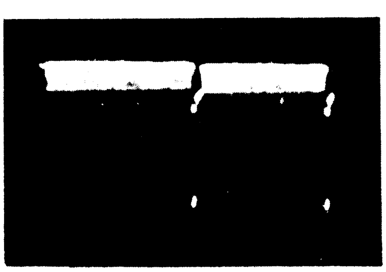
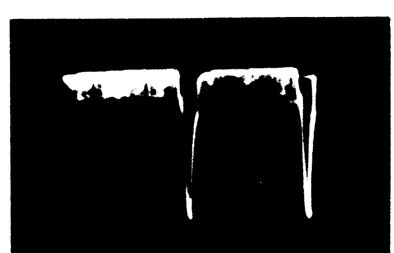


Plate of D-C Restorer (Pin 2 of V107-B) (6AL5)

Figure 74—Vertical (14 Volts PP)
←

Figure 75—Horizontal (14 Volts PP)
→



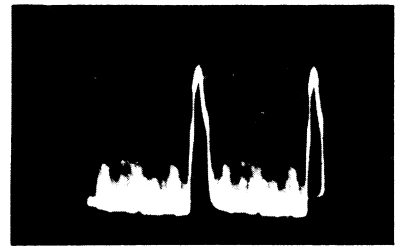
CV17E

CV18B

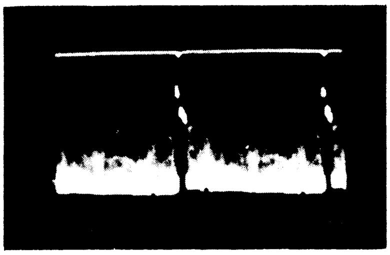
Plate of 1st Sync. Amplifier (Pin 8 of V114) (6SK7)

Figure 76—Vertical (70 Volts PP) ←

Figure 77—Horizontal (52 Volts PP) →



CV18A

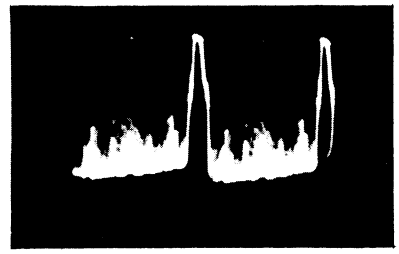


CV18D

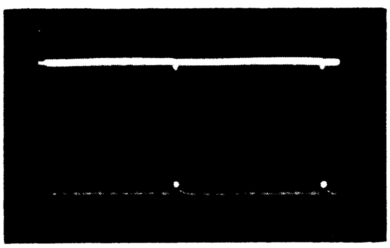
Grid of 2nd Sync. Amplifier (Pin 4 of V115) (6SH7)

Figure 78—Vertical (42 Volts PP) ←

Figure 79—Horizontal (42 Volts PP) →



CV18C

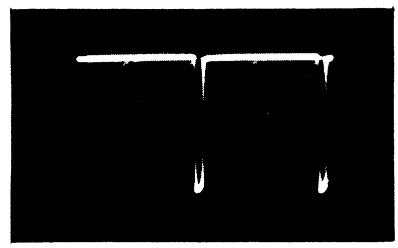


CV18F

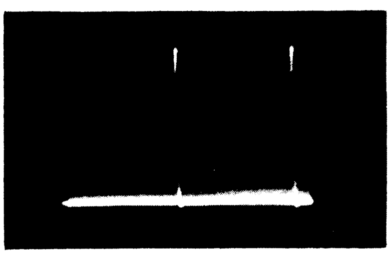
Plate of 2nd Sync. Amplifier (Pin 8 of V115) (6SH7)

Figure 80—Vertical (110 Volts PP) ←

Figure 81—Horizontal (110 Volts PP) →



CV18E

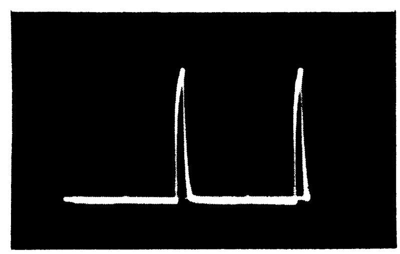


CV19B

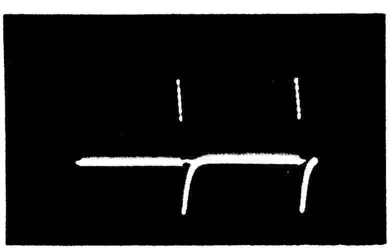
Plate of 3rd Sync. Amplifier (Pin 3 of V116) (6J5)

Figure 82—Vertical (36 Volts PP) ←

Figure 83—Horizontal (30 Volts PP) →



CV19A

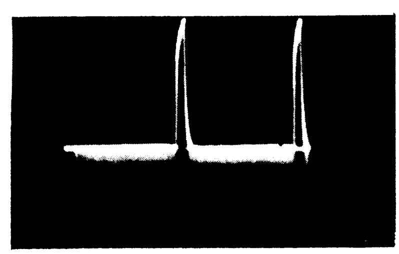


CV19D

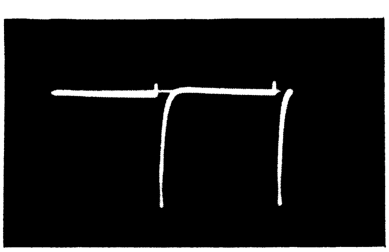
Input to Integrating Network (Junction of C143, R140 and R142)

Figure 84—Vertical (48 Volts PP) ←

Figure 85—Horizontal (30 Volts PP) →



CV19C



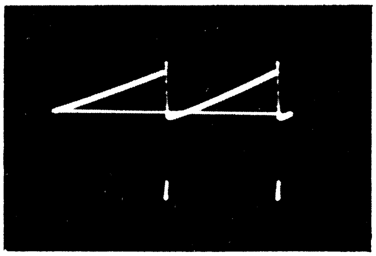
CV19E

Figure 86—Output of Integrating Network (Junction of R144, C150 and Yellow Lead of T107). Vertical (41 Volts PP) ←

Figure 87—Grid of Vertical Osc. (440 Volts PP) (Pin 5 of V117) (6J5) →

CV19F

WAVEFORM PHOTOGRAPHS



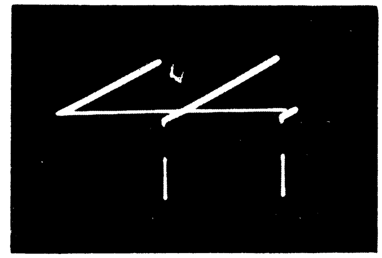
CV20A

Figure 88—Plate of Vertical Osc. (160 Volts PP) (Pin 3 of V117) (6J5)

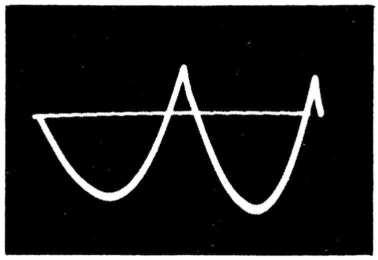
←

Figure 89—Input Coupling of Vertical Output (130 Volts PP) (Junction of C159, C160 and Read Lead of T107)

→



CV20B



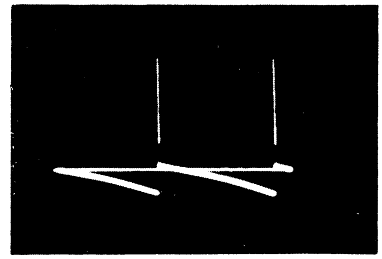
CV20C

Figure 90—Cathode of Vertical Output (1.3 Volts PP) (Pin 8 of V118) (6K6GT)

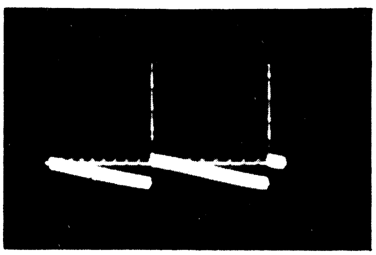
←

Figure 91—Plate of Vertical Output (800 Volts PP) (Pin 3 of V118) (6K6GT)

→



CV20D



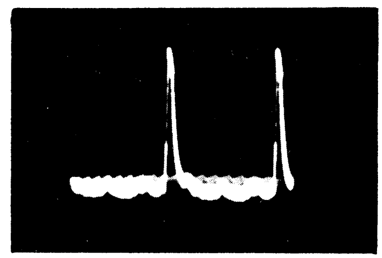
CV20E

Figure 92—Input to Vertical Deflection Coils (100 Volts PP) (Pins 2 and 3 on J102)

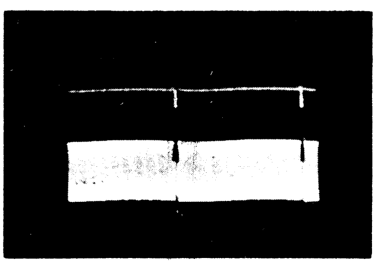
←

Figure 93—Vertical Boost of 1st Sync. Amplifier (16 Volts PP) (Junction of R121, R122 and C122)

→



CV21B



CV21D

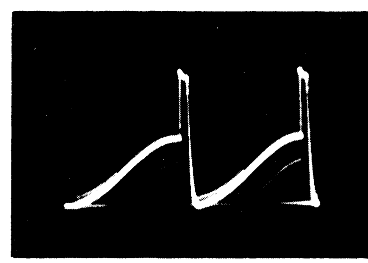
Terminal "E" of Sync. Discriminator Transformer (T301)

Figure 94—Vertical (21 Volts PP)

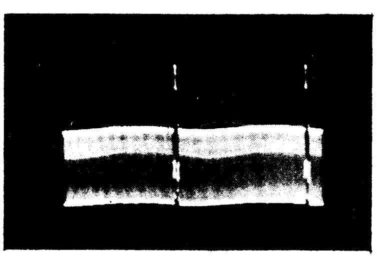
←

Figure 95—Horizontal (18 Volts PP)

→



CV21C



CV21F

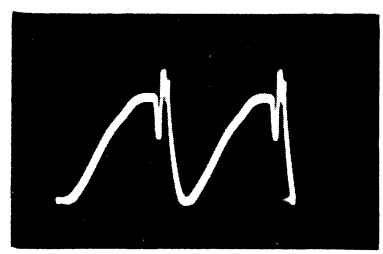
Junction of R301 and R303 (Cathode Resistors of Horizontal Sync. Discriminator)

Figure 96—Vertical (7 Volts PP)

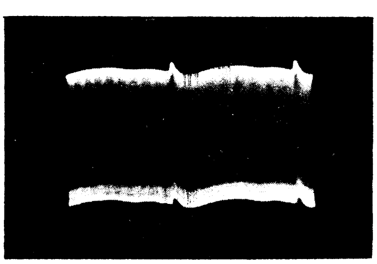
←

Figure 97—Horizontal (4.7 Volts PP)

→



CV21E



CV22B

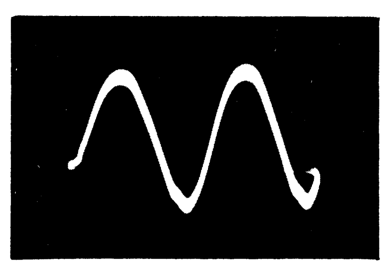
Cathode of Hor. Sync. Discriminator (Pin 4 of V301) (6H6)

Figure 98—Vertical (1.7 Volts PP)

←

Figure 99—Horizontal (1.7 Volts PP)

→



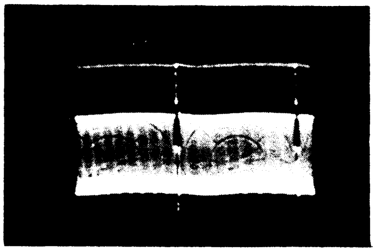
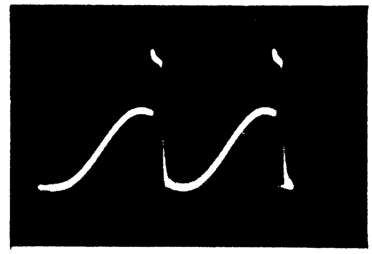


Plate of Hor. Sync. Discr. (Pin 5 of V301) (6H6)

Figure 100—Vertical (22 Volts PP) ←

Figure 101—Horizontal (18 Volts PP) →



CV23A

CV22F

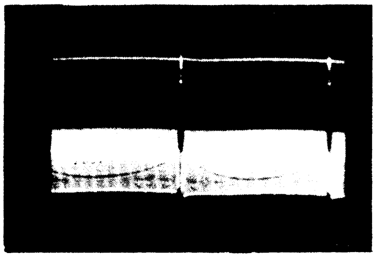
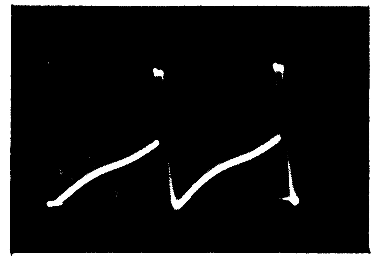


Plate of Hor. Sync. Discr. (Pin 3 of V301) (6H6)

Figure 102—Vertical (22 Volts PP) ←

Figure 103—Horizontal (16 Volts PP) →



CV22E

CV22D

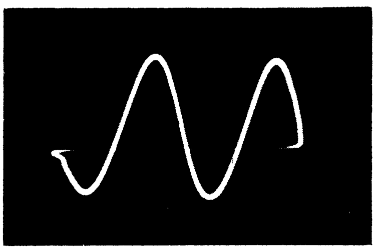
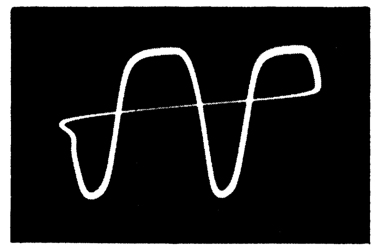


Figure 104—Terminal "A" of Sync. Discriminator Transformer (T301) Horizontal (100 Volts PP) ←

Figure 105—Plate of Horizontal Oscillator (260 Volts PP) (Pin 3 of V302) (6K6GT) →



CV23B

CV23D

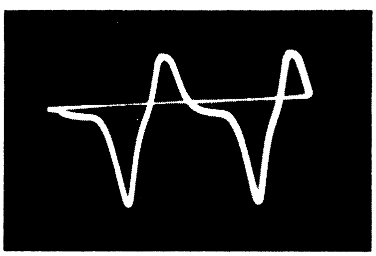
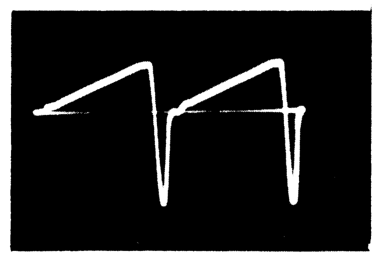


Figure 106—Input of Hor. Discharge (90 Volts PP) (Junction of C312, C314 and R314) ←

Figure 107—Plate of Hor. Discharge (100 Volts PP) (Pin 3 of V304) (6J5) →



CV23E

CV23F

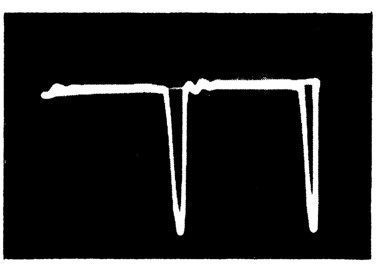
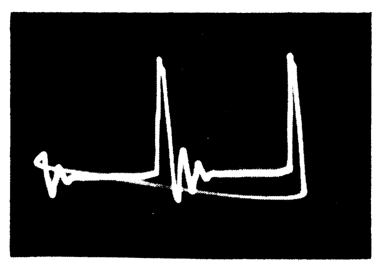


Figure 108—Horizontal Feedback (90 Volts PP) (Arm of Potentiometer R340) ←

Figure 109—Plate of Horizontal Output (Approx. 6000 Volts PP) (Measured Through a Capacity Voltage Divider Connected from Top Cap of V306 to Ground) →



CV24B

CV24A

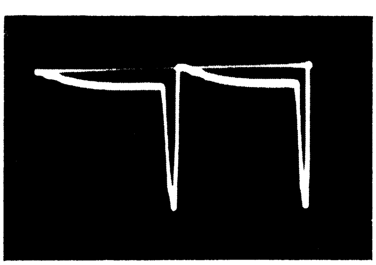
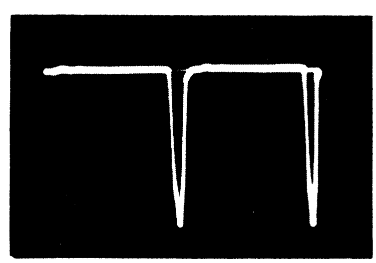


Figure 110—Grid of Damper (1200 Volts PP) (Pin 1 of V310) (6AS7G) ←

Figure 111—Input to Horizontal Deflection Coils (1500 Volts PP) (Pin 2 of V310) (6AS7G) →



CV24D

CV24C

Measurements made with receiver operating on 117 volts 60 cycles a-c and with no signal input. Voltages shown are read with Jr. "VoltOhmyst" between indicated terminal and chassis ground. Symbol < means "less than."

R-F, I-F CHASSIS, KCS24-1

Tube No.	Tube Type	Function	Operating Condition **	E. Plate Pin No.	E. Plate Volts	E. Screen Pin No.	E. Screen Volts	E. Cathode Pin No.	E. Cathode Volts	E. Grid Pin No.	E. Grid Volts	I Plate (ma.)	I Screen (ma.)	Notes on Measurements
V1	6J6	R-F Amplifier	Pictr. Min.	1 & 2	133	—	—	7	0	5 & 6	–34	<.1*	—	*Per Plate
			Pictr. Max.	1 & 2	58	—	—	7	0	5 & 6	–.25	6.0*	—	*Per Plate
V2	6J6	Converter	Pictr. Min.	1 & 2	128	—	—	7	0	5 & 6	–3 to –6.	.5 to 4*	—	*Per Plate
			Pictr. Max.	1 & 2	93	—	—	7	0	5 & 6	–2 to –5.	.2 to 3*	—	*Per Plate
V3	6J6	R-F Oscillator	Pictr. Min.	1 & 2	110	—	—	7	.3	5 & 6	–4.5 to –6.5	2.5*	—	*Per Plate
			Pictr. Max.	1 & 2	80	—	—	7	.2	5 & 6	–3.5 to –5.	1.7*	—	*Per Plate
V101	6BA6	1st Sound I-F Amplifier	Pictr. Min.	5	125	6	125	7	2.0	1	0	15.2	6.2	
			Pictr. Max.	5	107	6	107	7	1.65	1	0	13.	5.1	
V102	6BA6	2d Sound I-F Amplifier	Pictr. Min.	5	125	6	125	7	2.0	1	0	15.4	6.2	
			Pictr. Max.	5	107	6	107	7	1.65	1	0	13.2	5.0	
V103	6AU6	3d Sound I-F Amplifier	Pictr. Min.	5	47	6	47	7	0	1	–.23	2.8	2.8	
			Pictr. Max.	5	41	6	41	7	0	1	–.23	2.9	1.8	
V104	6AL5	Sound Discrim.	Pictr. Min.	2 & 7	–.35	—	—	4 & 5	—	—	—	—	—	
			Pictr. Max.	2 & 7	–.45	—	—	4 & 5	—	—	—	—	—	
V105-A	6AL5	AGC Detector	Pictr. Min.	2	–110	—	—	5	–110	—	—	—	—	
			Pictr. Max.	2	–110	—	—	5	–110	—	—	—	—	
V105-B	6AL5	Picture 2d Det.	Pictr. Min.	7	.15	—	—	1	0	—	—	—	—	
V106	6AT6	AGC Amplifier	Pictr. Min.	7	–100	—	—	2	–110	1	–108	—	—	
			Pictr. Max.	7	0	—	—	2	–110	1	–105	—	—	
V107-A	6AL5	AGC Diode	Pictr. Min.	7	–8.0	—	—	1	–8.0	—	—	—	—	
			Pictr. Max.	7	–3.2	—	—	1	–0.9	—	—	—	—	
V107-B	6AL5	DC Restorer	Brightness Min.	2	–110	—	—	5	–97	—	—	—	—	
			Brightness Max.	2	–1	—	—	5	0	—	—	—	—	
V108	6AG5	1st Pix. I-F Amplifier	Pictr. Min.	5	143	6	143	2 & 7	0	1	–8.1	0	0	
			Pictr. Max.	5	103	6	103	2 & 7	.2	1	–1.0	4.5	1.1	
V109	6AG5	2d Pix. I-F Amplifier	Pictr. Min.	5	145	6	145	2 & 7	0	1	–8.1	0	0	
			Pictr. Max.	5	117	6	117	2 & 7	.2	1	–1.0	3.9	1.3	
V110	6AG5	3d Pix. I-F Amplifier	Pictr. Min.	5	147	6	147	2 & 7	0	1	–8.1	0	0	
			Pictr. Max.	5	100	6	111	2 & 7	.21	1	–1.0	4.5	1.3	
V111	6AG5	4th Pix. I-F Amplifier	Pictr. Min.	5	98	6	138	2 & 7	1.4	1	0	7.3	2.3	
			Pictr. Max.	5	82	6	115	2 & 7	1.15	1	0	6.1	1.9	
V112	6AU6	1st Video Amplifier	Pictr. Min.	5	188	6	150	7	0	1	–2.25	6.7	2.6	
			Pictr. Max.	5	205	6	130	7	0	1	–2.35	4.3	1.6	
V113	6V6-GT	2d Video Amplifier	Pictr. Min.	3	180	4	255	8	8.9	5	–3.9	31.5	9.0	
			Pictr. Max.	3	175	4	249	8	8.5	5	–3.9	30.0	8.5	

R-F, I-F CHASSIS, KCS24-1 (Continued)

Tube No.	Tube Type	Function	Operating Condition **	E. Plate Pin No.	E. Plate Volts	E. Screen Pin No.	E. Screen Volts	E. Cathode Pin No.	E. Cathode Volts	E. Grid Pin No.	E. Grid Volts	I Plate (ma.)	I Screen (ma.)	Notes on Measurements
V114	6SK7	1st Sync. Amplifier	Pictr. Min.	8	165	6	113	5	0	4	–4.5	8.5	1.2	
			Pictr. Max.	8	180	6	99	5	0	4	–4.7	4.3	1.1	
V115	6SH7	2d Sync. Amplifier	Pictr. Min.	8	150	6	150	5	0	4	–5.3	0	0	
			Pictr. Max.	8	130	6	130	5	0	4	–5.6*	0	0	*Depends on noise
V116	6J5	3d Sync. Amplifier	Pictr. Min.	3	82	—	—	8	0	5	–.4	8.5	—	
			Pictr. Max.	3	73	—	—	8	0	5	–.4*	6.8	—	*Depends on noise
V117	6J5	Vertical Oscillator	Pictr. Min.	3	40*	—	—	8	–110	5	–144	.17	—	*Height, linearity and hold affect readings 2 to 1
V118	6K6-GT	Vertical Output	Pictr. Min.	3	215	4	215*	8	–81	5	–97	16.3	*	*Screen connected to plate

HORIZONTAL DEFLECTION CHASSIS, KRS20-1

Tube No.	Tube Type	Function	Operating Condition **	E. Plate Pin No.	E. Plate Volts	E. Screen Pin No.	E. Screen Volts	E. Cathode Pin No.	E. Cathode Volts	E. Grid Pin No.	E. Grid Volts	I Plate (ma.)	I Screen (ma.)	Notes on Measurements
V301	6H6	Horizontal Sync. Discr.	Pictr. Min.	3 5	–5.0 –5.0	—	—	4 8	–3.2 –2.2	—	—	—	—	
V302	6K6-GT	Horizontal Oscillator	Hold Max. Resistance	3	240	4	220	8	.30	5	–27.5	23.3	6.12	
			Hold Min. Resistance	3	230	4	192	8	.32	5	–23.0	24.8	6.87	
V303	6AC7	Horizontal Osc. Control	Pictr. Min.	8	246	6	127	5	0	4	–3	2.9	.75	
V304	6J5	Horizontal Discharge	Pictr. Min.	3	78	—	—	8	0	5	–38	.9	—	
V305	6BG6-G	Horizontal Output	Pictr. Min.	Cap	Do not Meas.*	8	280	3	14.0	5	–8	78	9.6	*6000 volt pulse present
V306	6BG6-G	Horizontal Output	Pictr. Min.	Cap	Do not Meas.*	8	280	3	14.0	5	–8	78	9.6	*6000 volt pulse present
V307	8016	H. V. Rectifier	Brightness Min.	Cap	*	—	—	2 & 7	10,500	—	—	—	—	*10,500 volt pulse present
			Brightness Max.	Cap	*	—	—	2 & 7	10,000	—	—	—	—	*10,500 volt pulse present
V308	8016	H. V. Rectifier	Brightness Min.	Cap	10,000	—	—	2 & 7	20,000	—	—	—	—	
			Brightness Max.	Cap	9,500	—	—	2 & 7	19,500	—	—	—	—	
V309	8016	H. H. Rectifier	Brightness Min.	Cap	19,500	—	—	2 & 7	29,000	—	—	—	—	
			Brightness Max.	Cap	18,500	—	—	2 & 7	28,000	—	—	—	—	
V310	6AS7-G	Damper	Pictr. Min.	2 & 5	Do not Meas.‡	—	—	3 & 6	470	1 & 4	290	78*	—	*Total both plates ‡1200 volt pulse present
V311	5V4G	Damper	Pictr. Min.	4 & 6		—	—	8	570	—	—	156*	—	
V312	5TP4	Kinescope	Brightness Min.	Cap	29,000*	10	200	11	0	2	–98	0	—	*Measured with "VoltOhmyst" and high voltage multiplier probe
			Brightness Max.	Cap	28,000*	10	200	11	0	2	–43	.35	—	

POWER SUPPLY CHASSIS, KRS21-1

Tube No.	Tube Type	Function	Operating Condition **	E. Plate Pin No.	E. Plate Volts	E. Screen Pin No.	E. Screen Volts	E. Cathode Pin No.	E. Cathode Volts	E. Grid Pin No.	E. Grid Volts	I Plate (ma.)	I Screen (ma.)	Notes on Measurements
V401	5U4G	Lo. V. Rectifier	Pictr. Min.	4 & 6	—	—	—	2 & 8	493	—	—	235*	—	*Total for both tubes
V402	5U4G	Lo. V. Rectifier	Pictr. Min.	4 & 6	—	—	—	2 & 8	493	—	—	*	—	
V403	5U4G	Lo. V. Rectifier	Pictr. Min.	4 & 6	—	—	—	2 & 8	265	—	—	172	—	

** Where separate readings are not listed for max. and min. gain settings of the picture control, the effect of the control is slight and readings are given for "Picture Min."

The radio receiver in the 648PTK is comprised of an eight-tube AM-FM tuner unit and a four-tube audio amplifier and power supply.

The tuner unit employs an r-f amplifier on all bands. One 455 kc. i-f stage and a conventional diode detector are employed on AM. On the FM band, three 10.7 mc. i-f stages and a ratio detector are employed.

When the radio function switch is in the phono position, the second FM i-f amplifier is used as a phono preamplifier. The .002 mf. capacitor on the screen of the 6AU6 bypasses the screen for i-f but not for audio. Therefore, for audio the 6AU6 screen has approximately the same characteristics as the plate of a triode. The audio output from the screen is fed to the volume control and into the radio audio system. The phono preamplifier permits the use of a low output-voltage crystal-pickup in the record player attachment.

In order to make the maximum use of space and components V4 is used as an i-f amplifier on AM and FM. When switching between AM and FM, the i-f transformers are switched simultaneously with the ant, r-f and osc coils.

The ratio detector, appearing in RCA post-war FM receivers, is a new device for converting a frequency modulated carrier to an audio signal, while at the same time offering a high degree of attenuation to any incident amplitude modulation. The relative insensitivity to amplitude variations, which is an inherent characteristic of ratio detectors, enables them to be used without the usual preceding limiter stage, thus affording the use of a high gain i-f stage instead of the low-gain limiter.

A brief review of the theory of the discriminator detector will help the serviceman to understand the action of the ratio detector.

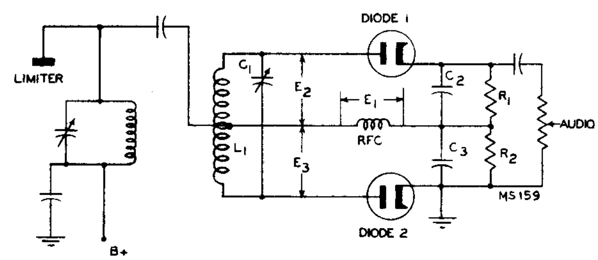


Figure 112—Basic Discriminator Circuit

Figure 112 portrays a conventional discriminator stage. It can be seen that it consists essentially of two diode rectifiers connected differentially so that the d-c potentials across their respective load resistors are subtractive. These two d-c voltages (across R1 and R2) are proportional to the a-c voltages applied to the diodes. The a-c voltage applied to each diode is the vector sum of E1 and the voltage across that half of L1 which is connected to the diode plate, as shown in the diagrams of Figure 114. E1 has practically the same amplitude and phase as the voltage across the tank in the limiter plate circuit. The current in this same tank circuit induces a voltage in L1, which causes a circulating current to flow in the resonant circuit composed of L1 and C1. E2 and E3 are the voltage drops which occur across each half of L1 as a result of this circulating current. When the carrier frequency is equal to the frequency at which the discriminator transformer is tuned (Figure 114A), the a-c voltage applied to diode 1 equals that applied to diode 2, therefore the rectified voltages are equal and since they are bucking voltages, the output of the discriminator is zero.

When the carrier frequency increases during a half cycle of modulation, the phase relations between E1, E2 and E3 change in accordance with Figure 114B. It is evident that the vector sum of the voltages applied to diode 2 exceeds the vector sum of the voltages applied to diode 1, resulting in a higher rectified voltage across R2 than across R1. The instantaneous difference of the rectified voltages appears as a negative voltage in the discriminator output. Figure 114C shows the condition occurring when the carrier frequency swings below the resonant frequency of the discriminator transformer, the end result being a positive voltage at the output of the discriminator.

The important fact in discriminator action is that the output voltage is proportional to the difference between E-diode 1 and E-diode 2. This is true because the d-c voltages appearing across R1 and R2 vary directly with E-diode 1 and E-diode 2, respectively, and the instantaneous output voltage is the difference between the rectified voltage drops.

In considering the effect of amplitude variation on discriminator output, refer again to the vector diagrams of Figure 114. An increase in the amplitude of the voltage applied to the discriminator would increase all of the vectors in the diagram proportionately. In other words, the effect would be as though the vector diagrams were enlarged photographically. It can be seen that while the phase relationships would remain the same, the difference between E-diode 1 and E-diode 2 would increase, so long as the frequency of the applied voltage differed even slightly from the receiver i-f. Thus components of amplitude modulation would be detected and passed on to the audio amplifier. Ordinarily, discriminators are preceded by limiters which remove most of the amplitude variation from the FM carrier, but the discriminator itself is not a device capable of rejecting amplitude modulation, except when the instantaneous frequency of the applied carrier is eactly equal to the resonant frequency of the discriminator transformer. This condition occurs only twice in every modulation cycle.

Note that while an increase in the amplitudes of the vectors in Figure 114 results in a proportionate increase in the difference between E-diode 1 and E-diode 2 for off-resonant conditions, the ratio of E-diode 1 to E-diode 2 is a constant, as far as amplitude variations are concerned. Therefore, a detector responsive only to changes in the ratio of E-diode 1 to E-diode 2, and insensitive to changes in the difference between these voltages would be a detector capable not only of converting frequency variations to audio variations, but of rejecting any amplitude modulation. Such a detector is the ratio detector.

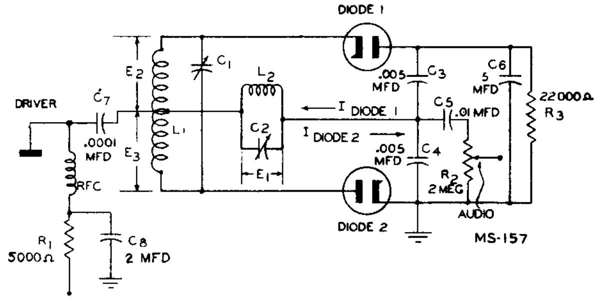
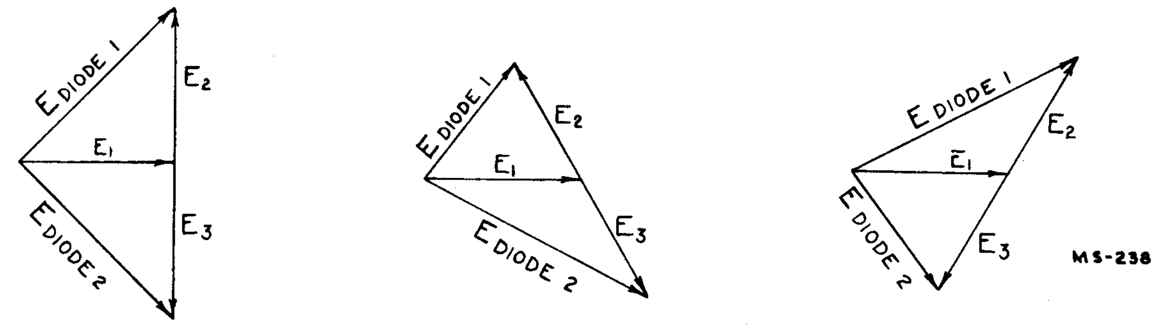


Figure 113—Basic Ratio Detector Circuit

A schematic of the fundamental ratio detector is shown in Figure 113. C7 and C4 have very little reactance at the intermediate frequency, so it is evident that the parallel resonant circuit L2 C2 is the true load for the driver stage, this stage being shunt fed. A driver stage, in this case, is nothing more than a conventional i-f amplifier preceding the ratio detector. L2 is inductively coupled to L1, therefore a comparison of Figures 112 and 113 will show that as far as the a-c voltages applied to the diodes are concerned, these circuits are almost ex-



(A) Carrier Frequency at I-F

(B) Carrier Frequency Above I-F

(C) Carrier Frequency Below I-F

Figure 114—Vector Diagram

actly similar, indeed, the same vector diagrams used in the analysis of Figure 112 can be used to portray the a-c voltages across the diodes in Figure 113. Here the similarity ends, because the ratio detector method of extracting intelligence from the FM carrier differs greatly from previously used methods. Diode 1, R3, and diode 2 complete a series circuit fed by the a-c voltage across L1. Since the two diodes are in series, they will conduct on the same half cycle, and the rectified current through R3 will cause a negative potential to appear at the plate of diode 1. The time constant of R3 C6 is usually about 0.2 second, so that the negative potential at the plate of diode 1 will remain constant even at the lowest audio frequencies to be reproduced.

C3 will be charged by the rectified current through diode 1 to a voltage proportional to the voltage represented by vector E-diode 1 (Figure 114), and C4 will be charged through diode 2 in proportion to the vector E-diode 2. Since the magnitudes of these vectors differ according to the instantaneous frequency of the carrier, the voltages across C3 and C4 will differ proportionately, the voltage across C3 being the larger of the two voltages at carrier frequencies below the i-f, and the smaller at frequencies above the i-f.

Note that the voltages across C3 and C4 are additive and that their sum is fixed by the constant potential across R3. Therefore, while the ratio of these voltages will vary at an audio rate, their sum will always be constant and equal to the voltage across R3. The potential at the junction of C3 and C4 will vary at an audio rate when an FM carrier is applied to the detector, hence the audio voltage is extracted at this point and fed into the audio amplifier.

There is no direct d-c return path across either C3 or C4; the reason for this is twofold. Firstly, a direct return path is not needed because whenever the potential of the junction of C3 and C4 is raised or lowered in accordance with the frequency of the voltage applied to the detector, there will be a point on R3 having a potential equal to the voltage across C4. This point will shift up and down on R3 in synchronism with the audio voltage across C4. If this point could be connected to the junction of C3 and C4, a d-c return for each diode would be provided, but no current would flow through the connection because there would be no difference of potential between the point on R3 and the junction of C3 and C4. Since no current would flow through this connection, a direct return path would be useless.

Secondly, a peculiar form of distortion, apparent at low carrier levels, is evident if a resistance is connected directly across C4. This distortion is caused by C4 discharging through the resistance whenever the carrier level falls below the level at which the diodes are biased off by the voltage across R3. The effect of the distortion is to add a long peak to one loop of the audio cycle.

The rejection of amplitude modulation in the ratio detector may be explained as follows: A rapid increase in the amplitude of the carrier applied to the ratio detector will tend to increase the d-c voltages across C3 and C4. The sum of these voltages must always be equal to the voltage across C6. The voltage across C6 cannot change with a rapid increase in the amplitude of the carrier, due to the large time constant of R3 and C6. Therefore, this constant potential across C6 prevents the voltages across C3 and C4 from rising with an increase in the strength of the carrier. A reduction in carrier amplitude is prevented from appearing as a reduction in the voltages across C4 in the same way. The constant voltage across C6 can be considered to be a stabilizing voltage; i.e., it stabilizes the ratio detector output against amplitude modulation of the applied carrier.

The time constant of R3 C6 is not too large to prevent average changes in carrier level from appearing as changes in voltage across R3; in other words, the voltage across R3 is proportional to the average strength of the received carrier. Thus, this voltage serves as an excellent AVC voltage.

There is no "threshold" effect apparent in the ratio detector; i.e., there is no minimum carrier level which must be applied to the detector to cause noise attenuation as in other types of FM detectors requiring the use of a limiter stage.

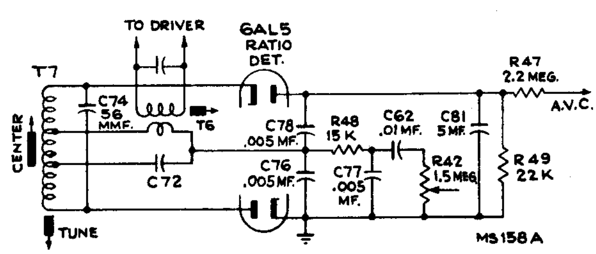


Figure 115—Ratio Detector in RK121A

The ratio detector used in this receiver, differing only in the method of applying i-f energy to L1 and C1, is shown in Figure 115. This circuit, as well as any other ratio detector circuit, can be broken down and analyzed in almost the same manner as was the basic ratio detector circuit of Figure 113.

RADIO ALIGNMENT PROCEDURE

If any lead dressing is necessary, it should be done before aligning the receiver. See Critical Lead Dress on page 51.
Before aligning set, completely mesh the gang and set the dial pointer to the mechanical max. calibration point at extreme left end of dial.
When making a complete alignment follow the tabulated form below in sequence.
If only a portion of the circuit is to be aligned select the portion required and follow with the remaining steps in the chart.
Any adjustments made on the FM 10.7 mc. I-F's make it necessary to adjust the AM 455 kc. I-F's.

FM RATIO DETECTOR ALIGNMENT

Steps	Connect High Side of the Test Osc. to—	Tune Test Osc. to—	Turn Vol. Cont. to—	Adjust
1	Connect a 680-ohm resistor between lugs D and E of the ratio detector transformer T7. Connect d-c probe of a "VoltOhmyst" to the negative lead of capacitor C81. Connect the common lead of the meter to chassis. Set the function switch to the FM position.			
2	Driver grid, pin 1, of V6 in series with .01 mfd	10.7 mc., 30% mod., 400 cycles AM	Maximum volume	Driver transformer T6 for maximum d-c voltage across C81
3	Remove meter leads and disconnect the 680-ohm resistor from D and E on T7. Connect two 68,000-ohm resistors (within 1% of each other) in series, across C81. Connect the common lead to the "VoltOhmyst" to the center point of the 68,000-ohm resistors and the d-c probe to contact No. 7 on the rear of S7. Use the 30-volt meter range.			
4	Same as step 2	Same as step 2	Maximum volume	*T7 bottom core for zero d-c balance on "VoltOhmyst" **T7 top core for minimum audio output. (Output meter across voice coil)
5	Reconnect "VoltOhmyst" as in step 1, omitting the 680-ohm resistor.			
6	Repeat step 2, omitting 680 ohms.			
7	Remove all connections.			

* Near the correct core position the zero point is approached rapidly and continued adjustment causes the indicated polarity to reverse. A slow approach to the zero point is an indication of severe detuning, and the bottom core should be turned in the opposite direction.

** The zero d-c balance and the min. a-f output should occur at the same point; if such is not the case, the two cores should be adjusted until both occur with no further adjustment of either core. It may be advantageous to adjust both cores simultaneously, watching the "VoltOhmyst," and an output meter connected across the voice coil for the point at which both zero d-c and min. output occur.

NOTE.—Two or more points may be found which will satisfy the condition required in step 4. T7 top core should be correctly adjusted when approximately ⅛ inch of threads extend above the can, therefore, it is desirable to start adjustment with top core at the max. "in" position and turn out, while adjusting the bottom core, until the first point of minimum a-f and minimum d-c is reached.

FM I-F ALIGNMENT

Steps	Connect the High Side of the Test Osc. to—	Connect Ground Side of the Test Osc.	Tune the Test Osc. to—	Radio Dial Tuned to—	Adjust
1	Connect "VoltOhmyst" d-c probe to negative lead of C81, and the meter common lead to chassis ground.				
2	Mixer grid (pin #1) of 6BA6 (V2) in series with .01 mfd (Adjust test osc. output for 6-10 volts developed across C81)	To r-f tube shelf ground	10.7 mc., 30% modulated at 400 cycles AM	Max. cap. (Fully meshed) (Function switch in FM position)	***T5, T3 and T1 top and bottom cores alternately loading pri. and sec. of each trans. with 680 ohms while the opposite side of the same trans. is being adjusted. Adjust all for max. voltage across C81

*** This method, which is known as alternate loading, involves the use of a 680-ohm resistor to load the plate winding while the grid winding of the same transformer is being peaked. Then the grid winding is loaded with 680-ohm resistor while the plate winding is being peaked. When windings are loaded, it is necessary to increase the 10.7 mc. input, since gain will decrease and voltage across C81 will be less.

AM I-F, OSC, R-F AND ANT ALIGNMENT

Test-Oscillator.—For all alignment operations, connect the low side of the test-oscillator to the receiver chassis, and keep the oscillator output as low as possible to avoid a-v-c action.

Output Meter.—Connect the meter across the speaker voice coil, and turn the receiver volume control to maximum.

Steps	Connect the High Side of the Test Osc. to—	Tune Test Osc. to—	Function Switch	Turn Radio Dial to—	Adjust the following
1	Pin #1 of 6BA6 (V2) in series with .01 mfd	455 kc.	"C" Band	High Freq. end of Dial	†Top and bottom cores of T2 and T4. (For max. voltage across voice coil.)
2	Ant. term #4 through dummy ant. of 25 mmfs in series with 150 ohms	15.5 mc.	"C" Band	15.5 mc.	††Osc.—C37; R-F—C15; Ant.—C8.
3		9.5 mc.	"C" Band	9.5 mc.	†††Osc.—L17; R-F—L12; Ant.—L5.
4	Repeat steps 2 and 3 for accurate alignment.				
5	Ant. term #4 through dummy ant. of 200 mmfs.	1400 kc.	"A" Band	1400 kc.	Osc.—C36; R-F—C84; Ant.—C90. (For max. voltage across voice coil.)
6		600 kc.	"A" Band	600 kc.	Osc.—L18; R-F—L13; Ant.—L21. (For max. voltage across voice coil.)
7	Repeat steps 5 and 6 for maximum output.				

RADIO ALIGNMENT PROCEDURE

AM I-F, OSC, R-F AND ANT ALIGNMENT (Continued)

†It is necessary to alternately load the primary and secondary of each 455-kc. i-f transformer with 10,000 ohms while the opposite side of the same transformer is being adjusted.

††To guard against the possibility of alignment of L17 and C37 to image frequencies, tune the test oscillator to 16.41 mc. (image frequency). By increasing the test oscillator output, a signal should be heard.

†††Tune the test oscillator to 10.41 mc. (image frequency). By increasing the test oscillator output, a signal should be heard. (If these image frequencies cannot be heard, the set is incorrectly aligned, therefore repeat steps 2 and 3.)

FM OSC, R-F AND ANT ALIGNMENT

Steps	Connect High Side of the Test Osc. to—	Connect Ground Side of the Test Osc.	Tune Test Osc. to—	Radio Dial Tuned to—	Adjust
1	Ant. term. #4 in series with 120-ohm resistor	Ant. term. #5 in series with 120 ohms	106 mc.	106 mc.	OSC, C20 for max. voltage across C81.
2			88 mc.	88 mc.	*OSC, L9 for max. voltage across C81.
3	Repeat steps 1 and 2 for accurate alignment.				
4	Remove or turn Test Oscillator off.			106 mc.	**R-F, C13 for max. noise voltage across C81.
5				90 mc.	*R-F, L11 for max. noise voltage across C81.
6	Repeat steps 4 and 5 for maximum output.				
7	Ant. term. #4 in series with 120-ohm resistor	Ant. term. #5 in series with 120 ohms	106 mc.	106 mc.	Ant. C5 for max. voltage across C81.
8			90 mc.	90 mc.	Ant. L3 for max. voltage across C81.
9	Repeat steps 7 and 8 for maximum output.				

* Two points may be found to fulfill the requirements. Use the one with the longest threaded end extending out of the transformer.
** Two points can be found having the greatest noise voltage developed. Use the one with the greater capacity (tighter adjustment).

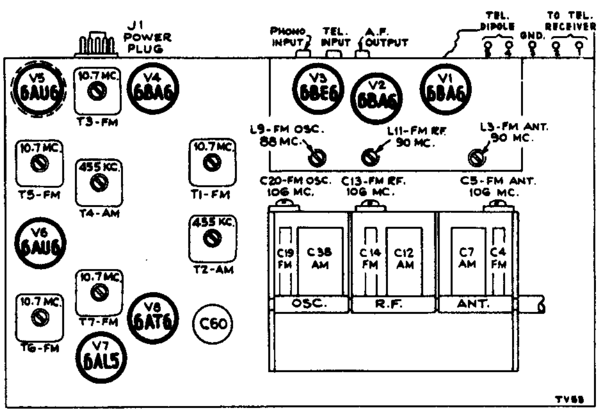


Figure 116—Chassis, Top View, Showing Adjustments

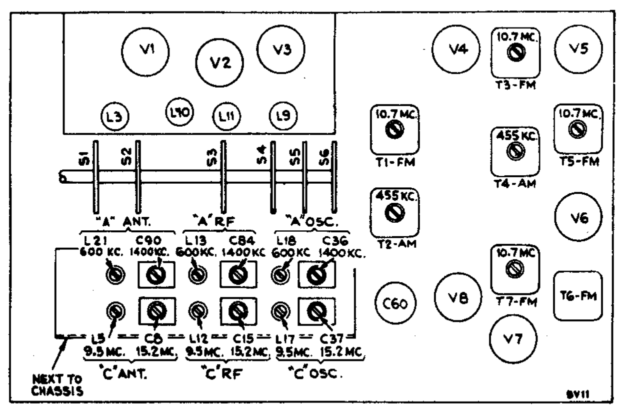


Figure 117—Chassis, Bottom View, Showing Adjustments

PUSH BUTTON ADJUSTMENT

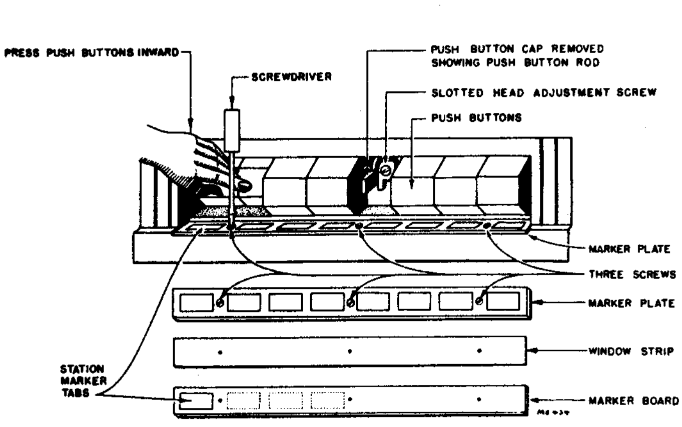


Figure 118—Push Button Adjustments

The push buttons should be adjusted for eight favorite stations after the receiver is operating, and has had a 5 or 10 minute warm-up period.

Any standard broadcast or frequency modulation stations may be chosen. The preferable arrangement is to adjust for stations in the order of frequency, from low to high. Proceed as follows:

1. Remove the first push button (just pull) and note the adjustment screw beneath.
2. Loosen the adjustment screw.
3. Manually tune very accurately for the desired station.
4. Push the push button rod in till it is against stop.
5. Tighten adjustment screw.
6. Make adjustment for the other buttons, setting up and checking each for the chosen station in a similar manner.
7. Recheck all push buttons and reset if found necessary.

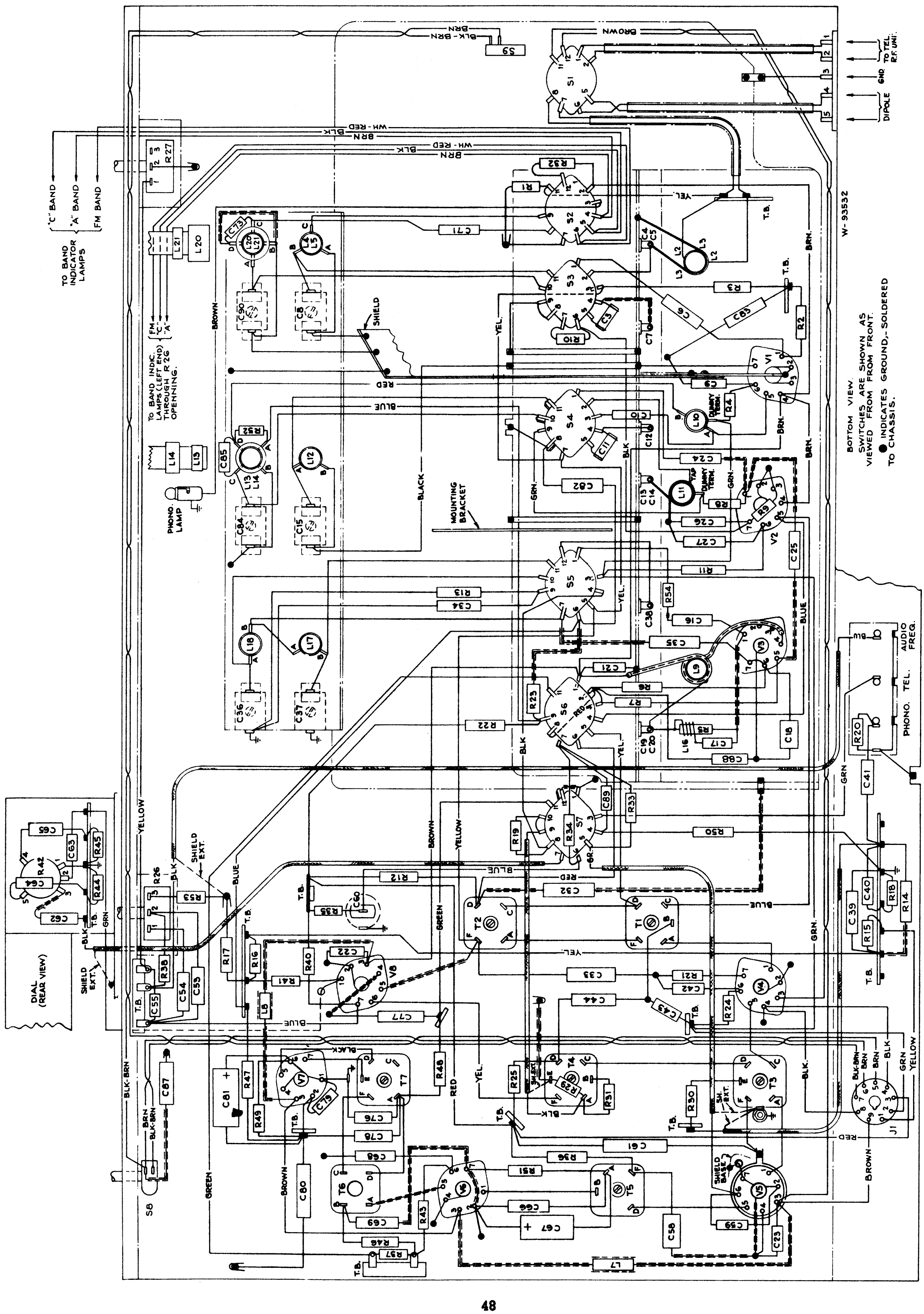


Figure 119—Radio Chassis Wiring Diagram

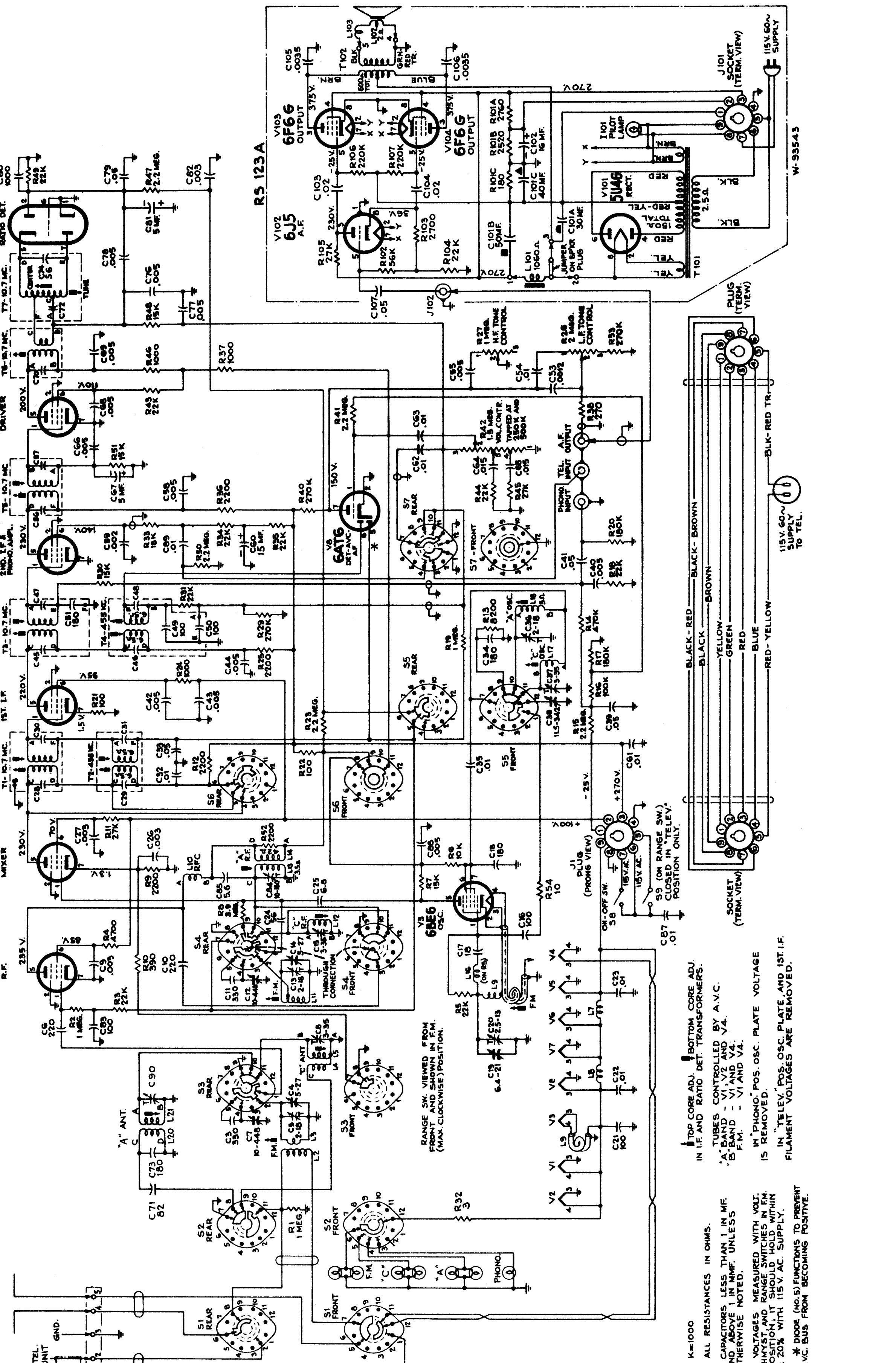


Figure 120—Radio and Audio Amplifier Schematic Diagram

RADIO MISCELLANEOUS DATA

RADIO VOLTAGE CHART

All voltages were measured with respect to ground, using a "VoltOhmyst."

Tube	Type		Pin #	Tel. or Phono	B.C.	S.W.	F.M.
V1	6BA6	Plate	5	260	225	220	235
		SCG	6	95	110	90	85
V2	6BA6	Plate	5	260	255	240	230
		SCG	6	90	100	70	70
		Cathode	7	6	6.5	1.8	1.3
V3	6BE6	Plate	5	0	160	155	140
		Grids 2-3-4	6, 7	0	155	160	140
		Grid 1	1	—	–5.2 (1600 KC)	–10.5 (9.5 MC)	–6.6 (108 MC)
		Grid 1	1	—	–2.7 (550 KC)	–15.5 (16.2 MC)	–9 (88 MC)
V4	6BA6	Plate	5	245	250	230	220
		SCG	6	110	120	105	95
		Cathode	7	1.4	1.2	1.4	1.5
V5	6AU6	Plate	5	255	245	240	230
		SCG	6	145	140	140	140
V6	6AU6	Plate	5	0	0	0	200
		SCG	6	0	0	0	110
V7	6AL5	—	—	—	—	—	—
V8	6AT6	Plate	7	150	150	150	150
V101	5U4G	Fil.	8	380	—	—	—
V102	6J5	Plate	3	230	—	—	—
		Cathode	8	36	—	—	—
V103 V104	6F6G	Plate	3	375	—	—	—
		SCG	4	270	—	—	—
		Grid	5	–25	—	—	—

CATHODE CURRENTS WITH FUNCTION SWITCH IN FM POSITION

V1	R-F Amp.	14 ma.	V7	Ratio Det.	—
V2	Mixer	4.7 ma.	V8	Det.-Avc.-AF	.5 ma.
V3	Osc.	15.9 ma.		Power Amp. RS123A	
V4	First I-F	12.4 ma.	V101	Rectifier	140 ma.
V5	2nd I-F-Phono. Amp.	5.6 ma.	V102	Phase Inverter	2.15 ma.
V6	Driver FM	13.7 ma.	V103, V104	Power Output	27 ma. each

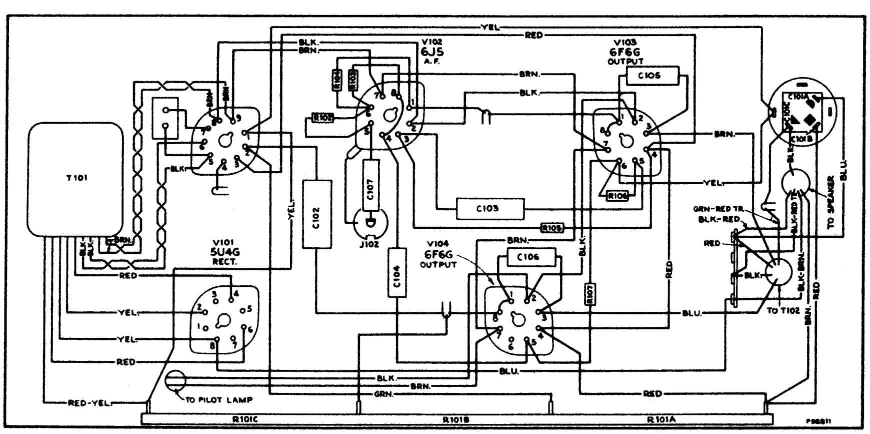


Figure 121—Audio Amplifier Wiring Diagram

CRITICAL LEAD DRESS

(Any lead dress should be made before alignment.)

1. Lead from pin 5, tube V2, to terminal "C" on transformer T1 should be dressed close to chassis.
2. Leads to terminals "C" and "D" on transformer T2 should be dressed close together.
3. The following capacitors must be dressed close to the chassis with leads kept as short as possible: C32, C33, C66, C69, C79, and C80.
4. All FM coil connections must be soldered in exact place as the original. (One-sixteenth inch difference in length may be excessive.)
5. Lead from pin 7, tube V8, must be dressed away from lead to terminal "D" of transformer T7.
6. All r-f and i-f wiring in the receiver is critical as to length and placement. It is therefore important when servicing, that extreme care should be taken so as not to disturb more of the wiring than absolutely necessary.

NOTE: Keep tuning capacitor rotor grounding brushes clean and making good contact.

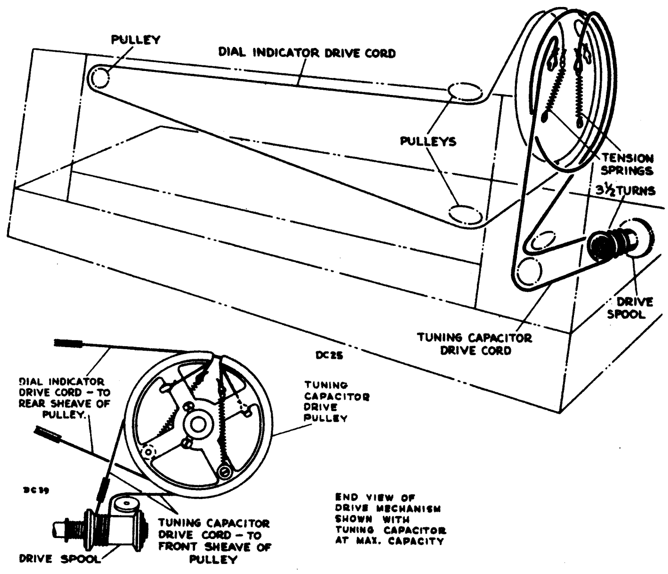


Figure 122—Dial and Drive Cord Assembly

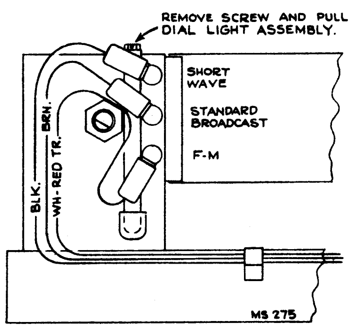


Figure 123—Removal of Dial Lamps

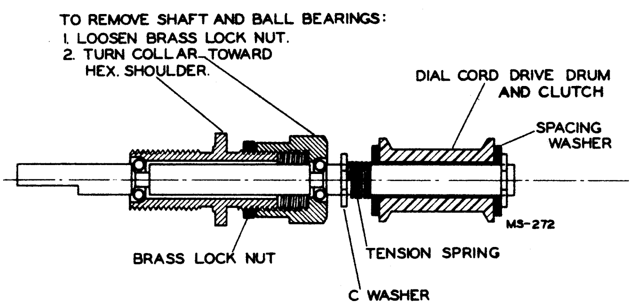


Figure 124—Tuning Shaft and Clutch Assembly

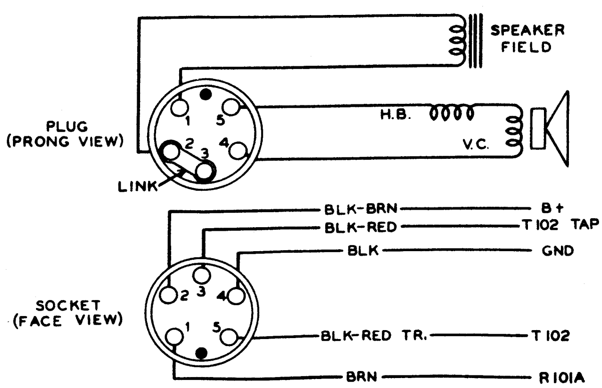


Figure 125—Speaker Connections

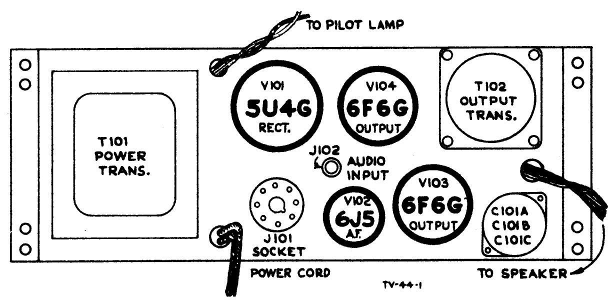


Figure 126—Top View of RS123A

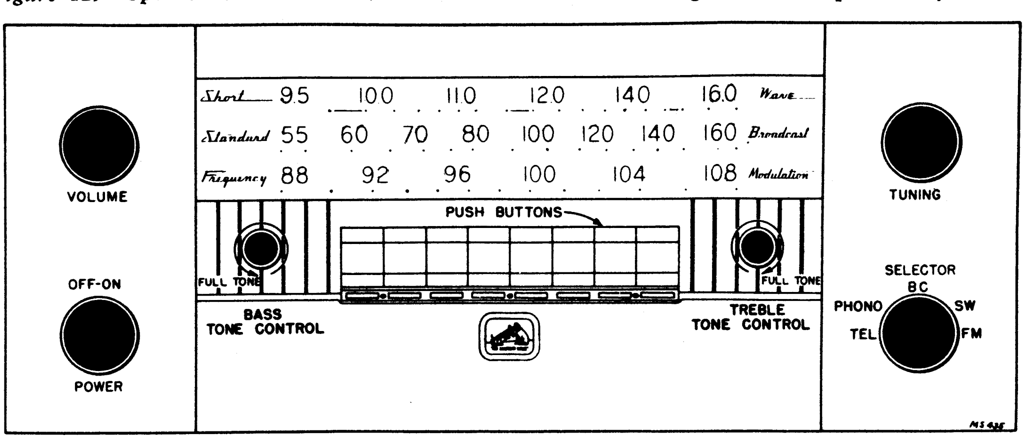


Figure 127—Radio Control Panel

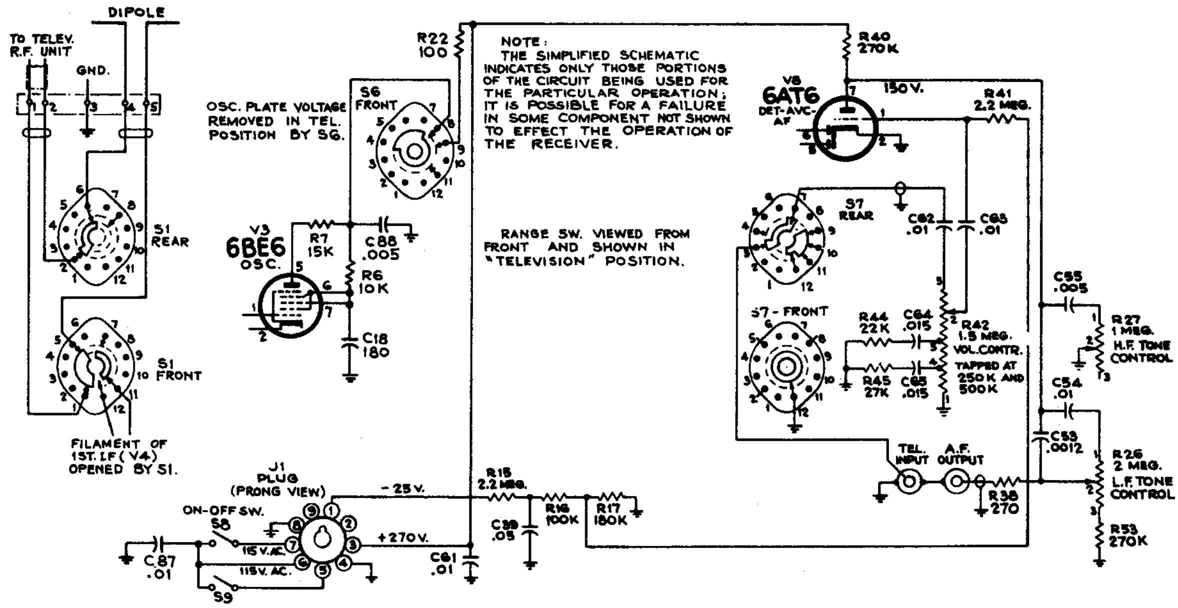


Figure 128—Simplified Schematic—Shown in Television Position

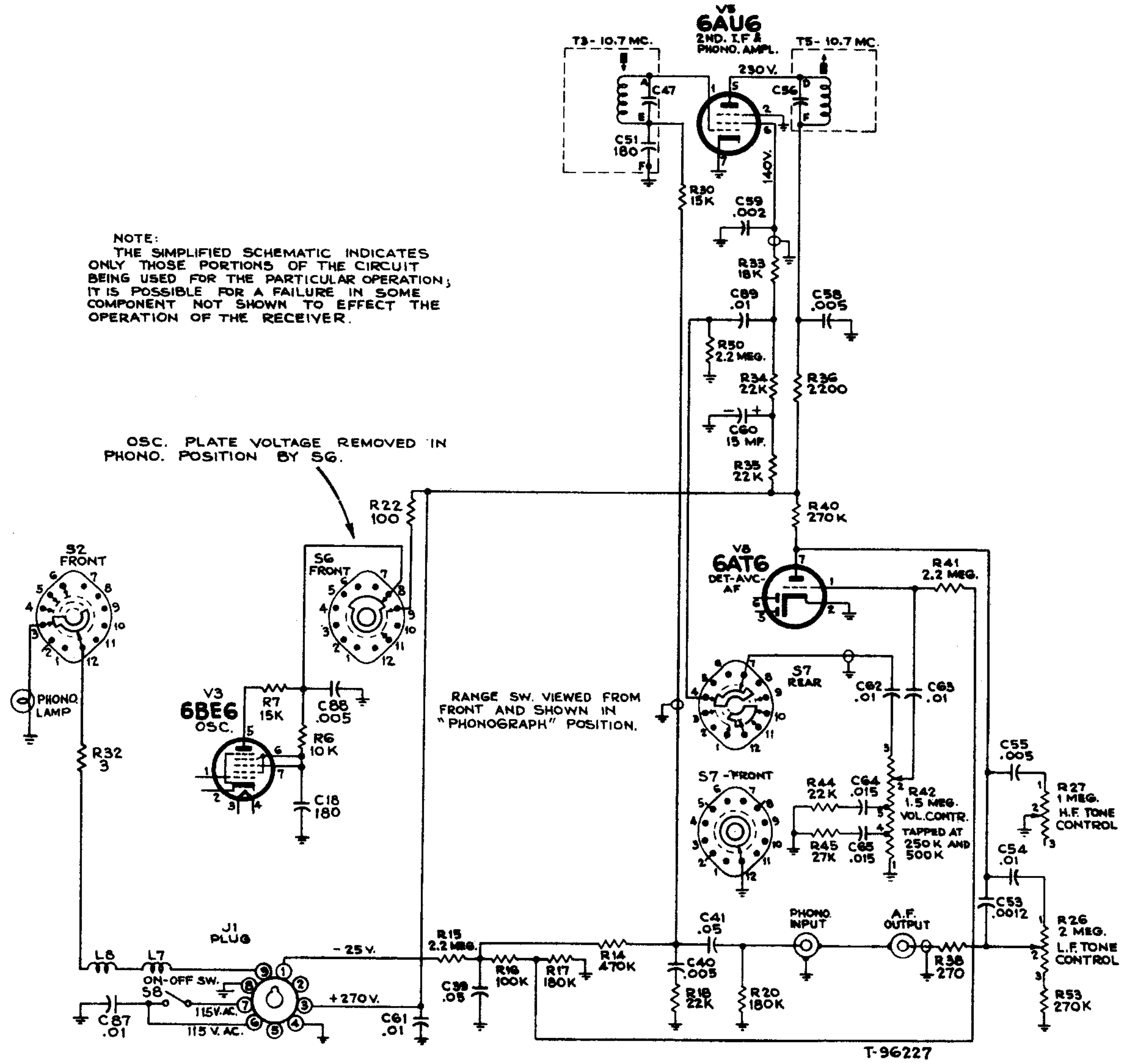


Figure 129—Simplified Schematic—Shown in Phono Position

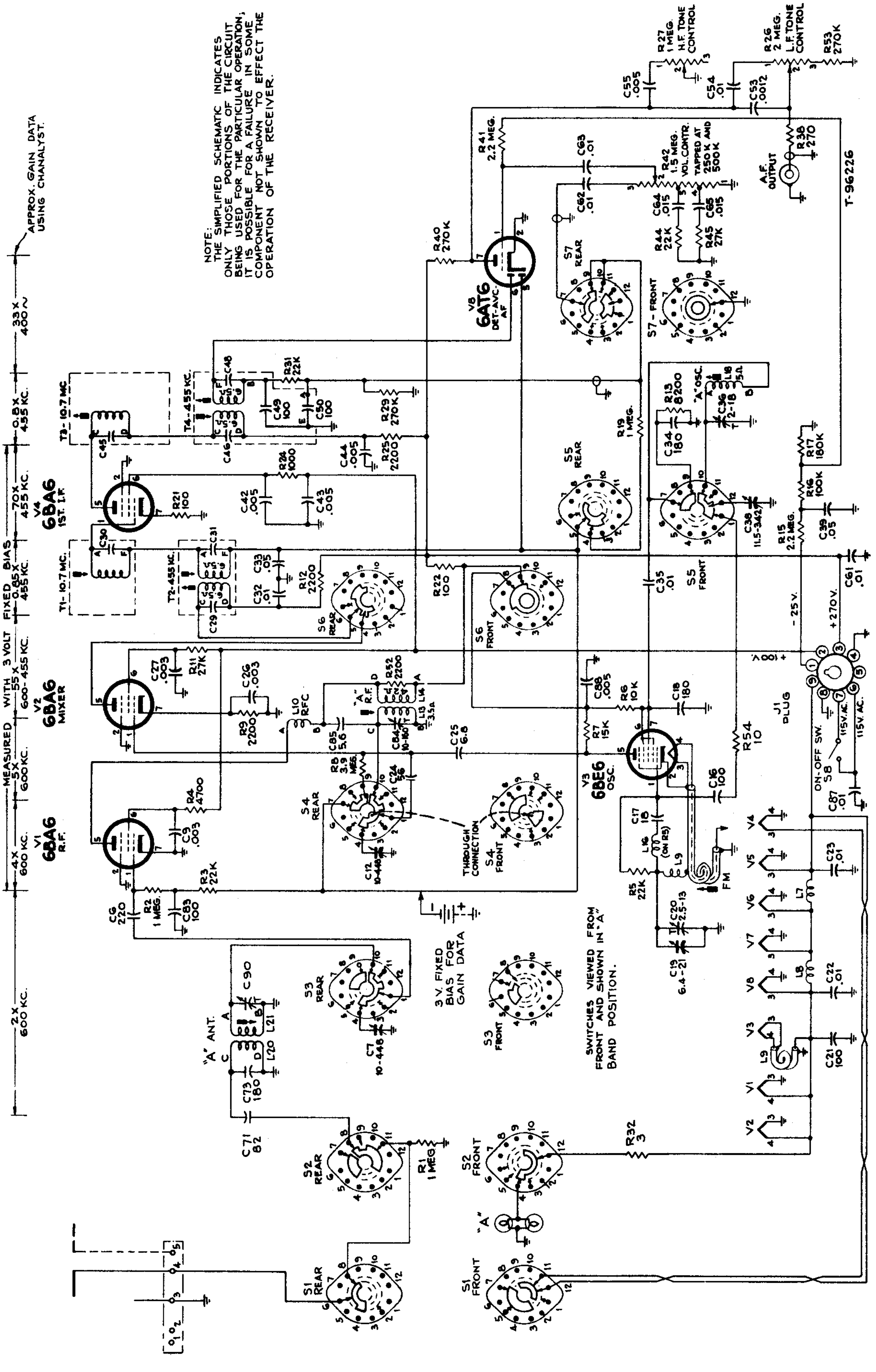


Figure 130—Simplified Schematic—Shown in "A" Band Position

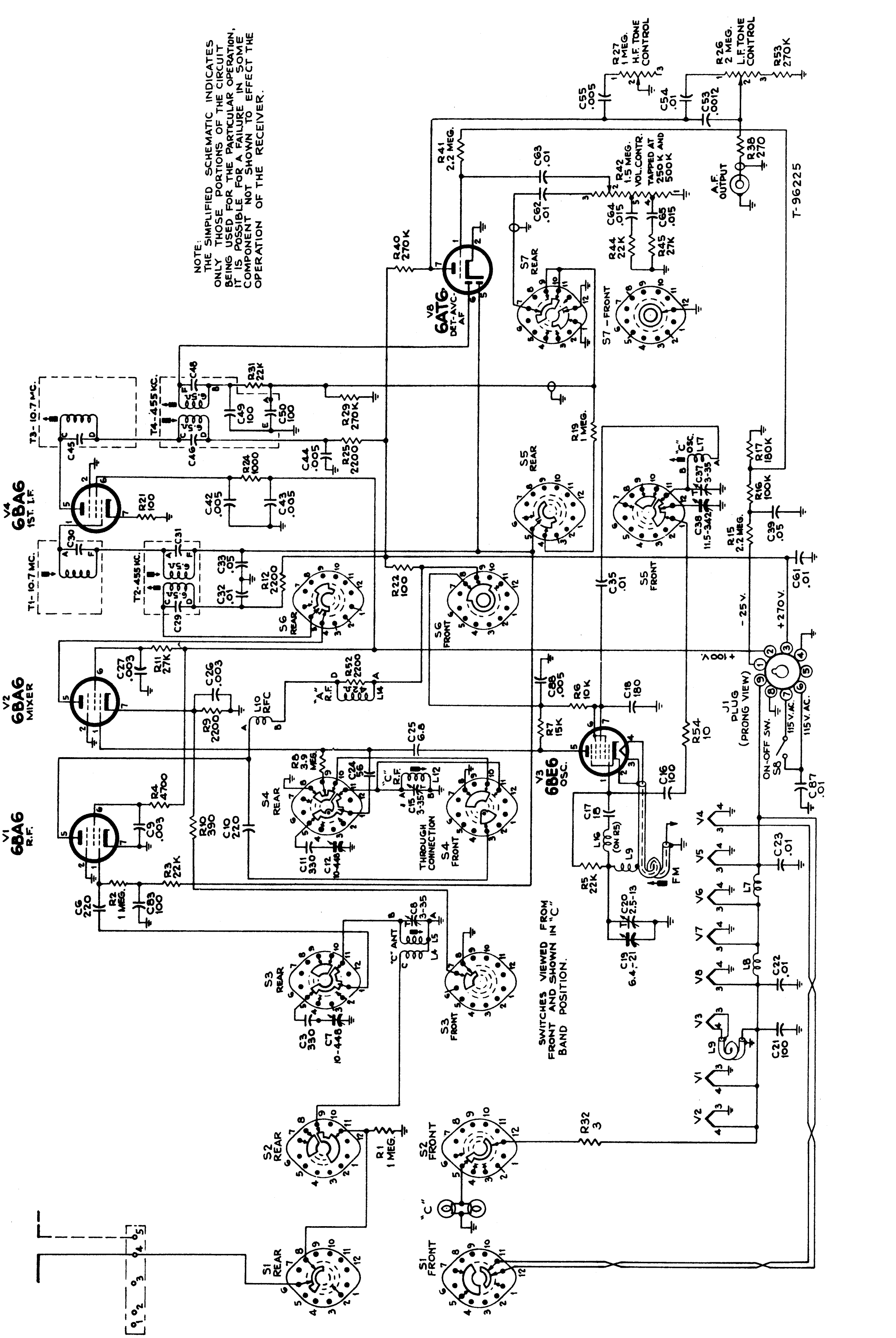


Figure 131—Simplified Schematic—Shown in "C" Band Position

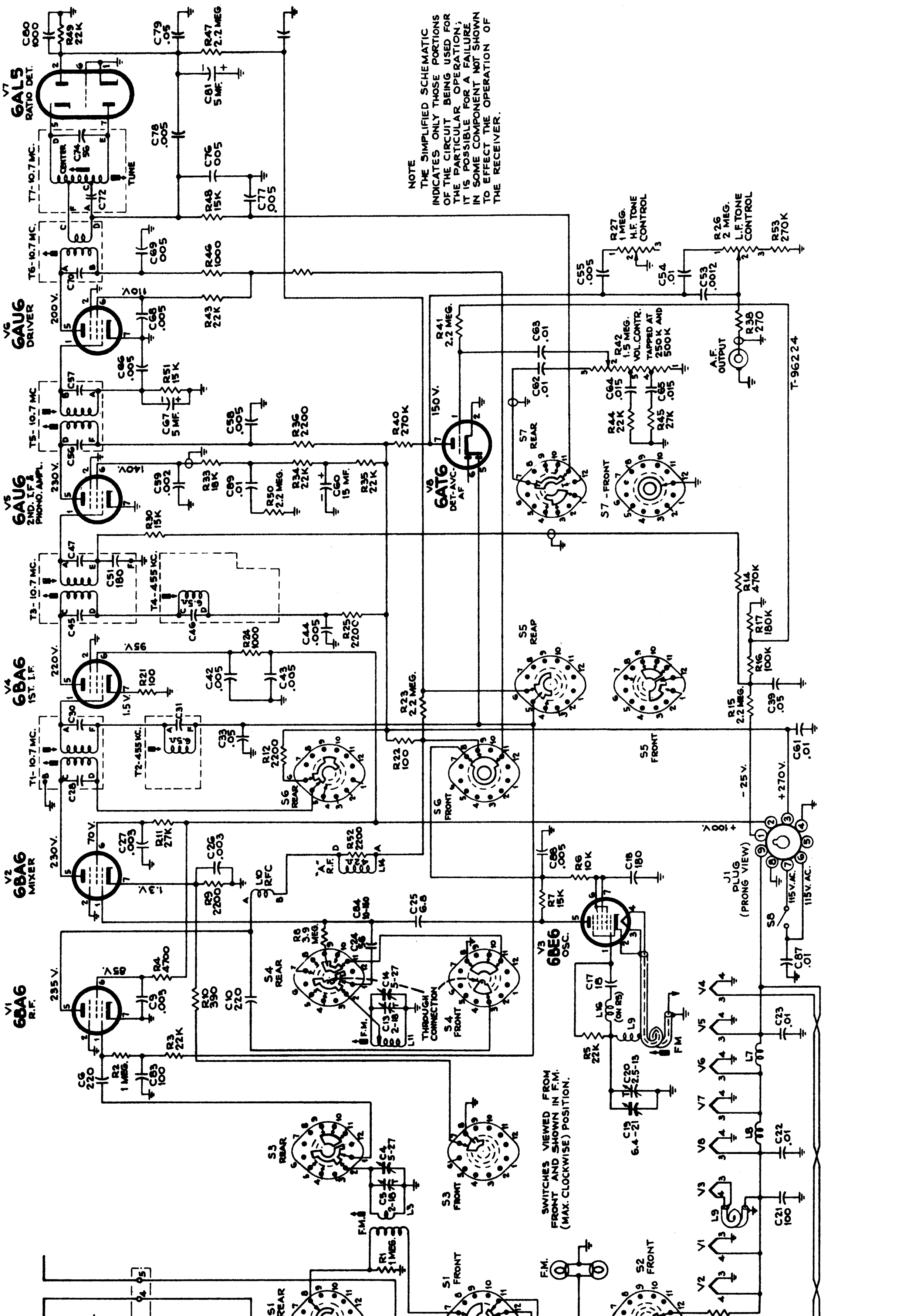
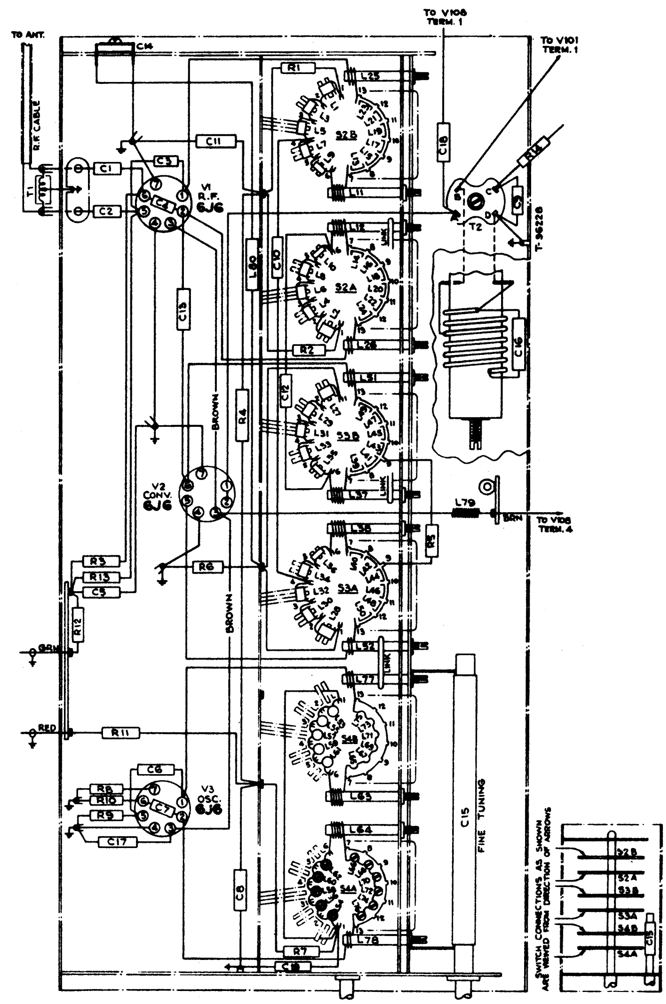


Figure 132—Simplified Schematic—Shown in FM Position

TELEVISION CHASSIS WIRING DIAGRAMS



Note: In some units C19 is omitted.

In most units C14 is fixed.

Figure 133—Television R-F Unit Wiring Diagram

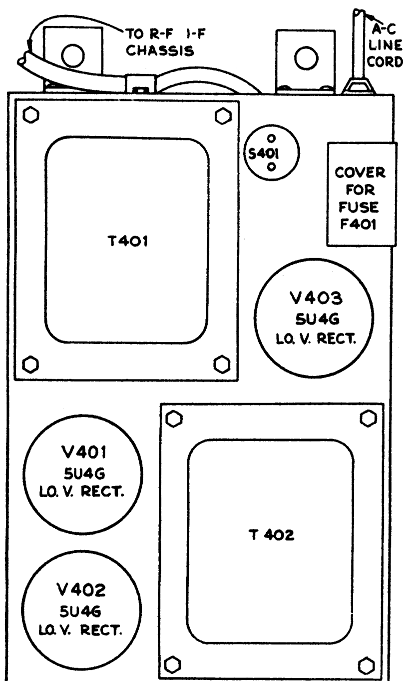


Figure 134—Power Supply, Top View

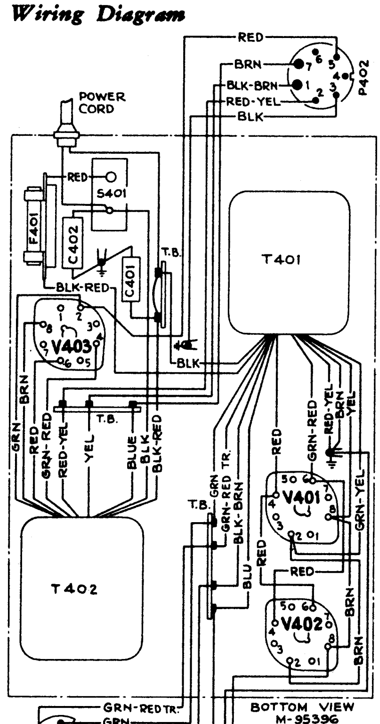


Figure 135—Power Supply Wiring Diagram.

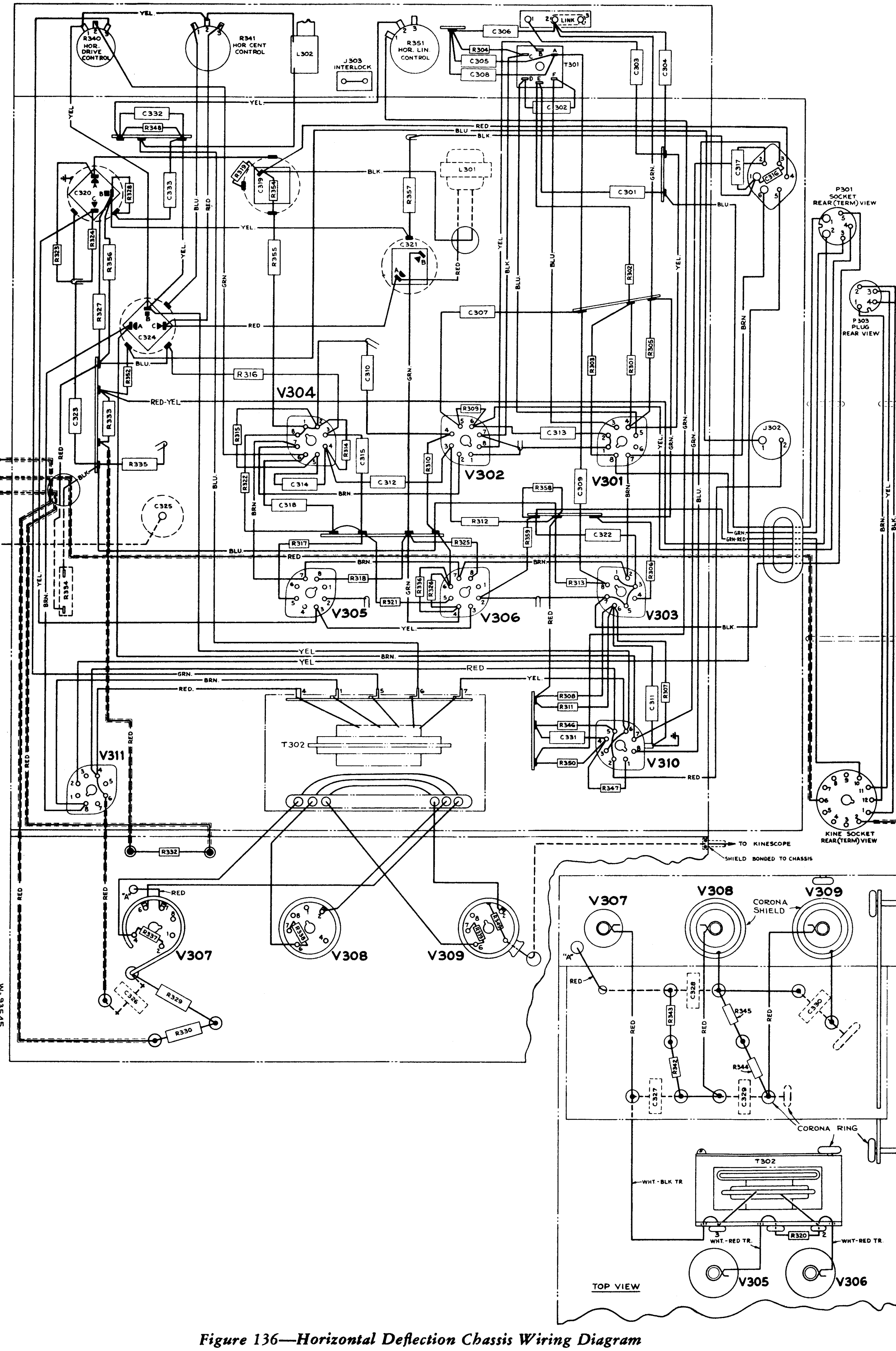


Figure 136—Horizontal Deflection Chassis Wiring Diagram

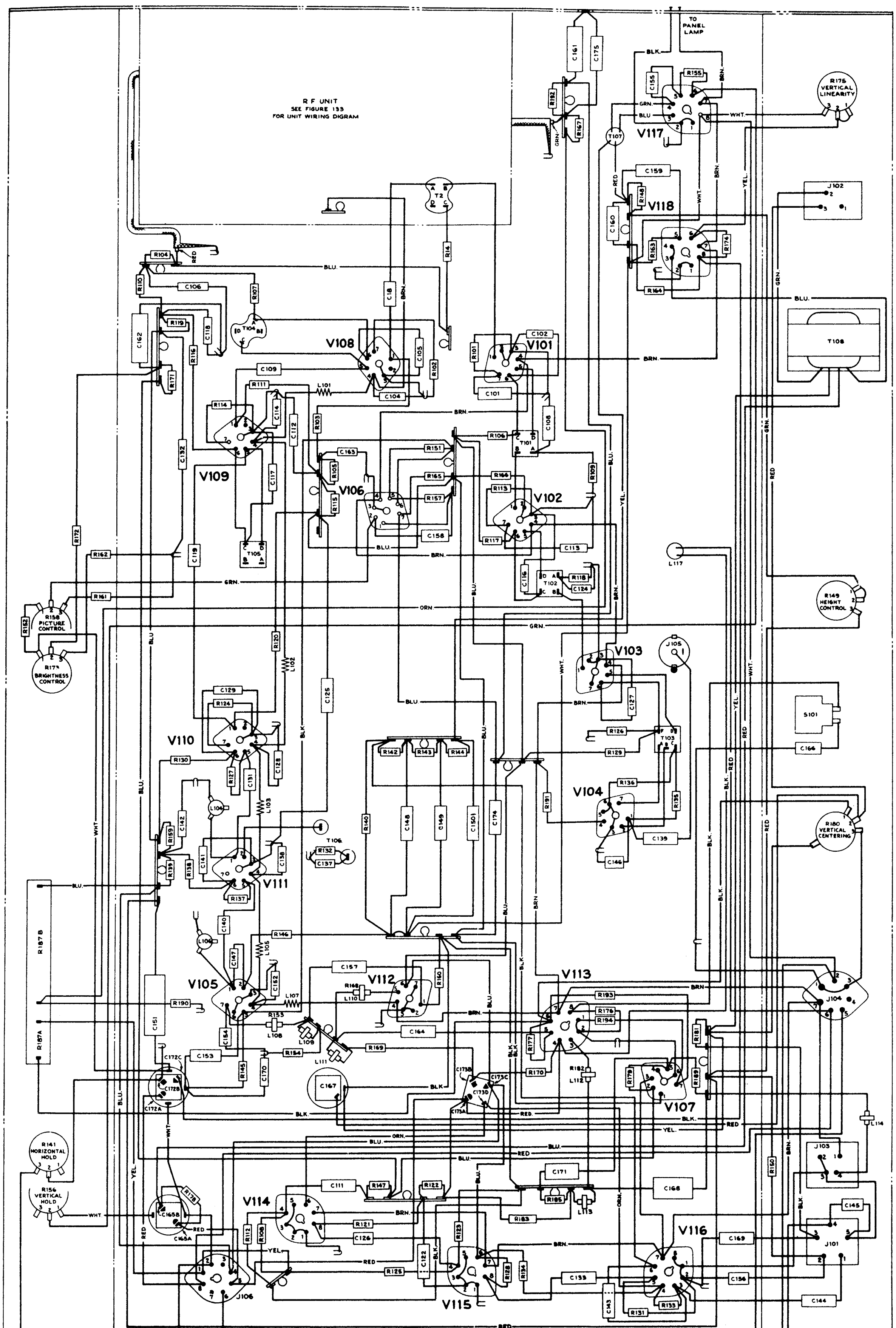


Figure 137—R-F, I-F Chassis Wiring Diagram

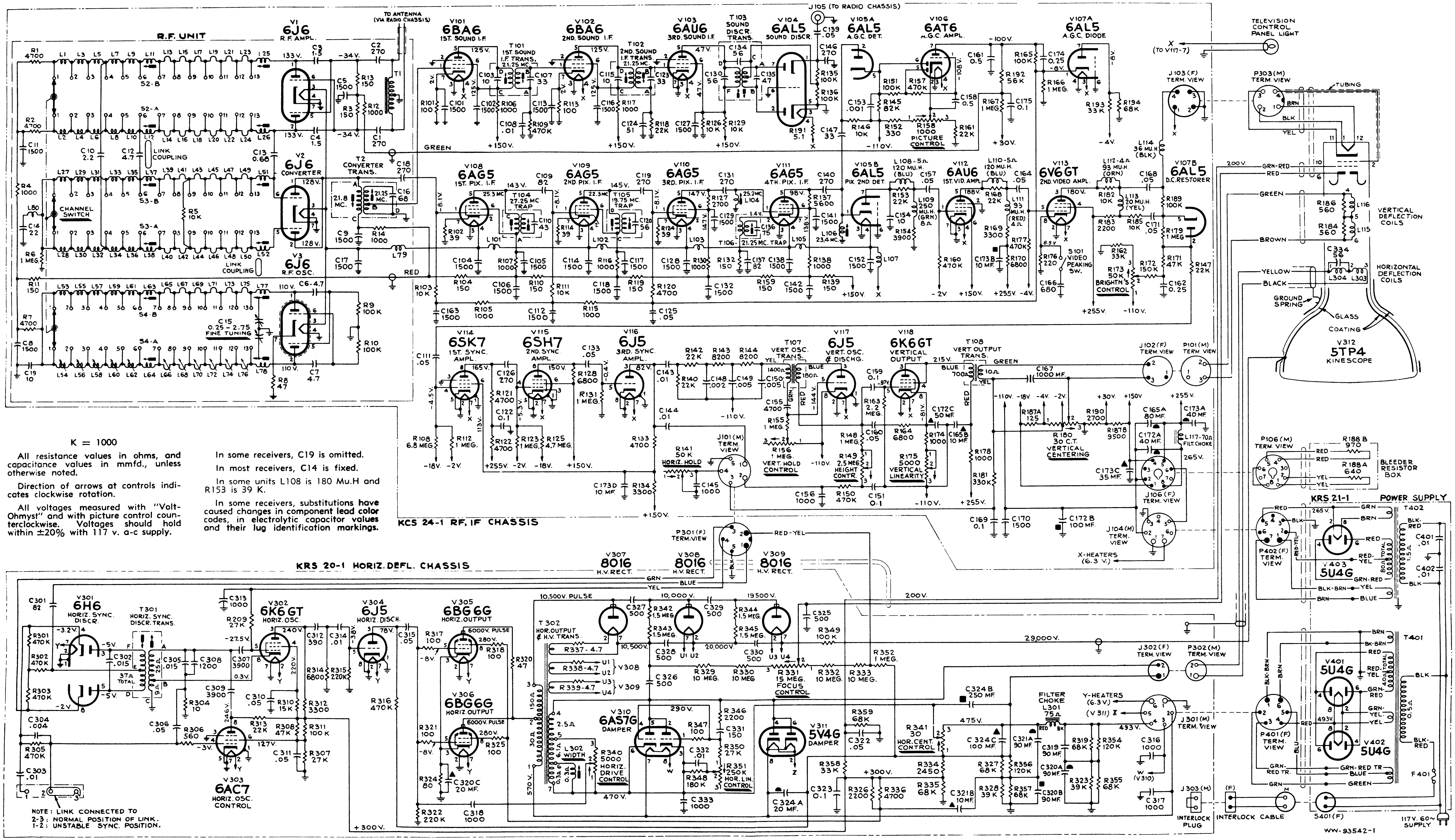


Figure 138—Television Schematic Diagram

STOCK No.	DESCRIPTION
	TELEVISION R-F UNIT
	KRK2A
71504	Capacitor—Ceramic, 0.68 mmf. (C13)
71500	Capacitor—Ceramic, 1.5 mmf. (C3, C4)
71502	Capacitor—Ceramic, 2.2 mmf. (C10)
71520	Capacitor—Ceramic, 4.7 mmf. (C6, C7, C12)
33101	Capacitor—Ceramic, 22 mmf. (C14)
71540	Capacitor—Ceramic, 270 mmf. (C1, C2)
65401	Capacitor—Mica, 270 mmf. (C18)
71501	Capacitor—Ceramic, 1500 mmf. (C5, C8, C9, C11, C17)
72122	Coil—Channel #1 r-f amplifier plate coil—front or rear section or channel #1 converter grid coil—front or rear section (L1, L2, L27, L28)
71479	Coil—Channels #2 and #3 r-f amplifier plate coil —front or rear section or channels #2 and #4 converter grid coil—front or rear section (L3, L4, L5, L6, L29, L30, L33, L34)
71480	Coil—Channel #4 r-f amplifier plate coil—front or rear section (L7, L8)
71481	Coil—Channel #5 r-f amplifier plate coil—front or rear section or channel #5 converter grid coil—front or rear section (L9, L10, L35, L36)
71492	Coil—Channel #6 oscillator, converter grid or r-f amplifier plate coil—front or rear sections (L11, L12, L37, L38, L63, L64)
71491	Coil—Channel #13 converter grid or r-f amplifier plate coil—rear section (L25, L51)
71490	Coil—Channel #13 converter grid or r-f amplifier plate coil—front section (L26, L52)
72597	Coil—Channel #3 converter grid coil—front or rear section (L31, L32)
71469	Coil—Channel #1 oscillator coil—front or rear section (L53, L54)
71471	Coil—Channel #5 oscillator coil—front section or channel #2 oscillator coil—rear section (L55, L62)
71470	Coil—Channels #2, #3 and #4 oscillator coil—front sections (L56, L58, L60)
72552	Coil—Channel #3 oscillator coil—rear section (L57)
72553	Coil—Channel #4 oscillator coil—rear section (L59)
71472	Coil—Channel #5 oscillator coil—rear section (L61)
71489	Coil—Channel #13 oscillator coil—rear section (L77)
71488	Coil—Channel #13 oscillator coil—front section (L78)
71505	Coil—Heater choke coil (L79)
71506	Coil—Converter grid i-f choke coil (L80)
71493	Connector—Segment connector
71597	Core—Channel #13 front and rear oscillator coils' adjustable core and stud
71498	Core—Channels #6 and #13 front and rear converter grid coils or front and rear r-f amplifier plate coils adjustable core and stud
71497	Core—Channel #6 front and rear oscillator coils adjustable core and stud
71463	Detent—R-F unit detent mechanism and fiber shaft
71465	Disc—Rotor disc for fine tuning control (Part of C15)
71464	Drive—Fine tuning pinch washer drive
71487	Form—Coil form only for channels #6 and #13 coils—less winding
71462	Loop—Oscillator to converter grid coupling loop
30732	Resistor—47 ohms, ½ watt (R8)
30880	Resistor—150 ohms, ½ watt (R3, R11, R13)
34766	Resistor—1000 ohms, ½ watt (R4, R12, R14)
30494	Resistor—4700 ohms, ½ watt (R1, R2, R7)
3078	Resistor—10,000 ohms, ½ watt (R5)
3252	Resistor—100,000 ohms, ½ watt (R9, R10)
30652	Resistor—1 megohm, ½ watt (R6)
14343	Ring—Retaining ring for drive
71475	Screw—#4-40 x 15/32" adjusting screw for coils L54, L56, L58, L60, L62
71476	Screw—#4-40 x ¼" binder head screw for adjusting coils L66, L68, L70, L72, L74, L76
71473	Segment—Converter grid section front segment—less coils or r-f amplifier plate section front segment—less coils (Part of S2, S3)
71474	Segment—Converter grid section rear segment—less coils or r-f amplifier plate section rear segment—less coils (Part of S2, S3)
71467	Segment—Oscillator section front segment—less coils (Part of S4)
71468	Segment—Oscillator section rear segment—less coils (Part of S4)
72951	Shield—Lead tube shield for V3
71494	Socket—Miniature tube socket
71461	Spring—Snap spring to hold fine tuning shaft
71466	Stator—Oscillator fine tuning stator and bushing (Part of C15)
71507	Transformer—Antenna transformer (T1)
71495	Transformer—Converter transformer (T2, C16)
	TELEVISION R-F, I-F CHASSIS
	KCS24-1
71894	Bearing—R-F unit shaft bearing
*72620	Cable—Television antenna cable
72615	Capacitor—Mica, 10 mmf. (C154)
33111	Capacitor—Ceramic, 33 mmf. (C147)
71771	Capacitor—Ceramic, 51 mmf. (C124)
72614	Capacitor—Mica, 82 mmf. (C109)
71514	Capacitor—Ceramic, 82 mmf. (C137)
39638	Capacitor—Mica, 270 mmf. (C119, C126, C131, C140, C146)
39648	Capacitor—Mica, 680 mmf. (C166)
39652	Capacitor—Mica, 1000 mmf. (C145)
72616	Capacitor—Mica, 1000 mmf. (C156)
71501	Capacitor—Ceramic, 1500 mmf. (C101, C102, C104, C105, C106, C112, C113, C114, C116, C117, C118, C127, C128, C129, C132, C138, C141, C142, C152, C163, C170)
72524	Capacitor—Mica, 4700 mmf. (C155)
70600	Capacitor—Tubular, .001 mfd., 400 volts (C153)
70601	Capacitor—Tubular, .002 mfd., 400 volts (C148)
70606	Capacitor—Tubular, .005 mfd., 400 volts (C149, C150)
70610	Capacitor—Tubular, .01 mfd., 400 volts (C108, C143, C144)
70615	Capacitor—Tubular, .05 mfd., 400 volts (C111, C125, C133, C139, C157, C164)
71702	Capacitor—Moulded paper, .05 mfd., 400 volts (C168, C171)
71515	Capacitor—Oil, .05 mfd., 600 volts (C160)
70618	Capacitor—Tubular, 0.25 mfd., 400 volts (C162, C174)
*70659	Capacitor—Tubular, 0.1 mfd., 1000 volts (C151)
70617	Capacitor—Tubular, 0.1 mfd., 400 volts (C122, C169, C175)
70638	Capacitor—Tubular, 0.1 mfd., 600 volts (C159)
70619	Capacitor—Tubular, 0.5 mfd., 400 volts (C158, C161)
*72611	Capacitor—Electrolytic, 1000 mfd., 3 volts non-polarized (C167)
71780	Capacitor—Electrolytic, comprising 1 section of 80 mfd., 450 volts, and 1 section of 10 mfd., 450 volts (C165A, C165B)
*72612	Capacitor—Electrolytic, comprising 1 section of 40 mfd., 450 volts, 1 section of 100 mfd., 150 volts, and 1 section of 50 mfd., 50 volts (C172A, C172B, C172C)
*72169	Capacitor—Electrolytic, comprising 1 section of 40 mfd., 450 volts, 1 section of 10 mfd., 450 volts, 1 section of 35 mfd., 350 volts, and 1 section of 10 mfd., 350 volts (C173A, C173B, C173C, C173D)
*72167	Choke—Filter choke (L117)
71505	Coil—Filament choke coil (L101, L102, L103, L105, L107)
71426	Coil—Third or fourth picture i-f coil (L104, L106)
71526	Coil—Choke coil (L109)
71527	Coil—Choke coil (L111)
*72618	Coil—Choke coil (L113)
71793	Coil—Choke coil (L114)
*72619	Coil—Peaking coil (L112, R182)
71529	Coil—Peaking coil (L110, R168, L108, R153)
*71971	Control—Brightness and picture control (R158, R173)
71440	Control—Height control (R149)
*72168	Control—Vertical centering control (R180)
71441	Control—Vertical linearity control (R175)
72758	Control—Vertical and horizontal hold control (R141, R156)
*72175	Cover—Insulating cover for electrolytics #71780 and #72612
35787	Jack—Output jack for audio cable
18469	Plate—Bakelite mounting plate for electrolytics #71780, #72611, #72612
*72174	Plug—5-prong male plug for cable from high-voltage horizontal deflection supply (J101)
14404	Plug—7-prong male plug for cable from television power supply (J104)

APPLY TO YOUR RCA DISTRIBUTOR FOR PRICES OF REPLACEMENT PARTS

* This is the first time this Stock No. has appeared in Service Data.

STOCK No.	DESCRIPTION
72067	Resistor—5.1 ohms, ½ watt (R191)
11956	Resistor—39 ohms, ½ watt (R102, R114, R124)
34765	Resistor—100 ohms, ½ watt (R101, R113)
30880	Resistor—150 ohms, ½ watt (R104, R110, R119, R132, R139, R159)
5201	Resistor—220 ohms, ½ watt (R176)
8063	Resistor—330 ohms, ½ watt (R152)
34766	Resistor—1000 ohms, ½ watt (R105, R106, R107, R115, R116, R117, R130, R138, R174)
71916	Resistor—1000 ohms, 1 watt (R178)
*72613	Resistor—Wire wound, 2200 ohms, 10 watts (R183)
30730	Resistor—2700 ohms, ½ watt (R127)
38876	Resistor—2700 ohms, 1 watt (R190)
71986	Resistor—3300 ohms, 1 watt (R134)
30733	Resistor—3300 ohms, ½ watt (R169)
30694	Resistor—3900 ohms, ½ watt (R154)
71987	Resistor—4700 ohms, ½ watt (R120)
30494	Resistor—4700 ohms, 1 watt (R121, R122, R133)
30734	Resistor—5600 ohms, ½ watt (R137)
14659	Resistor—6800 ohms, ½ watt (R164)
38887	Resistor—6800 ohms, 1 watt (R128, R170)
14250	Resistor—8200 ohms, ½ watt (R143, R144)
71914	Resistor—10,000 ohms, 1 watt (R103, R111, R126, R129, R146, R185)
30492	Resistor—22,000 ohms, ½ watt (R118, R140, R142, R147)
71989	Resistor—22,000 ohms, 1 watt (R161)
30685	Resistor—33,000 ohms, ½ watt (R162, R193)
30787	Resistor—47,000 ohms, ½ watt (R171)
30650	Resistor—56,000 ohms, ½ watt (R192)
14138	Resistor—68,000 ohms, ½ watt (R194)
8064	Resistor—82,000 ohms, ½ watt (R145)
3252	Resistor—100,000 ohms, ½ watt (R135, R136, R151, R165, R189)
30493	Resistor—150,000 ohms, ½ watt (R172)
14983	Resistor—330,000 ohms, ½ watt (R181)
30648	Resistor—470,000 ohms, ½ watt (R109, R150, R157, R160, R177)
*72171	Resistor—Voltage divider, comprising 1 section of 9500 ohms, 2 watts, and 1 section of 125 ohms, 2.5 watts (R187A, R187B)
30652	Resistor—1 megohm, ½ watt (R112, R123, R131, R148, R155, R166, R167, R179)
30649	Resistor—2.2 megohms, ½ watt (R163)
30931	Resistor—4.7 megohms, ½ watt (R125)
31071	Resistor—6.8 megohms, ½ watt (R108)
*72172	Socket—3-contact female socket for deflection yoke cable (J102)
31027	Socket—4-contact female socket for cable from horizontal deflection chassis (J103)
31364	Socket—Lamp socket
72516	Socket—Tube socket—miniature
31251	Socket—Tube socket—wafer
30953	Switch—Video peaking switch (S101)
71424	Transformer—First or second sound i-f transformer (T101, T102, C103, C107, C115, C123)
71427	Transformer—Sound discriminator transformer (T103, C130, C134, C135)
71423	Transformer—First picture i-f transformer (T104, C110)
71425	Transformer—Second picture i-f transformer (T105, C120)
71775	Transformer—Vertical oscillator transformer (T107)
72952	Transformer—Vertical output transformer (T108)
71422	Trap—Sound trap (T106, C136)
	HORIZONTAL DEFLECTION CHASSIS KRS20-1
71454	Board—"Sync Link" board
*72643	Cable—Anode cable complete
72614	Capacitor—Mica, 82 mmf. (C301)
*72640	Capacitor—Mica, 150 mmf. (C331)
72639	Capacitor—Mica, 390 mmf. (C312)
71450	Capacitor—High-voltage filter, 500 mmf. (C325, C326, C327, C328, C329, C330)
39652	Capacitor—Mica, 1000 mmf. (C313, C316, C317, C318, C333)
*72638	Capacitor—Ceramic, 1200 mmf. (C308)
72637	Capacitor—Mica, 3900 mmf. (C307, C309)
70605	Capacitor—Tubular, .004 mfd., 400 volts (C304)
71516	Capacitor—Tubular, oil impregnated, .015 mfd., 400 volts (C302, C305)
70610	Capacitor—Tubular, .01 mfd., 400 volts (C303, C314, C332)
70615	Capacitor—Tubular, .05 mfd., 400 volts (C306, C310, C311, C315, C322)

STOCK No.	DESCRIPTION
70617	Capacitor—Tubular, 0.1 mfd., 400 volts (C323)
*72621	Capacitor—Electrolytic, 90 mfd., 350 volts (C319)
*72622	Capacitor—Electrolytic, comprising 2 sections of 90 mfd., 200 volts, and 1 section of 20 mfd., 50 volts (C320A, C320B, C320C)
*72623	Capacitor—Electrolytic, comprising 1 section of 90 mfd., 350 volts, and 1 section of 10 mfd., 350 volts (C321A, C321B)
*72624	Capacitor—Electrolytic, comprising 1 section of 20 mfd., 150 volts, 1 section of 250 mfd., 15 volts, and 1 section of 100 mfd., 15 volts (C324A, C324B, C324C)
*72179	Choke—Filter choke (L301)
*72180	Coil—Width control coil (L302)
71532	Connector—High-voltage rectifier and horizontal output plate cap connector
71521	Connector—High-voltage filter capacitor connector
*72183	Control—Focus control (R331)
71441	Control—Horizontal drive control (R340)
*72181	Control—Horizontal centering control (R341)
*72182	Control—Horizontal linearity control (R351)
*72186	Cord—Interlock cord less male plug
33846	Coupling—Focus control shaft coupling
72175	Cover—Insulating cover for electrolytics #72621 and #72623
71437	Cover—Insulating cover for electrolytic #72624
71451	Nut—Speed nut to mount high-voltage capacitor
18469	Plate—Bakelite mounting plate for electrolytic capacitors 72621, 72623 and 72624
*72642	Plug—5-contact female plug on cable from horizontal deflection chassis to r-f, i-f chassis (P301)
*72625	Plug—6-pin male plug for cable from television power supply (J301)
71448	Plug—2-prong male plug for power cable
14793	Plug—2-prong male plug for interlock cable
30568	Plug—4-prong male plug on cable from horizontal deflection chassis to r-f, i-f chassis (P303)
*72633	Resistor—4.7 ohms, ½ watt (R337, R338, R339)
34761	Resistor—10 ohms, ½ watt (R304)
30732	Resistor—47 ohms, ½ watt (R320)
*72631	Resistor—Wire wound, 80 ohms, 5 watts (R324)
34765	Resistor—100 ohms, ½ watt (R317, R318, R321, R325, R347)
5164	Resistor—560 ohms, ½ watt (R306)
34767	Resistor—2200 ohms, ½ watt (R346)
71991	Resistor—2200 ohms, 1 watt (R326)
*72184	Resistor—2450 ohms, 16.5 watts, wire wound (R334)
48207	Resistor—Wire wound, 3300 ohms, 5 watts (R312)
30494	Resistor—4700 ohms, ½ watt (R336)
14659	Resistor—6800 ohms, ½ watt (R314)
*70723	Resistor—15,000 ohms, 1 watt (R310)
*72629	Resistor—22,000 ohms, 2 watts (R313)
30409	Resistor—27,000 ohms, ½ watt (R309)
71990	Resistor—27,000 ohms, 1 watt (R307, R350)
30685	Resistor—33,000 ohms, ½ watt (R358)
38891	Resistor—39,000 ohms, 2 watts (R323, R328)
71988	Resistor—47,000 ohms, 1 watt (R308)
38897	Resistor—68,000 ohms, 1 watt (R.355, R357, R359)
*72630	Resistor—68,000 ohms, 2 watts (R319, R327, R335)
3252	Resistor—100,000 ohms, ½ watt (R311)
*72635	Resistor—100,000 ohms, 1 watt (R349)
*72636	Resistor—120,000 ohms, 1 watt (R354, R356)
11959	Resistor—180,000 ohms, ½ watt (R348)
14583	Resistor—220,000 ohms, ½ watt (R315, R322)
30648	Resistor—470,000 ohms, ½ watt (R301, R302, R303, R305, R316)
30652	Resistor—1 megohm, ½ watt (R352)
*72634	Resistor—1.5 megohms, 2 watts (R342, R343, R344, R345)
31107	Resistor—10 megohms, 2 watts (R329, R330, R332, R333)
72008	Retainer—Focus control shaft flexible coupling
*72185	Shaft—Focus control fiber extension shaft
*72626	Socket—2 contact female socket for deflection yoke cable (J302)
*72641	Socket—Kinescope socket
71508	Socket—Tube socket for 8016 rectifier tubes
*72627	Socket—Tube socket, ceramic
31251	Socket—Tube socket, wafer
71559	Spring—Grounding spring for high-voltage capacitor
71428	Transformer—Horizontal sync. discriminator transformer (T301)
*72178	Transformer—Horizontal output and high-voltage transformer (T302, R320)

STOCK No.	DESCRIPTION
	TELEVISION POWER SUPPLY KRS21-1
71770	Capacitor—Moulded paper, .01 mfd., 400 volts (C401, C402)
10907	Fuse—3 ampere (F401)
13526	Mounting—Fuse mounting
*72644	Plug—6 contact female plug on cable from television power supply to horizontal deflection unit (P401)
14409	Plug—7 contact female plug on cable from television power supply to r-f, i-f chassis (P402)
14275	Socket—2 contact female socket for interlock cable
31251	Socket—Tube socket
*72176	Transformer—Power transformer for horizontal deflection chassis (T401)
*72177	Transformer—Power transformer for r-f and i-f chassis (T402)
	OPTICAL BARREL ASSEMBLY KRK1
*72188	Lens—Corrector lens
*72187	Mirror—Spherical mirror
*72661	Screw—3/8-32 x 3-1/4" optical barrel tilt adjustment screw (3 required)
*72662	Screw—8-32 x 15/16" screw for spherical mirror mounting springs (6 required)
*72191	Screw—8-32 x 1/2" screw for locking horizontal centering adjustment (2 required) or screw for locking focus adjustment (2 required)
*72660	Screw—12-24 x 2-5/8" focus adjustment screw
*72192	Screw—12-24 x 1-19/32" horizontal centering adjustment screw
*72663	Spring—Spherical mirror mounting spring (6 required)
*72189	Spring—6 turn spring for kinescope holder
*72190	Spring—8 turn spring for kinescope holder
*72664	Support—Melamine insulator support for kinescope holder (2 required)
11909	Washer—"C" washer for focus adjustment screw or for horizontal centering screw
	RADIO CHASSIS RK121A
71964	Arm—Push button arm and cam for tuning condenser
3658	Ball—Steel ball (3/32" dia.) for tuning condenser
10705	Ball—Steel ball (5/32" dia.) for tuning condenser
71651	Ball—Steel ball for manual tuning shaft
71638	Board—5 contact terminal board for antenna lead-in
71637	Board—Television, audio and phono input jack board
71811	Bracket—Idler bracket less pulleys
71643	Bracket—L.H. dial plate support bracket
71642	Bracket—R.H. dial plate support bracket
71791	Cable—R-F cable
71804	Capacitor—Adjustable, 1.6-18 mmf. (C5, C13)
71809	Capacitor—Adjustable, 1.6-18 mmf. (C36)
71803	Capacitor—Adjustable, 2.5-13 mmf. (C20)
71808	Capacitor—Adjustable, 3-35 mmf. (C37, C84)
71930	Capacitor—Ceramic, 5.6 mmf. (C85)
39043	Capacitor—Ceramic, 6.8 mmf. (C25)
71807	Capacitor—Adjustable, 10-160 mmf. (C8, C15, C90)
71924	Capacitor—Ceramic, 56 mmf. (C24)
71514	Capacitor—Ceramic, 82 mmf. (C71)
39396	Capacitor—Ceramic, 100 mmf. (C16, C21, C83)
71933	Capacitor—Mica, 180 mmf. (C18)
71922	Capacitor—Ceramic, 180 mmf. (C34, C73)
71920	Capacitor—Ceramic, 220 mmf. (C6, C10)
71919	Capacitor—Ceramic, 330 mmf (C3, C11)
71929	Capacitor—Ceramic, 1000 mmf. (C80)
72117	Capacitor—Tubular, .0012 mfd., 400 volts (C53)
71927	Capacitor—Tubular, .002 mfd., 400 volts (C59)
71921	Capacitor—Tubular, .003 mfd., 200 volts (C9, C26, C27, C82)
71926	Capacitor—Tubular, .005 mfd., 200 volts (C40, C42, C43, C66, C76, C77, C78)
71553	Capacitor—Tubular, .005 mfd., 400 volts (C44, C55, C58, C68, C69, C88)
72120	Capacitor—Tubular, .015 mfd., 200 volts (C64, C65)
71588	Capacitor—Moulded paper, .01 mfd., 600 volts (C87)
71923	Capacitor—Tubular, .01 mfd., 200 volts (C22, C23, C63)
71925	Capacitor—Tubular, .01 mfd., 400 volts (C32, C35, C54, C62, C89)
70631	Capacitor—Tubular, .01 mfd., 600 volts (C61)
71551	Capacitor—Tubular, .05 mfd., 200 volts (C33, C39, C41, C79)
72121	Capacitor—Electrolytic, 5 mfd., 50 volts (C67, C81)
32223	Capacitor—Electrolytic, 15 mfd., 300 volts (C60)
71646	Clamp—Dial clamp (2 required)
71940	Coil—F-M antenna coil (L2, L3)
71856	Coil—"C" band antenna coil (L4, L5)
71942	Coil—Filament choke coil (L7, L8)
71937	Coil—F-M oscillator coil (L9)
71939	Coil—Choke coil (L10)
71938	Coil—F-M r-f coil (L11)
71854	Coil—"C" band r-f coil (L12)
71857	Coil—"A" band r-f coil (L13, L14)
71853	Coil—"C" band oscillator coil (L17)
71852	Coil—"A" band oscillator coil (L18)
72071	Coil—"A" band antenna coil (L20, L21)
38405	Control—H-F tone control (R27)
38401	Control—L-F tone control (R26)
71596	Control—Volume control (R42)
32634	Cord—Indicator drive cord (approx. 42" overall length) NOTE: Before assembling, stretch to full length
32634	Cord—Manual drive cord (approx. 30" overall length) NOTE: Before assembling, stretch to full length
71941	Coupling—F-M coupling unit (L16, C17, R5)
71652	Dial—Short wave glass dial scale
71653	Dial—Standard broadcast glass dial scale
71654	Dial—F-M glass dial scale
71805	Drum—Drive drum
71800	Gear—12-tooth gear fastened to range switch flexible shaft coupling
71801	Gear—18-tooth gear fastened to range switch shaft
35844	Gear—Scissor gear for tuning condenser
71851	Grommet—Rubber grommet to mount socket (4 required)
71799	Grommet—Rubber grommet to mount cradle (6 required)
71647	Guide—Indicator slide guide
71832	Indicator—Station selector indicator
11765	Lamp—Dial lamp, Mazda #51
11891	Lamp—Pilot lamp, Mazda #44
71962	Pinion—Pinion and shaft for tuning condenser
71963	Plate—Bearing plate for tuning condenser pinion
71644	Plate—Dial back plate only, less window, dials, support, pulleys and indicator
71636	Plug—9-prong male plug for connecting to radio power cable (J1)
71648	Pulley—Idler pulley or indicator cord pulley
71650	Pulley—Manual tuning shaft cord pulley
72323	Resistor—3 ohms, 1/2 watt (R32)
34761	Resistor—10 ohms, 1/2 watt (R54)
34765	Resistor—100 ohms, 1/2 watt (R21, R22)
30929	Resistor—270 ohms, 1/2 watt (R38)
30498	Resistor—390 ohms, 1/2 watt (R10)
34766	Resistor—1000 ohms, 1/2 watt (R24, R37, R46)
34767	Resistor—2200 ohms, 1/2 watt (R9, R12, R25, R36 R52)
30494	Resistor—4700 ohms, 1/2 watt (R4)
14250	Resistor—8200 ohms, 1/2 watt (R13)
71914	Resistor—10,000 ohms, 1 watt (R6)
36714	Resistor—15,000 ohms, 1/2 watt (R30, R48, R51)
71915	Resistor—15,000 ohms, 1 watt (R7)
3219	Resistor—18,000 ohms, 1/2 watt (R33)
30492	Resistor—22,000 ohms, 1/2 watt (R3, R18, R31, R34 R35, R44, R49)
71989	Resistor—22,000 ohms, 1 watt (R43)
30409	Resistor—27,000 ohms, 1/2 watt (R11, R45)
3252	Resistor—100,000 ohms, 1/2 watt (R16)
11959	Resistor—180,000 ohms, 1/2 watt (R17, R20)
30651	Resistor—270,000 ohms, 1/2 watt (R29, R40, R53)
30648	Resistor—470,000 ohms, 1/2 watt (R14)
30652	Resistor—1 megohm, 1/2 watt (R1, R2, R19)
30649	Resistor—2.2 megohms, 1/2 watt (R15, R41, R47, R50
70592	Resistor—3.9 megohms, 1/2 watt (R8)
71917	Resistor—22 megohms, 1/2 watt (R23)
71798	Screw—#8-32 x 13/64" square head set screw for flexible shaft
71965	Screw—Push button arm locking screw
71806	Shaft—Coupling shaft for range switch flexible shaft
71641	Shaft—Flexible shaft for range switch knob
71812	Shaft—Manual tuning shaft less spring and pulley
72951	Shield—Lead tube shield
71834	Socket—Lamp socket, L. H.
71833	Socket—Lamp socket, R. H.
71931	Socket—Pilot lamp socket
71850	Socket—Tube socket, rubber mounted
72516	Socket—Tube socket, miniature

STOCK No.	DESCRIPTION
71649	Spring—Coil spring for manual tuning shaft
71936	Spring—Drive cord spring
33622	Spring—Push button arm return spring
71645	Support—Glass support, rubber (2 required)
*72062	Switch—Power switch (S8)
*72063	Switch—Range switch less television a-c power switch (S1, S2, S3, S4, S5, S6, S7)
*72517	Switch—Television a-c power switch (mounted on range switch) (S9)
71845	Transformer—First f-m, i-f transformer (T1 (C28, C30))
71846	Transformer—First a-m, i-f transformer (T2, (C29, C31))
71847	Transformer—Second f-m, i-f transformer (T3, (C45, C47, C51))
71848	Transformer—Second a-m, i-f transformer (T4 (C46, C48, C49, C50))
71849	Transformer—Third f-m, i-f transformer (T5 (C56, C57))
71935	Transformer—Driver transformer (T6 (C70))
71934	Transformer—Ratio detector transformer (T7 (C72, C74))
37435	Washer—"C" washer to hold gear on coupling shaft
31608	Washer—Spring washers for drive cord pulleys or idler cord pulley
2917	Washer—Spring washer for flexible or manual tuning shaft
71810	Window—Glass dial window
	RADIO POWER SUPPLY RS123A
70646	Capacitor—Tubular, .0035 mfd., 1000 volts (C105, C106)
70632	Capacitor—Tubular, .02 mfd., 600 volts (C103, C104)
72596	Capacitor—Tubular, .05 mfd., 200 volts (C107)
31323	Capacitor—Electrolytic, 16 mfd., 150 volts (C102)
72955	Capacitor—Electrolytic, comprising 1 section of 30 mfd., 450 volts, 1 section of 50 mfd., 400 volts, and 1 section of 40 mfd., 25 volts (C101A, C101B, C101C)
18469	Insulator—Mounting insulator for electrolytic
11765	Lamp—Pilot lamp, Mazda #51
12493	Plug—Speaker cable plug
30730	Resistor—2700 ohms, ½ watt (R103)
30492	Resistor—22,000 ohms, ½ watt (R104)
30409	Resistor—27,000 ohms, ½ watt (R105)
30650	Resistor—56,000 ohms, ½ watt (R102)
14583	Resistor—220,000 ohms, ½ watt (R106, R107)
71660	Resistor—Comprising 1 section of 180 ohms, 3.5 watts, 1 section of 2520 ohms, 3.97 watts, and 1 section of 2760 ohms, 9.3 watts (R101A, R101B, R101C)
71659	Socket—9-prong power socket (J101)
35787	Socket—Audio input socket (J102)
31364	Socket—Pilot lamp socket
31319	Socket—Tube socket
37048	Transformer—Power transformer, 115 volts, 50/60 cycle (T101)
71661	Transformer—Audio output transformer (T102)
	SPEAKER ASSEMBLIES—92567-2W, RL70R1
13867	Cap—Dust cap
71147	Clamp—Clamp to hold metal cone suspension (2 required)
71146	Coil—Field coil, 1060 ohms
11469	Coil—Neutralizing coil
36145	Cone—Cone complete with voice coil
31539	Plug—5-prong male plug for speaker
71144	Speaker—12" E.M. speaker complete with cone and voice coil less plug
71145	Suspension—Metal cone suspension
	NOTE: If stamping on speaker in instrument does not agree with above speaker number, order replacement parts by referring to model number of instrument, number stamped on speaker and full description of part required.
	MISCELLANEOUS
*72749	Back—Cabinet back
12716	Board—"Antenna-Ground" board—part of antenna cable
71888	Bottom—Radio chassis bottom cover
72446	Bracket—Television control panel light rod lamp bracket
36639	Bracket—Pilot lamp bracket
71874	Bushing—Bushing and fibre washer for large knobs (4 required)
71884	Button—Radio push button
*72665	Cable—Antenna cable to radio chassis
72447	Cable—Shielded audio cable complete with pin plugs—part of interconnecting cable—from radio power supply to radio receiver
*72195	Cable—Shielded audio lead between r-f, i-f chassis and radio chassis—complete with pin plugs
71892	Catch—Door catch and strike
*72669	Clamp—Television control panel light rod clamp
*72667	Clip—Kinescope second anode clip
*72666	Cover—Optical barrel dust cover
*72748	Decal—Control panel decal (1 set)
71984	Decal—Trade mark decal
*72677	Escutcheon—Radio escutcheon only, less screen, window and marker plate—for walnut instruments
*73076	Escutcheon—Radio escutcheon only, less screen, window, and marker plate—for mahogany instruments
*72197	Escutcheon—Television channel marker escutcheon
X1637	Grille—Grille cloth
*72674	Grommet—Rubber grommet to cushion side of radio chassis (2 required)
72069	Grommet—Rubber grommet for rear mounting feet of radio chassis (2 required)
*72670	Hinge—Radio compartment door hinge—L.H.
*72671	Hinge—Radio compartment door hinge—R.H.
13103	Jewel—Pilot lamp cap
71534	Knob—Television channel selector knob
71533	Knob—Television fine tuning knob
71536	Knob—Television horizontal hold or brightness control knob (inner)
71535	Knob—Television vertical hold or picture control knob (outer)
71883	Knob—Radio tone control knob
71821	Knob—Radio volume control, power switch, range switch or tuning knob
11765	Lamp—Television panel light rod lamp, Mazda #51
71969	Marker—Push button call letter marker
*72193	Mirror—45 degree plane mirror
*72673	Plate—Backing plate for hinges
71879	Plate—Backing plate for Victrola indicator screen
71881	Plate—Push button call letter marker plate
4573	Plug—2-contact female plug on radio interconnecting cable—connects radio cable to television power supply cable
71967	Plug—9-contact female plug on interconnecting cable —between radio and radio power supply
71968	Plug—9-prong male plug on interconnecting cable—between radio and radio power supply
14793	Plug—2-prong male plug on deflection yoke cable (P302)
14782	Plug—3-prong male plug on deflection yoke cable (P101)
35383	Plug—8-prong male plug on cable from television bleeder resistor box to r-f, i-f chassis (P106)
31048	Plug—Pin plug for shielded audio cable #72185 and #72447
*72712	Pull—Door pull for upper doors on television compartment (2 required)
*72705	Pull—Radio compartment door pull
*72170	Resistor—Wire wound resistor in television bleeder resistor box, comprising 1 section of 970 ohms, 9 watts, and 1 section of 640 ohms, 10.5 watts (R188A, R188B)
*72668	Rod—Television control panel lucite light rod
71878	Screen—Victrola indicator screen
*72194	Screen—Television viewing screen
*72675	Side—Radio chassis side panel—R.H.
*72676	Side—Radio chassis side panel—L.H.
71538	Spring—Channel marker escutcheon spring
*72672	Spring—Check spring for R.H. door
14270	Spring—Retaining spring for television channel selector knob #71534 or television vertical hold or picture control knob #71535
4982	Spring—Retaining spring for television fine tuning knob #71533
30330	Spring—Retaining spring for television horizontal hold or brightness control knob #71536
71867	Spring—Retaining spring for radio push button
30900	Spring—Retaining spring for radio control knobs #71821 and #71883
71880	Strip—Backing strip for call letter marker plate
71875	Washer—Spring—washer for fastening rubber spacer cushioning on radio chassis side
71882	Window—Window for station call letter markers
*72196	Yoke—Deflection yoke complete with cables (L115, L116, L303, L304, C334, R184, R186, P101, P302)