Motorola®

TV SERVICE MANUAL

CHASSIS TS-902A-03 & BP-902A-01

Price 50 Cents

Part No. 68P733054-A

GENERAL INFORMATION

This booklet contains service information covering the Motorola TS-902A-03 (horizontal chassis) and the BP-902A-01 (vertical chassis). These individual chassis are interconnected in the 19-inch Motorola color television receiver series which incorporate the 19VP22 tri-color picture tube.

CHASSIS DESCRIPTION

The receiver circuits are built around 29 circuit tubes, a 19VP22 19-inch tri-color picture tube (aluminized-glass envelope, electrostatic focusing, 62 degree deflection angle) plus three germanium diodes and three selenium rectifiers. The horizontal chassis contains all signal circuits except those devoted strictly to color, the scanning circuits, filament and "B" supply. The vertical chassis contains the color section.

ELECTRICAL SPECIFICATIONS

POWER RATING - Source: 117 volts, 60 cycle AC
360 to 375 watts

NUMBER OF TUBES - 29 tubes plus 3 selenium rectifiers, 3 germanium diodes and a tri-color picture tube

INTERMEDIATE FREQUENCIES - Video: 45.75 Mc
Sound: 41.25 Mc and 4.5 Mc

FREQUENCY RANGE - Channels 2 through 13 (VHF tuner - WTT-67)
Channels 14 through 83 (UHF tuner - TT-37)

ANTENNA INPUT IMPEDANCE - VHF & UHF: Balanced 300 ohm

FUSES - Filament: 1 inch #26 copper wire, located beneath chassis near filament transformer
Power: Special 7.5 ohm plug-in resistor, located near filament transformer on top rear of horizontal chassis

POWER SUPPLY VOLTAGES (117 volts AC line voltage) - B triple plus 390 volts
B double plus 240 volts
B plus 125 volts

AUDIO OUTPUT - 1.5 watts undistorted

INSTALLATION & OPERATION

Locating the receiver

It is advisable to determine the approximately permanent position of the receiver before any attempt is made to erect an antenna or to install lead-in wires. Once the location of the receiver is determined, it is desirable to retain this location, due to the effect of stray external magnetic fields on the purity adjustments of the color fields, etc. Balancing adjustments have been incorporated into the receiver to compensate for such natural conditions; however, these controls may require re-adjustment for each change in receiver location. Such receiver movements should be avoided.

The selection of the permanent location of the receiver should be based upon the best picture visibility from the greatest number of room positions; so that all persons can view the picture comfortably. Locating the receiver near windows and corners should be avoided. The location should be chosen so that the cabinet will be subjected to a minimum amount of heat and moisture; otherwise the cabinet finish may suffer damage. Allow sufficient space behind the cabinet for proper ventilation of the chassis.

Room lighting

It is desirable to have some light in the room when viewing any type of television picture. A completely darkened room tends to create eye-strain. Light from a shaded lamp which does not fall directly on the face of the screen is usually satisfactory.

A condition of room lighting must be taken into consideration with color receivers, however, which was not important previously. That is the overall color tint of the lighting used. The room lighting color tint can accentuate or reduce certain color reproductions acutely. While the receiver may be adjusted to compensate for such lighting conditions, it is desirable to use a colorless bulb and lampshade during color program viewing.

It is also important that any receiver set-up adjustments made by the technician are performed while using the room lighting that will be available during program viewing. If different color lighting is used during set-up, it is quite possible to adjust for white screen conditions only to find that under the viewing lights, the screen may have a predominant blue, green, or red tinge.

Antenna requirements

Indoor antennas of the portable type are often satisfactory for color reception, provided the receiver is located in a strong signal area. However, an outdoor antenna will invariably give a better overall picture on all channels and is recommended whenever possible.

A color signal, as received from the transmitter, contains a number of additional signals which must reach the receiver for good color reproduction. Due to these extra requirements, many present antenna types and their lead-in wires are unsatisfactory. Color reception requires a broad-band type of antenna, a narrow-band single channel antenna can completely remove the color signals. The same is true of incorrect lead-in wires and mismatched lines. Keep in mind that it is entirely possible for an existing antenna installation to furnish satisfactory reception on a black/white receiver, but fail completely on color broadcasts. In the case of antennas for UHF reception, the above information applies with the extra care required for more critical UHF antenna set-up.

When deciding on an antenna type, remember that it is entirely possible for stations to change channels in the VHF group, and that single-channel, high-band or low-band antennas may have to be replaced to receive the new channels.

INITIAL INSTALLATION INSTRUCTIONS

After the receiver has been placed in its permanent position as determined by the viewing requirements and lead-in facilities, it is necessary to remove the cabinet back cover and shift the lever connected to the dynamic convergence coils to such position that the coils are moved flush against the neck of the picture tube (the convergence coils are moved away from the picture tube neck during shipment only). This lever is at the extreme top of the rear CRT mounting bracket and may be seen in the top view drawing of the tri-color picture tube(Fig1).

As stated previously, external magnetic fields of varying degrees and directions are encountered for each new receiver location and it is necessary to balance the receiver circuitry for the initial installation location, as well as to correct any misadjustment caused in shipment. The first receiver checks to be made, therefore, are those for correct purity, convergence and focus. Since it is almost always necessary to adjust the purity and convergence systems in an initial installation, a complete set-up procedure follows.

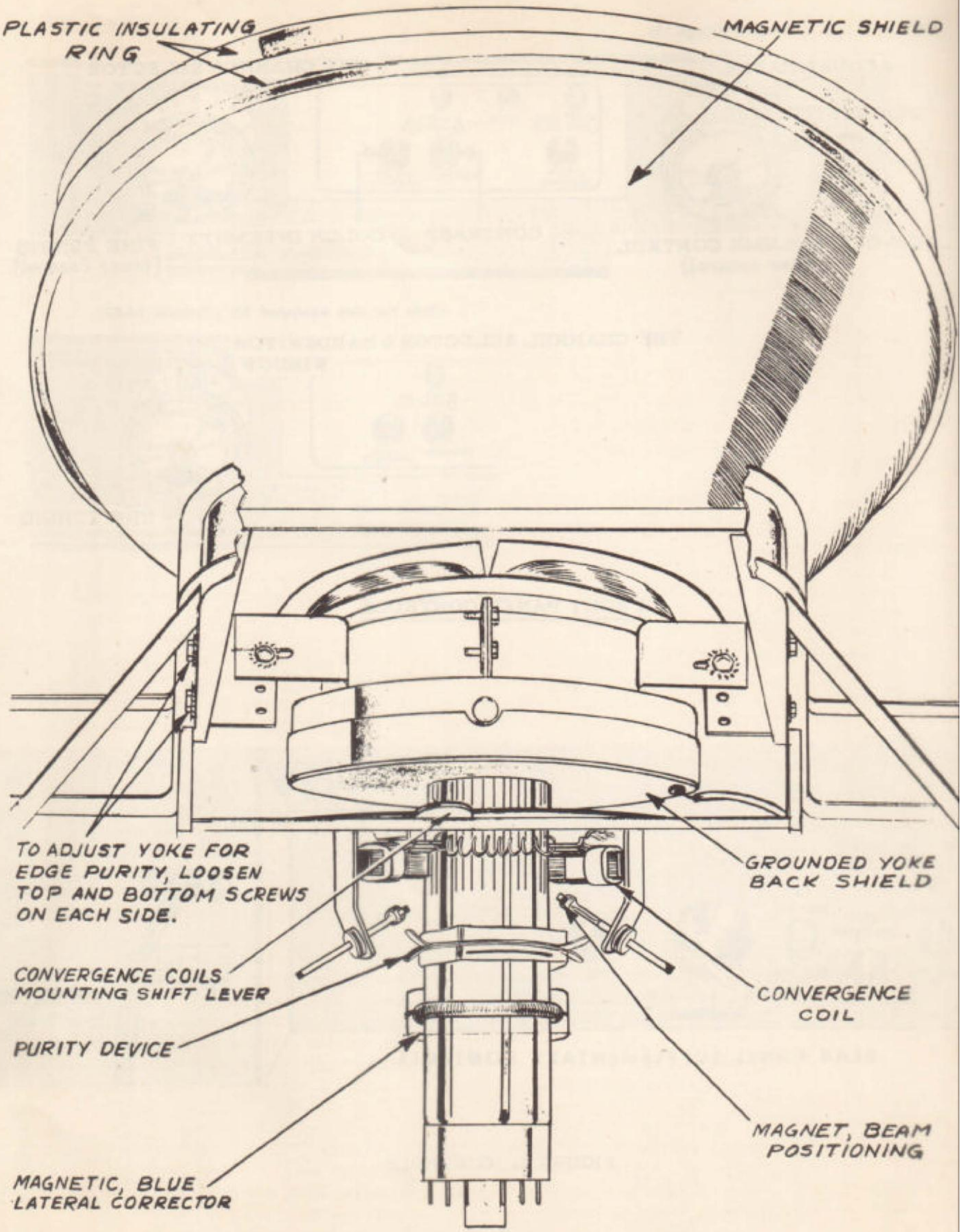
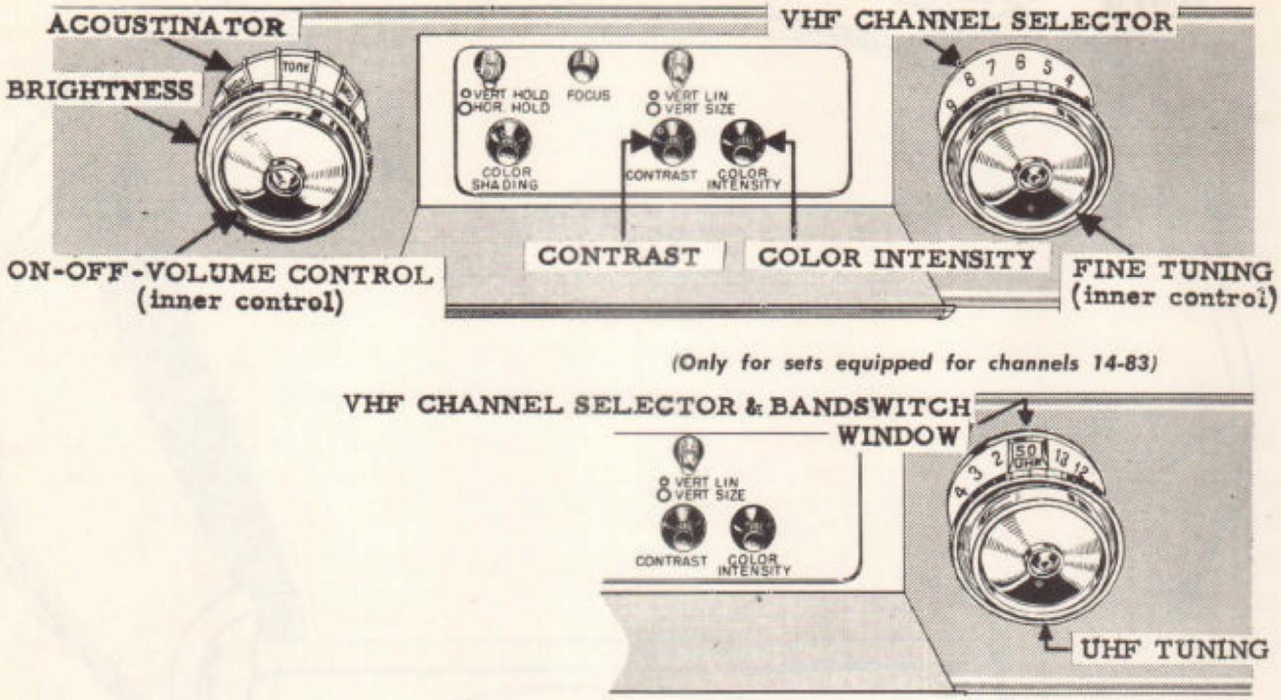
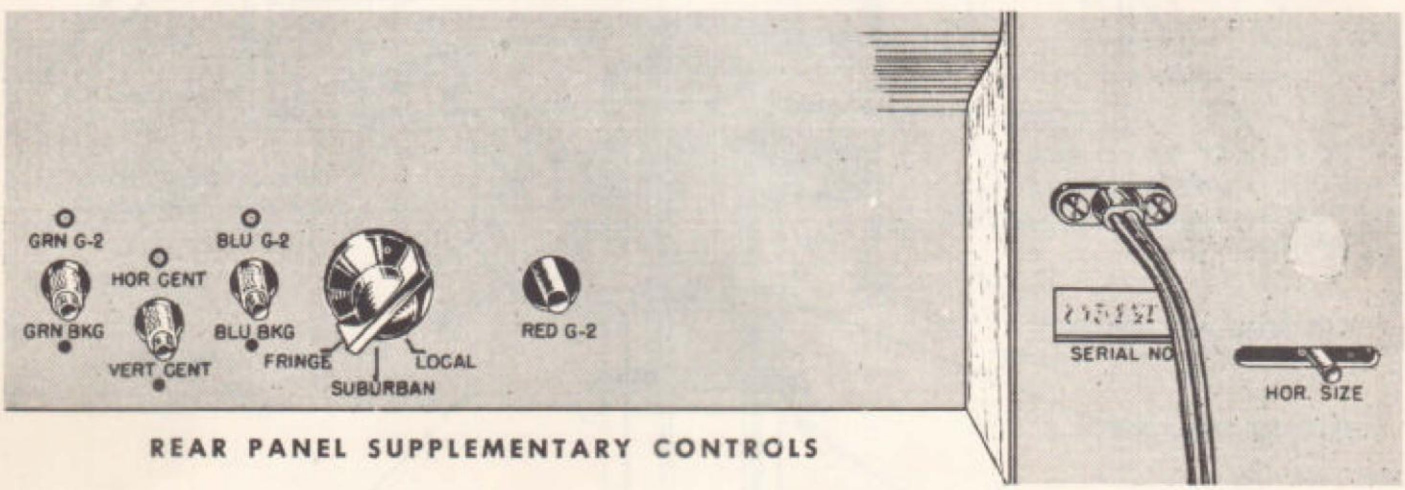


FIGURE 1. TOP VIEW OF TRICOLOR PICTURE TUBE

VHF OPERATION (channels 2 through 13)



FRONT PANEL CONTROLS



REAR PANEL SUPPLEMENTARY CONTROLS

FIGURE 2. CONTROLS

NOTE: To facilitate adjustments to the picture tube components and other parts, the cabinet is provided with a removable hinged top section. This top section may be moved only after the cabinet back has been removed.

Depending on the cabinet style, two different top panel locking mechanisms will be encountered. In one type, a small wooden slider, at the center underside of the top panel, will move to the rear; thus unlocking the top panel at the front end of the cabinet. The other type is fastened to the wooden side channels by thumbscrews.

HIGH VOLTAGE WARNING

Operation of this receiver with the chassis accessible involves shock hazard; therefore, no work should be done on this receiver by anyone not familiar with these hazards.

Due to the circuit used, there is always a potential difference between the chassis and ground. AN ISOLATION TRANSFORMER SHOULD BE USED WHEN SERVICING THIS RECEIVER.

Do not operate the receiver with the high voltage compartment shield removed. Make sure the ground springs between the chassis and the picture tube shield and between the yoke assembly and the picture tube shield are making contact.

PICTURE TUBE HANDLING PRECAUTIONS

Extreme care must be used in handling the picture tube as rough handling may cause it to implode due to atmospheric pressure. DO NOT NICK OR SCRATCH GLASS, OR SUBJECT IT TO ANY UNDUE PRESSURE IN INSTALLATION OR REMOVAL. Do not remove the receiver chassis, install, remove, or handle the picture tube in any manner unless shatterproof goggles and heavy gloves are worn. DISCHARGE 2nd ANODE LEAD BEFORE HANDLING.

THE TRI-COLOR PICTURE TUBE SET-UP (TS-902)

One of the first problems in setting up the picture tube is to make the apparent deflection centers of the three beams the same as that dictated by the particular picture tube design. The term "deflection centers" refers to the point inside or near the deflection yoke at which the three beams begin bending for horizontal and vertical sweeping. The forward and rear positioning of the deflection yoke on the neck of the tube locates the correct deflection centers of the beams. When the deflection center of any of the beams is incorrect, the beam will scan phosphor dots of incorrect colors.

The purity magnet mounted on the neck of the tube provides an adjustment whereby the three beams can be made to pass through their centers of deflection when the central area of the screen is being scanned.

PURITY ADJUSTMENT

1. Inject a signal from a dot pattern generator or other appropriate source into the receiver.

2. Adjust the three beam positioning magnets and the blue lateral corrector magnet for convergence of the three beams at the center of the screen. (Fig. 1).

3. Remove all signal to the receiver or switch the channel selector to a vacant channel.

4. Cut off the blue and green guns by grounding their grids into the ground holes of the receptacle. (See vertical chassis, front view.) (Fig. 14).

5. Adjust the BRIGHTNESS control for high raster brightness.

6. Loosen four screws (two screws on each side of bracket) to allow backward-forward movement of yoke. If set has not been previously adjusted for purity, position yoke back as far as the mounting will allow. If set has been adjusted previously for purity, confine yoke adjustment to a minimum. Keep yoke concentric with neck of picture tube.

7. Locate the purity device, consisting of two magnetic rings mounted on the tube neck. The device is between the blue corrector magnet and the dynamic convergence coils. Position the tabs of one ring opposite the tabs of the other ring so that a minimum strength magnetic field is produced. If the correct tabs are opposite each other, rotating both rings of the device together should have no affect on the raster. If the position of the tabs is incorrect, rotate the rings to place the opposite tabs adjacent to each other.

8. Check the purity at the center of the screen. If it is not satisfactory:

   a. Separate the tabs by a small amount to produce a weak magnetic field.

   b. Rotate the purity device to obtain better red purity in the central area of the screen.

   c. Continue the process of adjusting the field strength and direction of the magnetic field until the purity in the central area of the screen has been made as large as possible.

   NOTE: Use as weak a magnetic field as possible. Avoid shadow due to beam cut-off by the tube neck.

9. Move the yoke forward and backward along the neck of the tube to obtain best edge purity.

10. Re-adjust the purity device for best overall purity.

   NOTE: If satisfactory edge purity cannot be obtained, it may indicate either a defective yoke or picture tube.

11. Check the purity of the green and blue fields, one at a time, by keeping the grid of the desired gun inserted into the grid receptacle and grounding the grid plugs of the other two guns. Avoid any shadows due to neck cut-off of the beams.

12. It may be necessary to compromise the setting of the purity device which resulted in best red purity in an effort to obtain best overall purity of all colors. In any compromise setting, however, the red field should always be favored strongly. Re-insert all grid plugs after purity adjustments have been completed.

DYNAMIC CONVERGENCE SYSTEM

Because the phosphor screen is not a true spherical surface, the distance the three beams travel from the center of deflection is greater at the outer areas of the phosphor screen than at the center. At the outer areas, therefore, the beams will cross-over, or converge, before they reach the shadow mask, thus causing over-convergence in these areas. The dynamic convergence coils apply electromagnetic correction to each of the three beams at a horizontal and vertical sweep rate to correct this condition. This correction causes the point of convergence to change according to the sweep rate and beam position so that it always follows the curvature of the shadow mask.

PROCEDURE

1. Turn all dynamic amplitude controls to minimum (fully counterclockwise). (Fig. 14).

2. Turn vertical tilt controls to minimum (mid-position). (Fig. 14).

3. Position shift lever so that convergence coil pole pieces are seated on the neck of the picture tube. (Fig. 1).

4. Use the signal from a dot pattern generator or other suitable source. Adjust the brightness of each beam so that each color dot can be easily observed. (Use the background and G-2 controls.) CAUTION: Maintain picture tube brightness and modulation level of signal source within limits of good focus.

5. Adjust the three beam positioning magnets and the blue lateral magnet for best convergence at center of screen.

6. Using the red field, adjust yoke and purity device for optimum purity. (Refer to purity adjustment instructions.) NOTE: If purity has been adjusted previously, yoke adjustment is unnecessary.

7. Repeat step 5 for best convergence at center of screen.

VERTICAL DYNAMIC ADJUSTMENT

1. Choose a vertical column of dots near the center of the screen. Notice that the dots, while converged at the screen center, become progressively over-converged away from the screen center toward the top and bottom of the screen.

2. Observe the position of the blue dot in each dot trio along this vertical column of dots. Adjust the red and green vertical tilt controls so that the red and green dots are converged and spaced symmetrically from the blue dot in each group (trio). This symmetrical over-convergence should be made to increase uniformly from screen center to top and screen center to bottom.

3. Adjust the blue vertical tilt control so that all blue dots in each trio along a center vertical line have the same relative position with respect to the red and green dots.

4. Adjust the beam positioning magnets for center convergence, if necessary.

5. Adjust the green vertical amplitude control to position the green dots so that they are equally spaced from the blue dots from top to bottom of the screen.

6. Adjust the green beam positioning magnet to reconverge the green dot with the blue dot at the center of the screen.

7. Repeat step 5 for the red dots.

8. Adjust the red beam positioning magnet to converge the red dot with the blue and green dots at the center of the screen.

9. Adjust the blue vertical amplitude control using the same procedure as used for the blue and green amplitude controls.

10. Adjust the blue beam magnet for convergence of the vertical row of dots.

HORIZONTAL DYNAMIC ADJUSTMENT

1. a. Peak each of the horizontal dynamic phase coils one at a time for maximum as follows:

   b. Turn the blue horizontal dynamic amplitude control to maximum (fully clockwise). Set the red and green horizontal dynamic amplitude controls to minimum (fully counter-clockwise). (Fig. 14).

c. Tune the blue horizontal phase coil so that, over the center portion of the screen, the blue dot is displaced a maximum amount from the other two dots. This displacement, which makes the blue dots appear to follow a parabolic path across the screen, should be such that the blue dots are moved toward a horizontal reference line at edges of the screen.

d. Turn the blue horizontal dynamic amplitude control to minimum (fully counterclockwise).

2. Repeat the foregoing procedure for the green gun only.

3. Repeat the foregoing procedure (steps 1a to 1d) for the red gun only.

4. Select a horizontal row of dots at the center of the screen.

5. Adjust the blue dynamic amplitude and phase together to obtain the same amount of misconvergence of the blue dot at the screen center and the edges of the screen. This will establish a horizontal line across the screen which can be used as reference for positioning the red and green dots.

6. Adjust the blue beam positioning magnet (not the blue lateral corrector magnet) for convergence of the dots at the center of the screen.

7. Adjust the green horizontal dynamic amplitude and phase controls so as to obtain uniform and symmetrical displacement of the green dots away from the blue dots in all horizontal dot trios.

8. Adjust the green beam positioning magnet for center convergence.

9. Adjust the red horizontal dynamic amplitude and phase controls so as to obtain uniform and symmetrical displacement of the red dots away from the blue dots in all horizontal dot trios.

10. Adjust the red beam positioning magnet for center convergence.

11. Check purity and, if necessary, adjust the three beam positioning magnets and blue lateral magnet for center convergence.

12. Make any required touch-up adjustments necessary to give best possible overall convergence of all the dots. The beam positioning magnets and the dynamic controls are used as indicated by a study of the dot pattern. NOTE: It will not be necessary to reset purity when the touch-up adjustments are made since the adjustments should be small enough so as not to upset the purity.

BALANCING THE BACKGROUND AND G-2 CONTROLS

Compensation for differences in the three phosphor efficiencies, the cut-off voltages and the emission characteristics of the three guns is provided as follows: Three G-2 controls adjust the screen voltages for each gun; two BACKGROUND (grid 1) controls adjust the static bias on the blue and green guns. Static bias on the red gun is fixed by circuitry.

Procedure for balancing BACKGROUND and G-2 controls

1. Turn channel selector to a channel transmitting a black and white picture - preferably a test pattern. (Fig. 2).

2. Set BRIGHTNESS and CONTRAST controls for normal picture. Disregard color fringing effects due to misadjustment of the convergence controls.

3. Turn GREEN G-2, BLUE G-2 and RED G-2 controls to maximum clockwise position.

4. Adjust GREEN BACKGROUND, BLUE BACKGROUND and, if necessary, RED G-2 for highlight white on the brightest picture portions.

5. Turn BRIGHTNESS control counterclockwise so that screen becomes less bright (grey). If a color begins to tint the screen as brightness is reduced: Adjust the G-2 control corresponding to this color until the bright portions of the screen are white or grey.

6. Adjust the BRIGHTNESS control for normal brightness on the screen. Re-set the BACKGROUND controls so that brightest portions of picture appear white.

7. Repeat steps 2, 4, 5 and 6 until no color tinting occurs over the usable range of the BRIGHTNESS control. (Maximum brightness setting is not considered part of the usable range.)

OPERATING CONTROLS

Front Panel Operating Controls

The large twin front panel knobs control the basic receiver functions for monochrome reception. Only two additional controls are required on the front panel for color reception. These controls are the COLOR INTENSITY and COLOR SHADING controls, located under the front panel cover. (In some models the color intensity control is labeled "chroma" and the color shading control is labeled "fine phase".) (Fig. 2).

Front Panel Controls Used For Color Reception

COLOR INTENSITY CONTROL

The COLOR INTENSITY control governs the gain of the color system and thus the intensity of the reproduced colors. Turning the COLOR INTENSITY control counterclockwise will remove all color from the picture.

When receiving a black/white picture transmission, always keep the COLOR INTENSITY control turned to the counterclockwise stop. Viewing a black/white transmission with the COLOR INTENSITY control turned up may result in color fringes outlining picture subjects. This gives the appearance of colored "snow" in the picture.

COLOR SHADING CONTROL

The purpose of the COLOR SHADING control is to allow the picture colors to be tinted as desired. The most faithful color reproduction is usually obtained by adjusting the COLOR SHADING control for natural flesh tones. Any object having a familiar color (such as sky or water) may be used for this adjustment.

Front Panel Controls Used For Monochrome (black/white) Reception

1. ON-OFF-VOLUME CONTROL

Turn the receiver on by rotating the ON-OFF-VOLUME control to the right until a click is heard. Allow the receiver to warm up for a few minutes. (NOTE: The warm-up period required for a color television receiver to produce a good picture, either in color or in monochrome, is longer than that required for a black/white receiver.) After the receiver is turned on, allow several minutes for the circuitry to stabilize. Then, advance the ON-OFF-VOLUME control temporarily to mid-position and adjust later as required.

2. COLOR INTENSITY CONTROL (Under front panel cover)

Turn off by rotating counterclockwise until stop is reached.

3. CONTRAST CONTROL (Under front panel cover)

Turn CONTRAST control to about the middle of its range.

4. BRIGHTNESS CONTROL

Turn clockwise until picture screen is lighted. Readjust later in conjunction with CONTRAST as required.

5. VHF CHANNEL SELECTOR

Turn the VHF CHANNEL SELECTOR until the desired channel number appears on top. (VHF channels are numbered 2 through 13).

6. FINE TUNING

Adjust the FINE TUNING control for best picture detail. Readjust CONTRAST and BRIGHTNESS control for most pleasing picture.

7. ACOUSTINATOR

Adjust the ACOUSTINATOR tone control for the most pleasing tone.

Tuning UHF Stations

(Only for sets equipped to receive channels 14 to 83.)

Turn VHF CHANNEL SELECTOR control so that window located between numbers 2 and 13 is at top. This switches receiver to UHF and exposes the UHF dial scale.

With the VHF CHANNEL SELECTOR control set to the UHF position, UHF stations can be tuned with the FINE TUNING control. Tune first to desired channel, then tune for best picture detail. Readjust CONTRAST and BRIGHTNESS controls for most pleasing picture.

Receiving Color Programs

1. Adjust receiver for a satisfactory monochrome picture as outlined under "Front Panel Controls Used For Monochrome (Black/White) Reception".

2. COLOR INTENSITY CONTROL (Under front panel cover)

Advance COLOR INTENSITY control to right (clockwise) until color begins to appear in picture. Adjust COLOR INTENSITY control until desired strength of color is obtained.

3. COLOR SHADING CONTROL (Under front panel cover)

Adjust the COLOR SHADING control for most natural or pleasing flesh tones, or for natural appearance of some object having familiar coloring.

4. FINE TUNING

Readjust for best picture detail and most satisfactory color reproduction. If fine tuning control is not adjusted correctly, the color may be removed from the picture.

Supplementary Controls Located Under Front Panel Cover

The small controls located under the front panel cover are provided for customer use, as required. (These controls are practically independent of critical color and monochrome circuitry.) The more-frequently used supplementary controls are provided with knobs, while those used infrequently have knurled shaft ends. This provides instantaneous recognition of the primary and secondary supplementary controls. (Fig. 2).

It is advisable to adjust these "under-cover" controls while viewing a black/white transmission, preferably a test pattern. This will reduce the possibility of error when analyzing picture defects. During the adjustment of these controls, color effects can be eliminated by turning the COLOR INTENSITY control fully counterclockwise.

HORIZONTAL HOLD

This control locks the picture horizontally. If the picture has a tendency to move across the screen horizontally or appears as a series of sloping lines or bars, this control should be adjusted. This adjustment is very broad and should be set to the center of the range in which the picture remains locked-in, or stationary.

VERTICAL HOLD

When the picture exhibits intermittent or constant vertical movement; when the picture appears to be rolling up or down, the VERTICAL HOLD control should be adjusted. The correct adjustment is in the center of the lock-in range.

VERTICAL SIZE AND VERTICAL LINEARITY

When the size of the picture, from top to bottom, is too large or too small, adjust the VERTICAL SIZE control. Stretching or squeezing of the picture at the top or bottom can be eliminated by adjusting the VERTICAL LINEARITY control. It may be necessary to adjust the VERTICAL SIZE and VERTICAL LINEARITY controls simultaneously until a picture which is balanced in shape from top to bottom (linear) fills the screen. If the picture should roll during these adjustments, reset the VERTICAL HOLD control.

FOCUS

Adjust the FOCUS control for the clearest picture.

Supplementary Controls Located At Rear of Receiver

The supplementary controls located at the rear of the receiver fall into two classifications: those that can be adjusted easily without affecting the color balancing and picture tube set-up controls and those that require careful adjustment in conjunction with one another. The more critical controls are described in the section "Balancing the Background and G-2 Controls". These controls should be adjusted by a trained technician. (These controls should be adjusted when viewing a black/white test pattern.)

HORIZONTAL CENTERING CONTROL

This control shifts the entire raster and the picture, from left to right, on the screen. Adjust this control to get a picture that is well-centered from left to right.

VERTICAL CENTERING CONTROL

This control shifts the entire raster and the picture, from top to bottom, on the screen. Adjust this control to get a picture that is well-centered from top to bottom.

HORIZONTAL DRIVE CONTROL (On models which have a drive control)

This control affects the brightness and width of the picture. Adjust this control until white vertical bars appear on the screen; then back off control to the position where bars just disappear. (NOTE: Adjust HORIZONTAL DRIVE control before making horizontal size adjustment.)

HORIZONTAL SIZE CONTROL

This control varies the width of the picture. Move the horizontal size control to the left until dark edges can be seen on each side of the picture. Then move control to the right until picture is slightly larger than the picture mask.

AREA SELECTOR SWITCH

The quality and stability of the picture is controlled by the area selector switch. Set this switch to the position in which the picture is the clearest and most stable.

SERVICE NOTES

CHANGING OF TUBES

(Refer to TS-902 horizontal chassis top view and BP-902 vertical chassis top view for tube locations.) (See Figs. 11 & 14).

The receiver should be turned off when changing tubes. Indiscriminate changing or interchanging of tubes should be avoided for the following reasons:

1. A change of IF or RF tube, or crystal detector, can cause loss of sensitivity or poor picture quality. Check alignment and sensitivity after making such changes.

2. A change of limiter or ratio detector tubes can cause distorted audio, buzz, or loss of audio sensitivity. Check alignment and sensitivity after changing these tubes.

3. Changing the horizontal oscillator tube can result in poor noise rejection or cause the horizontal hold control to be out of range. This may necessitate re-adjustment of the horizontal oscillator coil.

FUSE REPLACEMENT

B plus and initial surge fuse (special 7.5 ohm resistor R-73)

This fuse is a plug-in type located on the top rear of the horizontal chassis, behind the vertical chassis. It is possible to replace this fuse by removing the back cover. Replacement is facilitated, however, by removing the four bolts from the baseboard and shifting the receiver assembly toward the rear of the cabinet.

Filament fuse (1 inch of #26 copper wire)

This fuse is located beneath the chassis in the area below the filament transformer. The chassis must be removed from the cabinet in order to replace the filament fuse. Replace with a 1 inch length of #26 wire soldered between two lugs of the terminal strip; the connection is in series with the heavy green lead from the filament transformer.

HORIZONTAL OSCILLATOR ADJUSTMENT

The HORIZONTAL HOLD control should have a sync range of approximately 25 degrees rotation. If the control adjustment is overly critical:

1. Increase the BRIGHTNESS and reduce the HORIZONTAL SIZE until the edges of the horizontal blanking pulse (grey vertical bars) are visible on either side of the raster.

2. Shunt the HORIZONTAL OSCILLATOR coil L-43 to ground with a .25 mf 400V, capacitor, and ground the control grid of the horizontal oscillator (pin 4).

3. Adjust the HORIZONTAL HOLD control until the picture is in sync or slowly floating through sync.

4. Remove the capacitor shunting L-43 to ground and adjust the HORIZONTAL OSCILLATOR coil until the picture is again in sync or floating through sync.

5. Remove short from control grid (pin 4) of horizontal oscillator.

REMOVAL OF THE CHASSIS

The chassis and the picture tube are mounted independently to a baseboard which is bolted into the cabinet. The chassis may be removed from the cabinet independently of the picture tube by removing four bolts. When removing only the chassis: disconnect the ground lead between the high voltage cage and the picture tube; disconnect the high voltage lead; disconnect antenna lead-in and unplug speaker plug; unplug the deflection yoke plug from chassis; disconnect yoke leads extending into the high voltage case; on models using a field neutralizing coil, unplug the field neutralizing coil plug.

Both the picture tube and the chassis can be removed by removing the four bolts which hold the baseboard to the cabinet. This operation must include the removal of the antenna from the side of the cabinet, disconnecting the antenna lead-in, unplugging the speaker plug and removing the wire braid from the bezel.

TONE CONTROL LINKAGE SETTING

In the event it becomes necessary to replace the tone control linkage:

1. Turn the tone control maximum counterclockwise.

2. Place the linkage over the TONE and CONTRAST-VOLUME shafts in such a manner that the arms and link are above the shafts.

3. Move the linkage assembly counterclockwise as far as possible.

NOTE: After chassis has been replaced in the cabinet, place the TONE control knob over the CONTRAST-VOLUME shaft so that the lettering on the knob is toward the top.

REMOVAL AND REPLACEMENT OF COLOR PICTURE TUBE

Replacement of the tri-color picture tube necessitates a complete purity and convergence alignment.

<u>To remove the color picture tube:</u>

1. Disconnect the picture tube socket. (Refer to Fig. 1).

2. Remove the blue lateral corrector magnet.

3. Remove the PM purity device.

4. Withdraw the dynamic convergence coils from the neck of the tube by shifting the coil lever toward a vertical position.

5. Remove the fibre picture tube mounting strap.

6. Disconnect the plastic high voltage interlock.

7. Loosen connecting rods between front and rear tube supports.

8. Remove front picture tube retaining brackets. Carefully remove the picture tube out the front of the assembly. Use extreme care while pulling the neck of the picture tube through the dynamic convergence coil assembly and the yoke.

9. Remove the magnetic shield from the flare of the picture tube.

10. Remove plastic insulating sleeve from around picture tube; remove second anode connector.

To install color picture tube:

1. Before installing tube in chassis mounts, clip second anode connector on metal flange of picture tube. Make this connection at a position approximately in line with pin #12 of the picture tube.

2. Place plastic insulating sleeve around picture tube front. Sleeve fold-over should be positioned in line with pin #4 of the picture tube.

3. Place magnetic shield on flare of the tube.

4. Mount picture tube to chassis with pin #4 toward top. Replace the front tube-retaining brackets. Position tube so that plastic sleeve over picture tube face edge is flush against retaining brackets.

5. Replace fibre picture tube strap; tighten connecting rods between front and rear tube supports; connect high voltage interlock.

6. Replace the PM purity device.

7. Replace the blue lateral corrector magnet so that it is directly below the blue gun and then replace tube socket.

8. Move the dynamic convergence coils in close proximity to the tube neck by shifting the dynamic convergence coil lever toward the tuner side of chassis.

9. Proceed with a complete purity and convergence alignment and background tracking set-up.

OPERATION OF THE COLOR RECEIVER

The modern color television receiver is more or less based on the original system in which three separate picture tubes were used. In this three-tube system, each picture tube had a transparent color filter of red, green and blue, respectively. Each tube could be driven with a video signal and, in this case, would show the same scene but, with the picture colored entirely red, green or blue, depending upon which tube was lighted. By a system of color sensitive mirrors and glass screens, it was possible to bring the three pictures together at one focal point in such manner that the viewer would see the three superimposed pictures (one over the other). If just the picture tube with the red filter were used, the result would be a good TV picture....but completely in red. The same would hold true for the blue and green tubes.

By the foregoing method of using three different picture tubes with color filters, it is possible to produce a color television picture provided that a method is available of breaking the picture down at the transmitter so that the red parts of the scene are sent to just the red picture tube, the blue parts of the scene to just the blue picture tube, and the green parts of the picture to just the green picture tube. This can be accomplished by having three cameras at the transmitter viewing the same scene, but with one camera having a color filter so that it can "see" only the red parts of the picture, a second camera with a filter so that it can "see" only the blue parts of the picture and the third camera that can "see" only the green parts of the picture.

If the signals from the individual cameras reach only the appropriate color picture tube, we have a method of taking the picture apart, color by color, at the transmitter and putting it back together correctly at the receiver. For any colors other than those of the color filters, a combination of two or more of the screen colors could be used and mixed to form the desired color.

The system described is possible to construct and was actually used at one time. However, the mechanical, optical and electrical problems involved make it impractical. For example, each picture tube would have to show a picture identical in height, width and linearity in order for them to superimpose perfectly. Experience with obtaining suitable linearity, etc., in just one receiver, gives an insight into the troubles encountered.

One solution to the problem is the three-electron gun picture tube which attempts to combine the three separate picture tubes used previously into one glass envelope. In this manner, the same deflection yoke and sweep system may be used for all three picture beams, resulting in identical height, width and linearity.

The tri-color picture tube is designed to give the equivalent action of the three separate tubes by dividing its screen into extremely small color dots and by lighting all screen dots of any one basic color by a particular electron gun of three used. In this way, the screen may be made completely red, blue, or green by controlling the beam currents of the individual guns. Likewise, color may be added to a picture by controlling the red gun by the signal from the red camera at the transmitter, the blue gun by the blue camera information, and the green gun by the green camera information.

RECEIVING BLACK AND WHITE

All screen dots of any one color are lighted by just one of the three electron guns and thus the light intensity of the three-screen color may be controlled by the beam currents of the individual guns. The beam currents of the three guns may be individually adjusted by grid bias voltages in order to adjust the separate color intensities when there is no signal. If the red dots are made brighter than the blue and green dots, the entire screen will appear with a red tinge, etc. When the light intensity value of all the red, blue and green dots are equal...the entire screen will appear white to the viewer. This is due partly to the inability of the human eye to distinguish individual colors of equal light intensity values and also to the fact that the

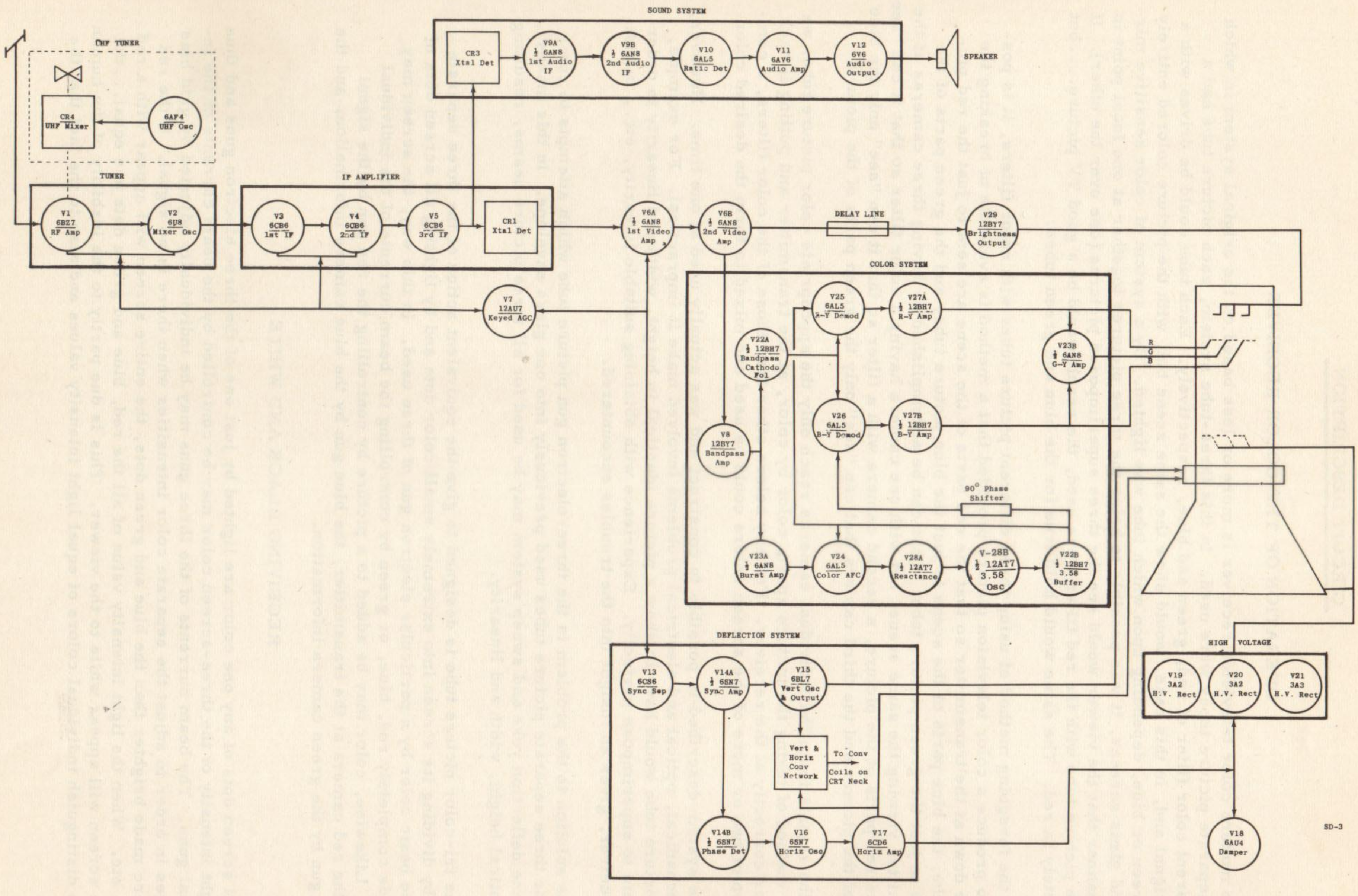


FIGURE 3. BLOCK DIAGRAM

screen dots are so tiny that the individual color dots cannot be resolved. It is by this optical trick that the screen of the tri-color picture tube may be made to appear white to the observer and as long as the equal-intensity light-values of the red, blue and green dots are maintained (as determined by the gun grid bias and anode voltages).....the entire screen can be made brighter or dimmer and still appear as white or shadings of white. A standard black and white station transmission can now be used to modulate the three electron beams simultaneously and the screen will appear to follow the shadings of black and white necessary to reproduce the picture. Compatibility is thus maintained between black and white and color receivers.

The circuitry of the color receiver used to carry the black/white (brightness) signal from the second detector to the picture tube, is very similar to the standard video system used in conventional receivers. This system consists of the first and second video amplifiers, through the brightness amplifier and on to the cathodes of the three electron guns, so that the beam currents of all three are increased and decreased by the brightness (Y) signal.

ADDING THE COMPLETE COLOR SIGNAL

In the formation of an actual color telecast, three cameras are used for pick-up at the station. One camera is for the red parts of the picture, a second for the blue parts and the third for the green picture information. The outputs of these three cameras are re-combined in the correct proportions to produce a video signal practically identical to that of a conventional black and white camera. This video signal is transmitted as the "Y" signal and contains all the brightness information necessary to reproduce a picture in black and white. It corresponds closely to a standard black/white signal in bandwidth, etc., and may be reproduced on a standard black/white receiver. The "Y" signal will also produce a good definition black and white picture through the "Y" channel of a color receiver. In a sense, a color receiver reproduces a good definition black/white picture through the "Y" channel and then correctly colors this picture by information sent over a separate subcarrier and through the "chroma" channel.

The entire signal, brightness "Y" and color "chroma" is passed through the receiver from the antenna to the second video amplifier. The output of the second video amplifier divides into two paths, the brightness channel for the video signal and the chroma channel for the color signal. The brightness signal continues on through the brightness amplifier and to the cathodes of the tri-color picture tube to produce a good detail monochrome picture. The color information continues on through the bandpass amplifier, bandpass cathode follower and to the demodulators. The demodulators recover the original color signals and pass them on to the grids of the tri-color picture tube guns by way of the R-Y (red), B-Y (blue), and G-Y (green) amplifiers.

The color information from the three cameras at the transmitter is sent over a separate subcarrier of 3.58 megacycles, using a two-phase modulation, suppressed-carrier system. (NOTE: In the suppressed carrier system, the actual 3.58 megacycle carrier is not transmitted......only the upper and lower sidebands, which contain the actual picture color information, reach the receiver. However, for ease of understanding and for all practical purposes, you may assume that a conventional carrier signal and its sidebands is being received. The color subcarrier is modulated in amplitude (same as standard black and white video) as well as in phase (phase may be considered as the amount of lead or lag of one signal as compared to a fixed reference signal standard). The phase of the subcarrier determines the particular color (hue) that is to be reproduced at any particular instant of a horizontal scanning line. The amplitude of the subcarrier determines the strength of this hue in comparison to the black and white signal (brightness) and thus determines its shade or tint (saturation).

THE PHASE ANGLE OF THE SUBCARRIER DETERMINES THE COLOR (HUE)

Two demodulators are used in the receiver to recover the color information brought in by the color subcarrier. Each demodulator can detect a change in the phase of the subcarrier since they are supplied with a signal standard by the local 3.58 megacycle color oscillator (the oscillator signal also effectively re-inserts the 3.58 megacycle subcarrier). A change in phase of the subcarrier can produce a most important action through the demodulators.. it can change the polarity of the output voltage. Depending on the phase angle of the transmitted subcarrier, a positive or negative voltage may be developed at the output of either of the demodulators.

Since the polarity of the output voltage of a demodulator is dependent on the phase of the subcarrier in comparison to the phase of the local oscillator signal supplied this particular demodulator, it should be apparent that the demodulators can be designed to produce different polarity outputs from the same subcarrier merely by shifting the phase of the oscillator signal fed to one of the demodulators. This is accomplished by inserting a phase shifting network between the local oscillator and the B-Y demodulator (the network shifts the phase of the local oscillator fed to the B-Y demodulator by 90 degrees, in respect to the oscillator signal to the R-Y demodulator). In this manner, it is possible to obtain four different polarity output voltages from the two demodulators as the same subcarrier signal is shifted through 360 degrees. The demodulator output voltages may be: both positive, both negative, or one positive and one negative--or one negative and the other positive.

The output voltages of the two demodulators (R-Y & B-Y) are amplified through their respective amplifiers (R-Y and B-Y) and used to drive the control grids of the red and blue picture tube guns, respectively. If we put a positive voltage on the control grid of the red gun, the red phosphor dots over the entire picture screen will be more brightly lighted. If we put a negative voltage on the control grid of the blue gun, the blue phosphor dots over the entire picture screen will be dimmed. Thus we have the first fundamental action required to produce a particular color on the screen, since it is possible to transmit a subcarrier phase angle which will produce a positive voltage on the red electron gun lighting the red dots more brightly; at the same time producing a negative voltage on the blue electron gun reducing the brightness of the blue dots. The second requirement is to get a third negative voltage on the green gun in order to reduce the brightness of the green dots. This is accomplished by feeding some of the positive voltage of the red system and some of the negative voltage from the blue system to a third amplifier (G-Y). The two voltages subtract from each other across the G-Y resistor input system and only the remainder of the larger of the two signals will operate the tube. In this particular case, the red positive signal is the larger and the remainder is amplified and inverted through the G-Y amplifier so that a negative voltage is supplied to the control grid of the green electron gun. (NOTE: In the case of a phase angle producing positive or negative voltage outputs at both demodulators.... the G-Y amplifier would add voltages.)

The preceding paragraphs explained how positive and negative voltages are produced by two separate demodulators operating on a single subcarrier and how the control grids of the three electron guns receive the correct polarities to increase or decrease the brightness of the colors. We must now take into consideration the fact that a video signal is being fed to the picture tube cathodes simultaneously with the color signals arriving at the control grids. It should be obvious that the signals at the control grids can either add to or subtract from the video brightness signals at the cathodes, resulting in an increase of brightness of a particular color or no change at all due to cancellation. Using the red signal as an example of this, as before, we find that the R-Y demodulator and amplifier will feed a positive voltage to the red CRT control grid and the B-Y demodulator and amplifier feeds a negative voltage to the blue CRT control grid. The negative B-Y signal feeds into the control grid of the blue gun and cancels the brightness signal (negative) at the cathode of the blue gun, resulting in no change in the blue beam current. The positive R-Y signal feeds into the grid of the red gun and adds to the negative brightness signal at the cathode of the red gun. Thus, the red electron gun increases its emission and colors the area red.

The green electron gun is fed by the signal from the G-Y amplifier and since the G-Y amplifier is receiving a signal from the output of both the R-Y and B-Y amplifiers, it will either add or subtract these signals. In this case, there is a positive signal at the output of the R-Y amplifier and a negative signal at the output of the B-Y amplifier, the G-Y amplifier finds the difference, inverts it, and feeds it to the green gun in the correct polarity to cancel the brightness signal at the cathode of the green gun. Thus, we find that the green gun as well as the blue gun do not change conduction, leaving only the red gun emitting heavily and coloring the area red.

Blue and green signals are formed in the same manner, the only difference being in the phase angle of the 3.58 Mc color subcarrier which, in turn, produces voltages in the demodulators of such polarities that the two unwanted color guns do not change conduction. For example, when transmitting blue, the phase angle of the subcarrier is such that the red electron gun receives a negative signal at the control grid, cancelling the negative brightness signal at the red cathode. The blue electron gun receives a positive signal at the control grid adding to the negative brightness signal at the blue gun cathode. The red and blue signals are fed to the green (G-Y) amplifier and result in a negative output to the green control grid cancelling the negative brightness signal of the cathode. Thus, we find that the red and green guns remain at the same brightness level as when no signal was applied and that the blue gun conducts heavily... coloring the particular area being scanned blue.

A similar action occurs for any green areas, with the exception that the polarities are such that the red and blue signals cancel their portion of the brightness signal, while the green signal adds to the brightness signal giving a green area.

It should be apparent that the phase angle of the color subcarrier determines the polarity output of the demodulators and thus, which signals will add and which will cancel creating the particular color required. As the phase angle of the color subcarrier is shifted, from 0 to 360 degrees, the color of the screen will not only change through the three basic colors of red, blue and green, but also through the entire color spectrum capable of being reproduced by the combinations of these three colors.

Now, let us suppose that the phase of the subcarrier is such that a red area is being produced on the screen and that the voltage of just the color signal alone is reduced. The result is that there is more brightness signal than red color signal and the red takes on a faded tint. In other words, when the amplitude of the color subcarrier is changed in respect to the brightness signal, the shade or tint of the particular color reproduced will change. The change of shade, or tint, of a color is called its saturation. Thus, we find that the amplitude of the color subcarrier in respect to the brightness signal determines the particular shade (saturation) of the basic color and that the phase angle of the subcarrier determines the particular color desired (hue).

In order for the demodulators to be able to detect a change in the phase of the color subcarrier, they must compare the subcarrier against a standard. This standard is the local 3.58 Mc color oscillator in the receiver. However, the local oscillator must have the same phase and frequency as that of the 3.58 Mc oscillator of the transmitter (before the phase of the transmitter subcarrier oscillator is changed by phase shifting). To accomplish this, a color synchronizing signal is sent at the trailing edge of the horizontal synchronizing pulse which is approximately nine cycles of 3.58 megacycles. This signal is called the "burst" signal and its purpose is to pull the receiver's local 3.58 Mc oscillator into the correct phase and frequency. During the horizontal line scanning, the local oscillator maintains its phase and frequency due to the action of the AFC control system. Oscillator stability is achieved by crystal control. Because the oscillator is held to a rigid phase relationship with the burst, a change in the phase of the color subcarrier will result in a change in amplitude or polarity of the demodulator output voltage.

THE BANDPASS AMPLIFIER AND COLOR BURST BOOST SYSTEM

The bandpass amplifier is the first tube stage of the color channel. It receives the color signal from the plate of the second video amplifier through a potentiometer mechanically ganged with the contrast control (cathode of the brightness amplifier). In this manner, the amplitude of the color signal through the chroma channel is tracked with the amplitude of the video signal through the brightness channel. An independent gain control potentiometer, located in the cathode of the bandpass amplifier, regulates the strength of the color signal only. This control is located on the front panel and is labeled "color intensity".

The synchronizing burst signal also travels through the bandpass amplifier, to reach the automatic frequency control (AFC) system of the local 3.58 megacycle oscillator.

To insure constant burst signal to the AFC system, at all settings of the color intensity control; the gain of the bandpass amplifier is automatically increased to maximum during the burst signal by injection of a positive pulse of voltage (burst boost pulse) at its control grid. This positive pulse is generated at the cathode of the damper tube during the retrace time of the horizontal sweep system and, therefore, arrives at the grid of the bandpass amplifier at approximately the time of the burst signal. (NOTE: The burst pulse is transmitted immediately following the horizontal sync pulse: the sync pulse coincides with the retrace of the horizontal system, therefore, the burst and boost pulses should arrive at the grid of the amplifier almost simultaneously.

The burst boost pulse, if of constant amplitude, would always increase the gain of the bandpass amplifier during the burst signal. However, the total amplification factor of the stage would still be dependent on the setting of the color intensity control plus the boost voltage and the burst signal would change amplitude as the setting of this control were changed. Since it is desirable to maintain the burst signal at a constant level for best AFC action in the following circuits, a clamping diode (1N60 crystal) is provided from the boost pulse input to the "hot" end of the color intensity control which varies the amplitude of the boost pulse. The clamping action of the diode is regulated by the voltage produced across the intensity control and thus the amplitude of the boost pulse is regulated by the intensity control setting. In this manner, the amplitude of the boost pulse is always such that the burst signal is amplified by the same amount (maximum gain). The constant amplitude of the burst signal, provided by this circuit, gives superior AFC control action of the 3.58 Mc crystal oscillator.

Inspection of the bandpass stage will show that a type 12BY7 sharp cut-off pentode type tube is used. However, a sharp cut-off type tube does not readily lend itself to gain-controlled circuits due to the fact that, as the bias is increased on the control grid, the tube begins acting as a clipper and the gain of the stage is not appreciably changed. A unique action is achieved in the bandpass amplifier, between the high gain of the sharp cut-off pentode and the variable gain characteristic of the remote cut-off pentode, by the use of a larger-than-normal value of screen dropping resistor (approximately 22K ohms). The screen voltage of the tube varies with the setting of the cathode bias potentiometer since the total tube current is changed in accordance with the bias. For example, as the bias is increased, the total tube current is decreased and the I x R drop, occurring across the screen resistor, is decreased resulting in a higher screen potential. As the screen voltage is increased, the tube becomes harder to cut-off due to the fact that the cut-off voltage and gain of the tube are quite dependent on the screen voltage. Thus, we find that the tube begins to act similar to a remote cut-off type of tube; also that the gain is changed, due to the characteristic curve of the tube changing with the screen voltage.

OPERATION OF THE CLAMP CIRCUIT (BURST BOOST)

Inspection of the schematic diagram shows that a positive pulse (boost signal) is coupled from the damper tube's cathode through a network (R-150, C-140, C-141 and C-142). The signal is fed to the junction of the grid resistors R-101 and R-102 and is developed across resistor R-102 (10K ohms). The resistor R-101 (3300 ohms) and peaking coil L-42 apply the voltage to the control grid. The purpose of the 1 megohm resistor returned to B++ is to counteract any negative voltage developed by the diode's conduction.

The clamping crystal CR-5 connects from the boost signal input point to the "hot" end of the color intensity control. Resistor R-103 is a conventional cathode biasing resistor, as are the cathode bypass capacitors C-105 and C-66C. Capacitor C-66C (100 mfd electrolytic) provides sufficient bypass action to prevent degeneration, with resultant loss of gain, at low frequency signals. Due to the inefficient bypass action of an electrolytic capacitor on higher frequency components, a second paper capacitor (.01 mfd - C-105) parallels the electrolytic.

The crystal CR-5 is connected in the circuit in such manner that a positive pulse voltage at the junction of the grid resistors R-101 and R-102 will cause the crystal to conduct. Considering a case in which the viewer might prefer strong color intensity signals and in which the color intensity control is set to minimum resistance (maximum stage gain), the cathode of CR-5 is at or near chassis ground potential. In this case, the forward resistance of the crystal is effectively shunted across the boost signal input R-102. CR-5 acts as a low resistance path to ground for any positive pulses appearing at this point. Thus, the boost pulse is removed or reduced, since the burst signal is receiving maximum gain and does not require a boost.

Considering the opposite case, in which the viewer might prefer weak color intensity signals, the gain of the bandpass amplifier would be decreased by increasing the resistance of the color intensity control (increased tube bias). Since it is desired to maintain the gain of the bandpass amplifier constant for the burst signal, the boost pulse now is allowed to appear at the tube input. When the resistance of the cathode potentiometer is increased (as the color intensity control is adjusted) the tube current flowing through this resistance will produce a voltage which will be positive at the cathode end, negative at the ground end. This voltage must be overcome by the boost signal before the crystal diode will conduct; therefore, a positive boost pulse will be aiding the signal at the control grid which will give maximum gain to the burst signal. The amplitude of this pulse will nearly equal the DC voltage across the cathode resistor.

THE 3.58 MC COLOR OSCILLATOR SYSTEM

The path of the synchronizing burst signal, the AFC voltage and local 3.58 Mc oscillator signal is as follows:

From the plate of the second video amplifier to:

1. The burst amplifier
2. The color AFC phase detector
3. The reactance tube
4. The 3.58 Mc crystal oscillator
5. The oscillator buffer stage (output).

The burst amplifier receives the entire color signal, at its control grid, from the bandpass amplifier's output link coupling system. Since the screen of the burst amplifier has no B+ voltage other than that fed from a winding on the horizontal output transformer, the tube is without screen voltage except during retrace of the horizontal sweep circuit. In this manner, the bandpass amplifier is allowed to operate only during horizontal retrace, which corresponds to the time of the burst transmission. In other words, the burst amplifier tube is gated to operate only during the color burst.

The output of the burst amplifier is transformer coupled to the color AFC phase detector and, due to the keying of this stage as explained, allows only the burst to enter the phase detector. A second input to the phase detector is through transformer coupling from the output of the buffer amplifier, which in turn, is driven by the local 3.58 Mc color oscillator.

The phase detector compares the phase and frequency of the incoming burst signal, from the burst amplifier, with that of the local color oscillator. Any difference in phase or frequency results in a DC output from the center tap of the load resistors and is applied to the control grid of the reactance tube.

The reactance tube's plate current then, is under the direct control of the phase detector. Any change in the current of this stage presents varying amounts of capacitance (produced electronically by the reactance tube) to the crystal controlled oscillator and restores the phase and frequency of the oscillator.

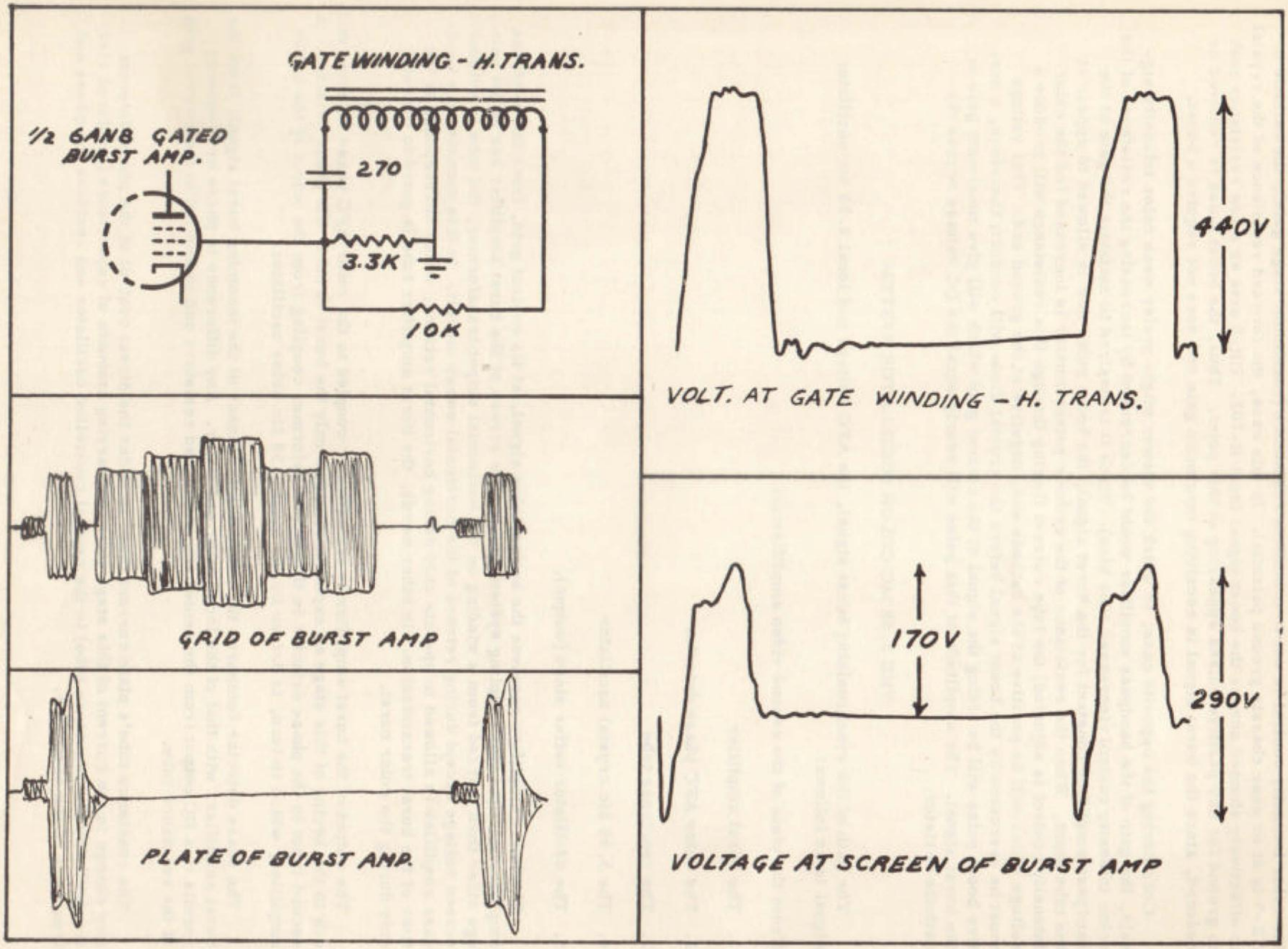


FIGURE 4. GATED BURST AMPLIFIER

THE BURST AMPLIFIER

The burst amplifier performs a similar function in the color system as the sync separator performs in the sync section of the conventional black and white receiver...it separates the color synchronizing burst signal (from the black and white sync as well as from the coloring information). Stated in a different manner, the burst amplifier tube allows only the color sync burst to reach the phase detector for frequency control action.

The burst amplifier is inoperative during the scanning of horizontal picture lines due to the fact that it is not supplied with screen voltage. The tube is made operative during the burst signal by a positive pulse of voltage fed to the screen from an independent gate winding located on the horizontal output transformer. The transformer and gate winding produces sizeable voltages only during the time of horizontal retrace -- during which time the burst amplifier is allowed to conduct.

The burst signal is transmitted during the blanking pedestal immediately following the horizontal sync pulse. In a receiver which is operating properly, retrace of the horizontal sweep system is initiated in close coincidence with the transmitted horizontal sync pulse. Therefore, the time of the horizontal retrace, in the receiver, occurs very close to that of the burst signal. The burst tube is keyed by the pulse fed to its screen during retrace and since the sync burst signal arrives at the grid at approximately the same time, the burst signal only is amplified and passed on to the following stages (see "Gated Burst Amp" drawing).(Fig. 14)

As stated, the burst signal is transmitted after the sync pulse and it is apparent that the keying pulse fed to the burst amplifier screen will slightly lead the burst signal at the grid ...in which case a portion of the last few burst cycles would be lost. To shift the time of the keying pulse so that it more closely coincides with the burst signal, a network (10K ohm resistor, 3300 ohm resistor and 270 mmf capacitor) is utilized to shape and delay the keying pulse.

The grid input system of the burst amplifier consists of a parallel resonant tank to ground. When tuned to 3.58 Mc, the tank will develop maximum burst voltage to the burst amplifier. Inspection of the circuit shows that the tank is adjustable capacitively as well as inductively and that the capacitor is the color shading control located on the front panel of the receiver.

It has been established that the voltage reaching the burst amplifier is that produced across the resonant tank in the grid circuit, and that this voltage represents the burst signal. When the tank is tuned to approximately 3.58 Mc, the signal produced by the tank will have the same phase as that of the incoming burst signal. On the other hand, if the tank circuit is above or below resonance (detuned), as determined by the color shading capacitor...the burst signal developed across the tank will lead or lag the actual burst signal. Since the local color oscillator is synchronized with the burst signal appearing across the burst amplifier grid tank, the local color oscillator will shift its phase to follow that of the tuned tank.

The color oscillator is being used as the standard against which the color subcarrier phase and frequency are being compared. When the phase of the subcarrier changes, the new phase angle represents a specific hue. Therefore, shifting the phase of the local oscillator, by means of the color shading capacitor, is equivalent to shifting all hues by the amount of the oscillator phase shift. This is the method used: to obtain correct, or desired tints and shades of the picture hues; to compensate for phase shift occurring through the chroma channel.

THE COLOR AFC TUBE (Phase Detector)

The purpose of the phase detector is to compare the phase and frequency of the local 3.58 Mc color oscillator against the 3.58 Mc color burst sent from the transmitter. Should a difference in phase or frequency exist between the burst and color oscillator signals, the phase detector (color AFC) will supply a DC voltage to the reactance tube which will pull the color oscillator into the desired phase and frequency with the burst signal. The polarity of this corrective voltage is dependent upon whether the color oscillator is running faster or slower (leading or lagging) than the reference burst signal; the amplitude of the DC voltage depends upon the degree of lead or lag. When both the burst signal, from the station, and the local color oscillator signal are matched in phase and frequency, the phase detector has zero output and no correction takes place.

The color AFC diodes (phase detector) may be considered as two conventional second detectors connected in such manner that one of the detectors will put out a positive rectified voltage while the other detector puts out a negative rectified voltage. Diode V-24A produces a positive rectified voltage at its cathode (junction of the .0015 mfd capacitor and 1 meg resistor). Diode V-24B produces a negative rectified voltage at its plate (junction of the .0015 mfd capacitor and 1 megohm resistor). The local color oscillator signal is fed to the phase detector at all times by the tap on coil L-210. The signal is fed equally to both diodes and both diodes will produce the same amount of rectified DC voltage across their load resistors, positive at top end of R-232 and negative at the bottom end of R-234 (see schematic). Maximum positive voltage will be found at the top end of R-232 and maximum negative voltage will be found at the bottom end of R-234....at some point between these maximum voltage values, a zero point exists. The movable rotor arm of the 250K ohm AFC balance potentiometer can locate this zero point. It should now be clear that when the oscillator signal only, is incoming to the phase detector, a zero DC voltage will be produced at the output.

As stated, the oscillator signal is injected into the phase detector at all times from coil L-210 and by itself produces a zero output voltage. During color reception, the burst signal is also injected into the phase detector; injection is from the tuned transformer T-203. The simultaneous injection of two AC signals into the phase detector create resultant voltages (added vectorially) which affect the two diodes differently. Considering the case when the phase of the burst and oscillator signals are of the required phase, the resultant of the burst and oscillator signal voltages to both diodes V-24A & B are equal and zero output results. If the phase of the oscillator signal, as compared to the burst signal, is not that required, the resultant voltage to diode V-24A would increase while the resultant voltage to diode V-24B would decrease. This would produce increased positive voltage at the cathode of V-24A, as compared to decreased negative voltage at the plate of V-24B, and result in a positive DC output from the detector. This condition results when the phase of the oscillator signal leads the phase of the burst signal. On the other hand, when the phase of the oscillator signal lags the phase of the burst signal, the resultant voltage to diode V-24B would increase and the resultant voltage to diode V-24A would decrease. This results in increased negative voltage at the plate of V-24B and decreased positive voltage at the cathode of V-24A. The phase detector would now have a negative DC output voltage.

SUMMARY: When both the phase of the oscillator and burst signals are that required by the circuitry, a zero DC output voltage is produced by the phase detector. When the phase of the oscillator signal leads the burst signal, V-24A conducts more heavily and diode V-24B conducts less heavily, producing a positive output DC voltage. When the phase of the oscillator signal lags the burst signal, diode V-24B conducts more heavily and diode V-24A conducts less heavily, producing a negative DC output voltage. This DC output voltage is supplied to the control grid of the reactance tube causing a capacitor tuning action to result which, in turn, pulls the oscillator into correct phase and frequency.

THE REACTANCE TUBE

The purpose of the reactance tube is to control the phase and frequency of the local 3.58 Mc color oscillator as dictated by the DC voltage produced by the phase detector (a DC voltage is produced in the phase detector when the phase of the local 3.58 Mc oscillator is not correct).

The reactance tube is connected across the crystal circuit of the oscillator and operates as an electronic capacitor, tuning the resonant crystal circuit to the correct frequency.

The oscillator signal voltage is fed, in reverse manner, to the plate of the reactance tube through the 100 mmf capacitor (C-236) and arrives at the grid of the reactance tube through the internal plate to grid tube capacity (in some chassis a 2 mmf capacitor is connected externally from plate to grid of the tube). The oscillator signal voltage arriving at the grid of the reactance tube leads the oscillator signal applied at the plate, due to the capacitor action. This leading voltage, at the tube's grid, produces a leading plate current through the reactance tube which makes the entire reactance tube circuit appear as a capacitor to the crystal oscillator. If the reactance tube's plate current and output signal are increased by a positive voltage on the control grid, the tube acts as a larger value capacitor and tunes the crystal to a lower frequency. If the reactance tube's plate current and output signal are decreased by a less positive (negative) voltage at its control grid, the tube acts as a smaller value capacity and tunes the crystal to a higher frequency. It should be clear that the apparent capacity presented to the crystal circuit is determined by the reactance tube's output signal and that this AC signal can be controlled by the voltage applied to the reactance tube's grid. A method is now available for controlling the frequency of the crystal oscillator by a DC voltage (as applied to the control grid of the reactance tube). The phase detector produces a DC output voltage when the phase and/or frequency of the local oscillator is not exactly that of the burst synchronizing signal sent from the transmitter. Therefore, a method of complete automatic frequency control of the local 3.58 Mc oscillator is available.

The plate current and output signal of the reactance tube determines the apparent value of capacity that is tuning the crystal to resonance. Therefore, if the reactance tube plate current is cut off by sufficient grid bias, it produces no capacity effect. It is easy to see that if minimum capacity of the tube (as produced by minimum plate current) does not tune the oscillator to the correct frequency before the reactance tube is completely cut off, the reactance tube will lose control of the oscillator. To insure sufficient range of the reactance tube's capacitor action, a tunable inductor (L-215) is incorporated in the plate circuit. This makes it possible to tune the crystal to resonance and still have the reactance tube operate over its most desirable range of voltages and currents.

THE 3.58 MC OSCILLATOR

The 3.58 Mc local color oscillator is basically a tuned plate-tuned grid type of circuit using shunt fed plate tank.

The oscillator is stabilized by a crystal in the grid circuit which replaces the usual L-C tuned tank. The crystal acts as a high "Q" tuned circuit and will operate within a few hundred cycles of the correct frequency, or not at all. The circuit is therefore operating at approximately the correct frequency.

The output of the oscillator increases as the plate L-C tank is tuned toward resonance. However, the circuit will continue to oscillate only when the tank is tuned on the high frequency side of the resonant point (the high frequency side is with the iron core out of the coil and moving into the coil) due to the phase of the feedback voltage required from the plate to grid through the tube's internal capacity. Since the circuit will not operate on the low side of resonance, it can be seen that as the tuning of the plate tank approaches resonance, the oscillator can become unstable, intermittent, or stop oscillating entirely; therefore, the correct point of the oscillator plate tank setting is always below the point of maximum output voltage (resonance) and on the high frequency side of the resonant point.

When operating, the oscillator is controlled by grid leak bias produced by capacitor C-237 (57 mmf) and R-246 (150K ohms) in the grid circuit. This negative voltage may be measured by a VTVM, as in any oscillator, and will give a good indication of the performance of the circuit.

The crystal CR-7, in the grid circuit, replaces the usual L-C tank; however, in action, it is similar to a parallel tuned circuit operating with a very high "Q". The crystal (in conjunction with the extraneous circuit capacities) will determine the frequency at which the oscillator will operate.

The 100 mmf capacitor (C-236) couples the oscillator voltage to the reactance tube V-28A which, in turn, acts as a variable electronic capacitor across the crystal, tuning it to the correct phase and frequency as dictated by the DC voltage produced in the color AFC circuit. The 100 mmf capacitor acts as a coupling from the reactance tube back to the crystal as well as from the crystal to the reactance tube.

The parallel tuned plate tank, consisting of L-216 and C-242 (180 mmf capacitor) is DC isolated from, and "RF" coupled to, the plate of the oscillator by capacitor C-241 (.01 mfd).

The plate receives DC voltage through the 150K ohm resistor R-249. Since the plate current for the oscillator does not flow through the plate L-C tank, it is called a shunt fed oscillator.

A tap on the plate tank coil feeds the oscillator signal to the buffer amplifier which acts as an output amplifier and isolation stage for the oscillator. The tap on the tank matches the impedance of the tank to the grid input impedance of the buffer stage for maximum power transfer.

THE BUFFER AMPLIFIER

The output of the local oscillator is coupled to the buffer amplifier by means of an impedance matching tap on the tuned plate tank of the oscillator. The buffer amplifier increases the oscillator signal and acts as an isolation stage between the oscillator and the demodulators, thus, keeping changes of voltages from affecting the oscillator stability. The output of the buffer amplifier is from the plate through a system of tuned coils. One tuned coil (L-210) feeds the signal to the R-Y demodulator in phase with the oscillator signal. The opposite coil (L-209) feeds the oscillator signal to the B-Y demodulator at a phase shift of 90 degrees. The output of the buffer amplifier is fed to the first tuned coil by the .01 mfd coupling capacitor. Coil L-210, in parallel with capacitors C-212 (180) and C-213 (.002) as well as other extraneous circuit capacities, constitute a parallel resonant tank. Therefore, tuning coil L-210 will result in maximum voltage developed across this circuit and maximum voltage fed to the R-Y demodulator. A portion of this voltage is tapped off by the divider circuit composed of C-212 (180 mmf) and C-213 (.002). The voltage developed across C-213 is fed to the following circuit consisting of C-211 (220), L-209 and C-214 (.01). C-214 is an RF bypass across the blue background control. C-211 and L-209 constitute a series resonant circuit and will develop maximum current through the series path when tuned to resonance. Thus, maximum voltage will be developed across coil L-209 and fed to the B-Y demodulator when properly tuned. However, since the voltage across the inductive portion of a series resonant circuit will lead the current by 90 degrees, the voltage fed to the B-Y demodulator will be 90 degrees out of phase with that fed to the R-Y demodulator. The purpose of these out-of-phase voltages, to the demodulators, is explained in the demodulator section. The oscillator signal into the demodulators is detected in the same fashion as by any peak detector and a DC voltage is developed across the load resistors proportional to peak of the oscillator signal. (This assumes absolutely no other incoming signal.)

On first thought, it would seem that the phasing of this circuit would be quite critical and require complicated and expensive equipment to tune the buffer tank coils for the correct voltage phases. However, an operational characteristic of the circuit makes the job quite easy. This characteristic is that, when the phase shifting coil L-209 is tuned to resonance, it will place maximum load on the parallel tuned tank (L-210). In other words, the voltage developed by coil L-210 will drop below its normal value as the series tank L-209 is tuned to resonance. Thus, we have the effect of the voltage fed to the R-Y demodulators dropping as the voltage to the B-Y demodulator is being increased. The voltage being referred to, is the rectified voltage developed at the junction of the 33 mmf capacitor and the 10K ohm load resistor of the demodulators. This voltage can be measured by use of a VTVM connected from this junction to ground (the hot lead of the meter connects to the junction and the ground lead of the meter connects to chassis).

The method of tuning the phase shifting coils in the output of the buffer amplifier is then to connect the meter to the load side of the R-Y demodulator and tune the first coil (L-210) for maximum voltage reading. Next, tune the phase shifting coil (L-209) for maximum voltage to the B-Y demodulator...this will result in reduced voltage to the R-Y demodulator. Retune coil L-210 for maximum voltage to the R-Y demodulator. Retune coil L-209 for maximum voltage to the B-Y demodulator and minimum voltage to the R-Y demodulator. It is necessary to work between the two coils until minimum interaction is obtained. The procedure is nothing more than tuning both tank coils to resonance and when this is accomplished, the phase shift will automatically be correct...provided there are no component part failures in the system.

THE DEMODULATORS

The function of the demodulators in the receiver's color section is similar to that of the second detector in a standard TV or radio receiver; they demodulate the color subcarrier. The demodulators continuously test the phase and amplitude of the incoming color subcarrier during horizontal picture scanning and produce an output voltage when the phase or amplitude changes. The reference phase during scanning is that of the local 3.58 Mc oscillator.

Two separate demodulators are required in the receiver to demodulate the color subcarrier signal completely. Although both demodulators operate on the same subcarrier signal, each is capable of extracting different signal information. This will be explained in the later paragraphs.

One of the demodulators is labeled the R-Y demodulator and consists of the diodes V-25A and B (see the schematic diagram). The other demodulator (B-Y) consists of the diodes V-26A and B. Considering the diode sections of tube V-25 only (the R-Y demodulator), we may regard the diode sections A and B as two conventional second detectors connected in such manner that one of the diode detectors (A) will produce a positive rectified output voltage at its cathode while the other detector (B) will produce a negative rectified output voltage at its plate. These voltages will be produced across the load resistors R-241 and R-265 (10K ohms) respectively.

The local color oscillator signal is fed to the demodulators (pins 7 and 5) continuously from the output of the buffer amplifier. Since the oscillator signal voltage is fed to both diodes equally (pins 7 and 5 are tied together), both diodes will produce the same value of rectified DC voltage (opposite polarity) across their load resistors. The load resistor voltage will be maximum positive at the top end of R-241 and maximum negative at the bottom end of R-265. The center tap of R-241 and R-265 will be at a zero voltage point since it is at the mid-point of positive and negative voltages. It should now be clear that when the oscillator signal only is incoming to the demodulator, zero output voltage is produced and no signal reaches the R-Y amplifier. An identical action occurs in the B-Y demodulator with the oscillator signal only. As stated, the oscillator signal is injected into the R-Y and B-Y demodulators continuously from the output of the buffer amplifier. During color reception, the color subcarrier is also injected into the demodulators from transformer T-202. The simultaneous injection of two alternating current signals into a demodulator produce resultant voltages that are of quite a different value than either of the injected signals alone. The phase angle between the two injected signals determines the final resultant voltage value that will be applied to each diode (A and B) of any one demodulator. For example, if the phase of the subcarrier signal lags the oscillator signal at the R-Y demodulator, a larger resultant voltage is applied to diode V-25A and a smaller resultant voltage is applied to diode V-25B. Increased conduction current through diode V-25A produces a greater positive voltage at the junction of resistor R-241 and capacitor C-207, in respect to ground. Decreased conduction current through diode V-25B produces a decreased negative voltage at the junction of resistor R-265 and capacitor C-208, in respect to ground. The load voltages are unequal and do not cancel at the center junction. The larger voltage (positive) of the two load voltages will now appear at the output of the R-Y demodulator. If the phase of the subcarrier signal leads the oscillator signal at the R-Y demodulator, the reverse action would occur and the demodulator would have a negative output voltage. The fundamental action of the R-Y demodulator, just explained, is repeated in the B-Y demodulator. The major difference between the R-Y and B-Y demodulator operation is due to a difference in the phase of the local 3.58 Mc oscillator signal fed to each.

In order to understand the action of the two demodulators (R-Y and B-Y) when operating on the same subcarrier, it is necessary to first learn some fundamental characteristics of a demodulator. The important rules are that: when the waveform of the incoming subcarrier leads or lags the oscillator signal (the oscillator is used as the standard) by a quarter of a cycle (90 degrees), the output of the demodulator is zero. When the incoming subcarrier is in phase with the demodulator: maximum positive voltage appears at the output of the demodulator. When the incoming subcarrier is of opposite polarity (180 degrees out of phase) as compared to the local oscillator, the output is maximum negative voltage.

Summary:

1. A demodulator has zero output when the two input signals are a quarter cycle (90 degrees) apart.

2. A demodulator has maximum positive output voltage when the two input signals are in phase.

3. A demodulator has maximum negative output voltage when the two input signals are in phase ...but of opposite polarity (180 degrees apart).

It should now be a simple matter to understand the action of the two demodulators on the same color subcarrier signal. The B-Y demodulator is fed a local 3.58 Mc oscillator signal which is in phase with the subcarrier reference (zero degrees) and if a subcarrier signal were received at this phase, the demodulator would produce maximum positive output voltage. The R-Y demodulator is fed with a local 3.58 Mc oscillator signal which is a quarter cycle (90 degrees) away from the reference phase (zero degrees) and, as explained previously, would have zero output when a signal at zero reference phase is injected into it. In the case just described, the B-Y demodulator would have maximum positive output voltage and the R-Y demodulator would have zero output voltage on the same signal. If the phase of the subcarrier began to shift, the output of the R-Y demodulator would increase and the output of the B-Y demodulator would decrease.... until finally the output of the B-Y demodulator would be zero and the R-Y demodulator would be maximum. This represents a shift of a quarter cycle (90 degrees) of the subcarrier.

When one of the three primary phosphor colors (red, green or blue) is transmitted, the phase angle of the subcarrier is such that it falls somewhere between maximum output voltage of one demodulator and zero output voltage of the other demodulator. In this manner, both demodulators will have some output voltage. Also, the polarity of the voltage out of either of the demodulators will be determined by the phase angle of the subcarrier in reference to the local oscillator. An example of this is the phase angle of the subcarrier for a red picture area (104 degrees leading). In this case, the subcarrier phase slightly leads the oscillator signal into the R-Y demodulator and consequently the R-Y demodulator will have a positive output voltage. The same subcarrier lags the oscillator signal [-(B-Y) 180 degree phase] into the B-Y demodulator and it will have a negative output signal. If the outputs of the demodulators were fed directly into the control grids of the picture tube, the output voltages of the demodulators, as explained, would be correct. However, the signals out of the demodulators must pass through the R-Y and B-Y amplifiers and the polarities of all voltages would be inverted. This presents no problem in the circuit since it is only necessary to interchange the connections to the demodulator diodes to produce opposite polarity outputs for the same phase of input signal.

The final result of the demodulator action is to feed a positive voltage to the red electron gun's control grid (during the scanning of red areas) and a negative voltage to the control grids of the blue and green guns. In this manner, the color signal at the electron gun of the red tube adds to that of the brightness signal at the cathode and lights the red phosphors with greater intensity. In the same way, the negative signal at the blue and green control grids cancels the brightness signal at their cathodes and the blue and green phosphors have no change in brightness. For a review, see "Operation of the Color Receiver".

PURPOSE OF THE DYNAMIC CONVERGENCE SYSTEM

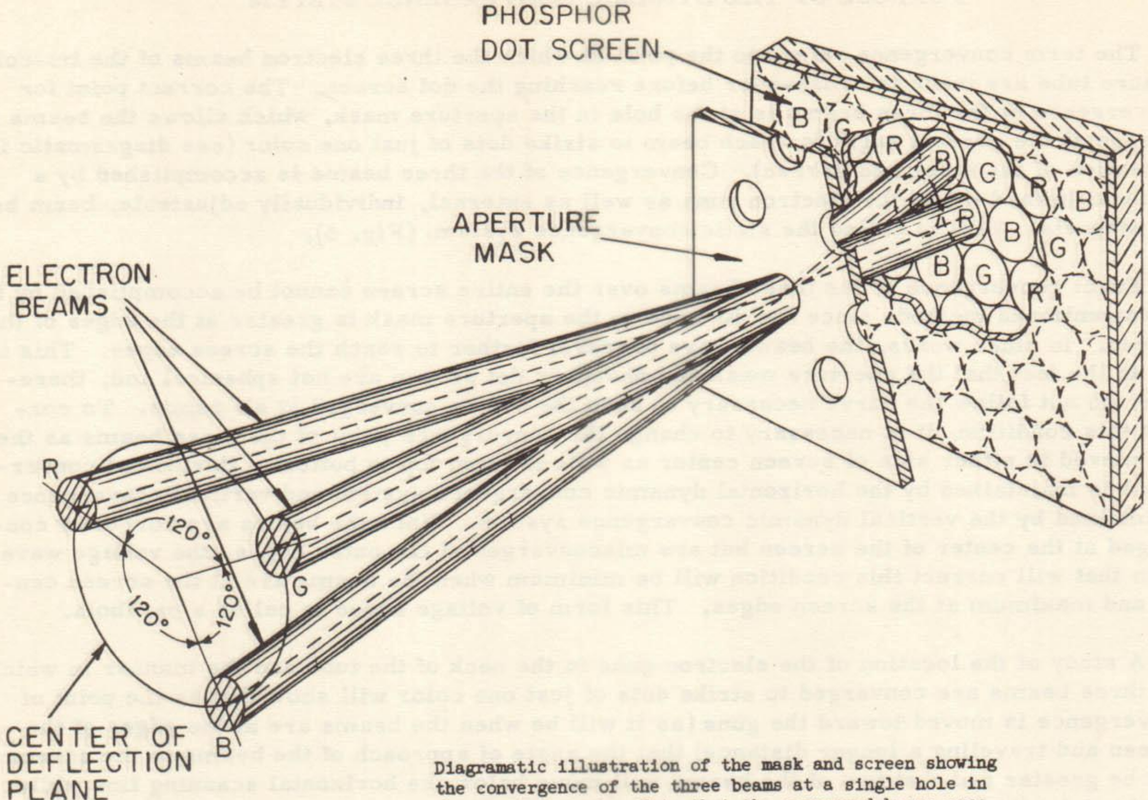
The term convergence refers to the point at which the three electron beams of the tri-color picture tube are made to cross-over before reaching the dot screen. The correct point for convergence of the three beams is at the hole in the aperture mask, which allows the beams to emerge at the correct angle for each beam to strike dots of just one color (see diagramatic illustration of the mask and screen). Convergence of the three beams is accomplished by a physical inward tilt of the electron guns as well as external, individually adjustable, beam bending magnets. This is called the static convergence system. (Fig. 5).

Exact convergence of the three beams over the entire screen cannot be accomplished by the aforementioned methods since the distance to the aperture mask is greater at the edges of the screen. In other words, the beams have to travel farther to reach the screen edges. This is due to the fact that the aperture mask and phosphor dot screen are not spherical and, therefore, do not follow the curve necessary to keep the beams converged at all points. To correct this condition, it is necessary to change the convergence point of the three beams as they are moved to either side of screen center as well as from top to bottom. Horizontal convergence is maintained by the horizontal dynamic convergence system and vertical convergence is maintained by the vertical dynamic convergence system. Since the beams are correctly converged at the center of the screen but are misconverged at the outer edges, the voltage waveform that will correct this condition will be minimum when the beams are at the screen center and maximum at the screen edges. This form of voltage curve is called a parabola.

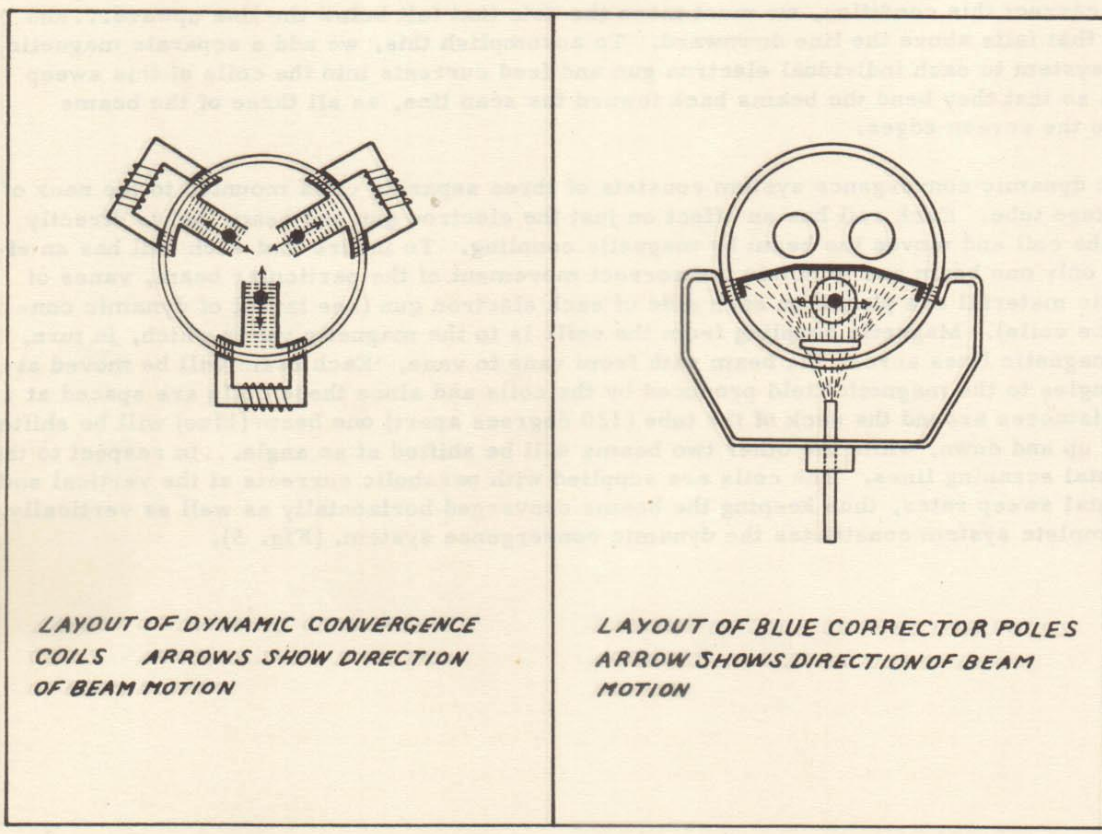
A study of the location of the electron guns in the neck of the tube and the manner in which the three beams are converged to strike dots of just one color will show that as the point of convergence is moved toward the guns (as it will be when the beams are at the edges of the screen and traveling a longer distance) that the angle of approach of the beams to the screen will be greater and that two of the beams will move below the horizontal scanning line while the third dot (blue) will move above the horizontal scan line.

To correct this condition, we must move the dots that fall below the line upward...and the dot that falls above the line downward. To accomplish this, we add a separate magnetic sweep system to each individual electron gun and feed currents into the coils of this sweep system so that they bend the beams back toward the scan line, as all three of the beams move to the screen edges.

The dynamic convergence system consists of three separate coils mounted to the neck of the picture tube. Each coil has an effect on just the electron gun and beam that is directly under the coil and moves the beam by magnetic coupling. To insure that each coil has an effect on only one beam and to obtain the correct movement of the particular beam, vanes of magnetic material are placed on each side of each electron gun (see layout of dynamic convergence coils). Magnetic coupling from the coils is to the magnetic vanes which, in turn, place magnetic lines across the beam path from vane to vane. Each beam will be moved at right angles to the magnetic field produced by the coils and since these coils are spaced at equal distances around the neck of the tube (120 degrees apart) one beam (blue) will be shifted exactly up and down, while the other two beams will be shifted at an angle...in respect to the horizontal scanning lines. The coils are supplied with parabolic currents at the vertical and horizontal sweep rates, thus keeping the beams converged horizontally as well as vertically. The complete system constitutes the dynamic convergence system. (Fig. 5).



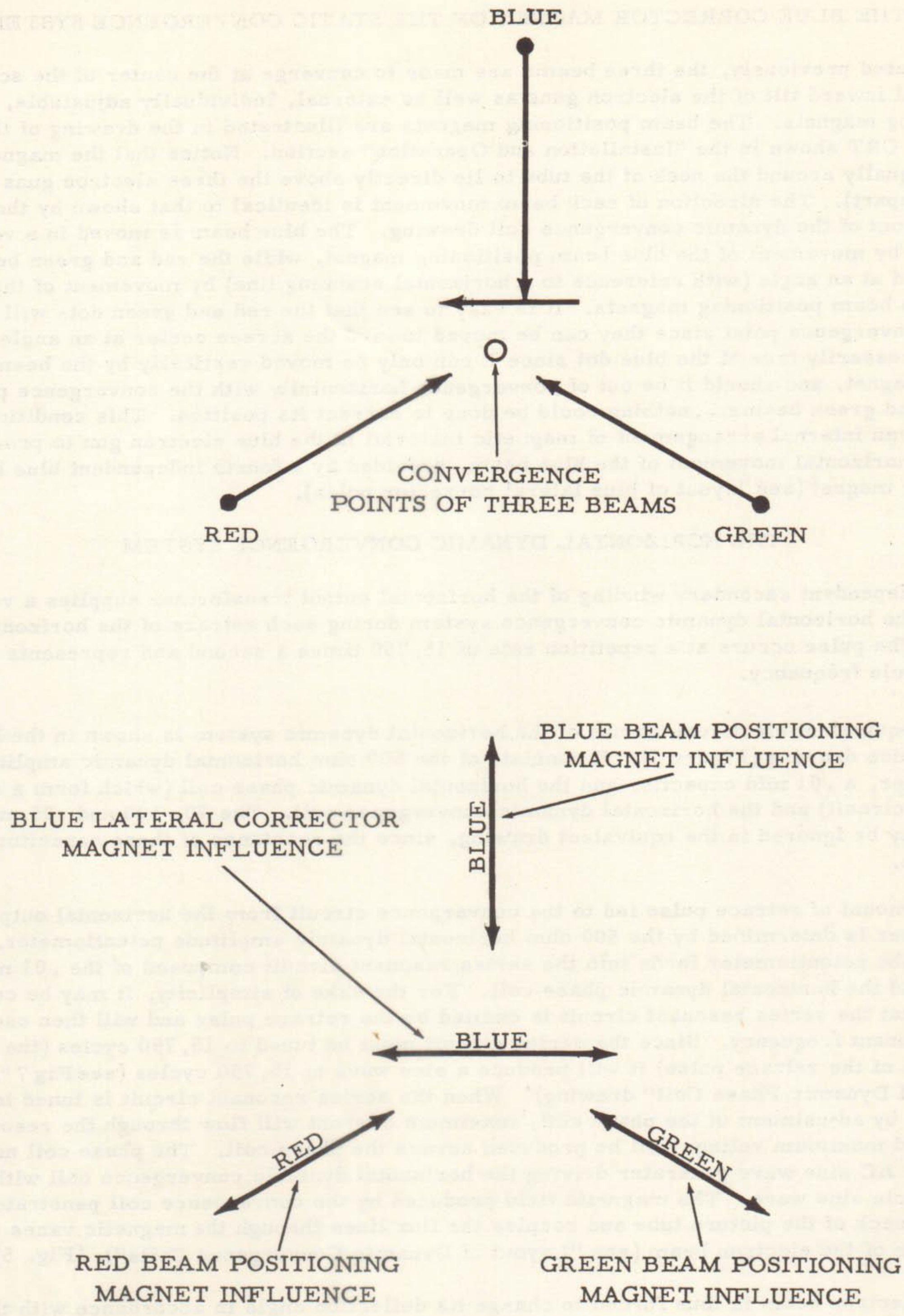
Diagramatic illustration of the mask and screen showing the convergence of the three beams at a single hole in the aperture mask. Note that the converged beams pass through the hole and strike their respective phosphor dots.



LAYOUT OF DYNAMIC CONVERGENCE COILS ARROWS SHOW DIRECTION OF BEAM MOTION

LAYOUT OF BLUE CORRECTOR POLES ARROW SHOWS DIRECTION OF BEAM MOTION

FIGURE 5.



STATIC CONVERGENCE

Direction of beam movement due to adjustment of three beam positioning magnets and blue lateral corrector magnet. (Beams shown overconverged)

SB-1

FIGURE 6. STATIC CONVERGENCE

THE BLUE CORRECTOR MAGNET OF THE STATIC CONVERGENCE SYSTEM

As stated previously, the three beams are made to converge at the center of the screen by a physical inward tilt of the electron guns as well as external, individually adjustable, beam positioning magnets. The beam positioning magnets are illustrated in the drawing of the 19-inch tri-color CRT shown in the "Installation and Operation" section. Notice that the magnets are spaced equally around the neck of the tube to lie directly above the three electron guns (120 degrees apart). The direction of each beam movement is identical to that shown by the arrows in the layout of the dynamic convergence coil drawing. The blue beam is moved in a vertical direction by movement of the blue beam positioning magnet, while the red and green beams are moved at an angle (with reference to a horizontal scanning line) by movement of the red and green beam positioning magnets. It is easy to see that the red and green dots will always have a convergence point since they can be moved toward the screen center at an angle. This is not necessarily true of the blue dot since it can only be moved vertically by the beam positioning magnet, and should it be out of convergence horizontally with the convergence point of the red and green beams... nothing could be done to correct its position. This condition is solved by an internal arrangement of magnetic material in the blue electron gun to provide a field for horizontal movement of the blue beam, provided by a fourth independent blue lateral corrector magnet (see layout of blue lateral corrector poles).

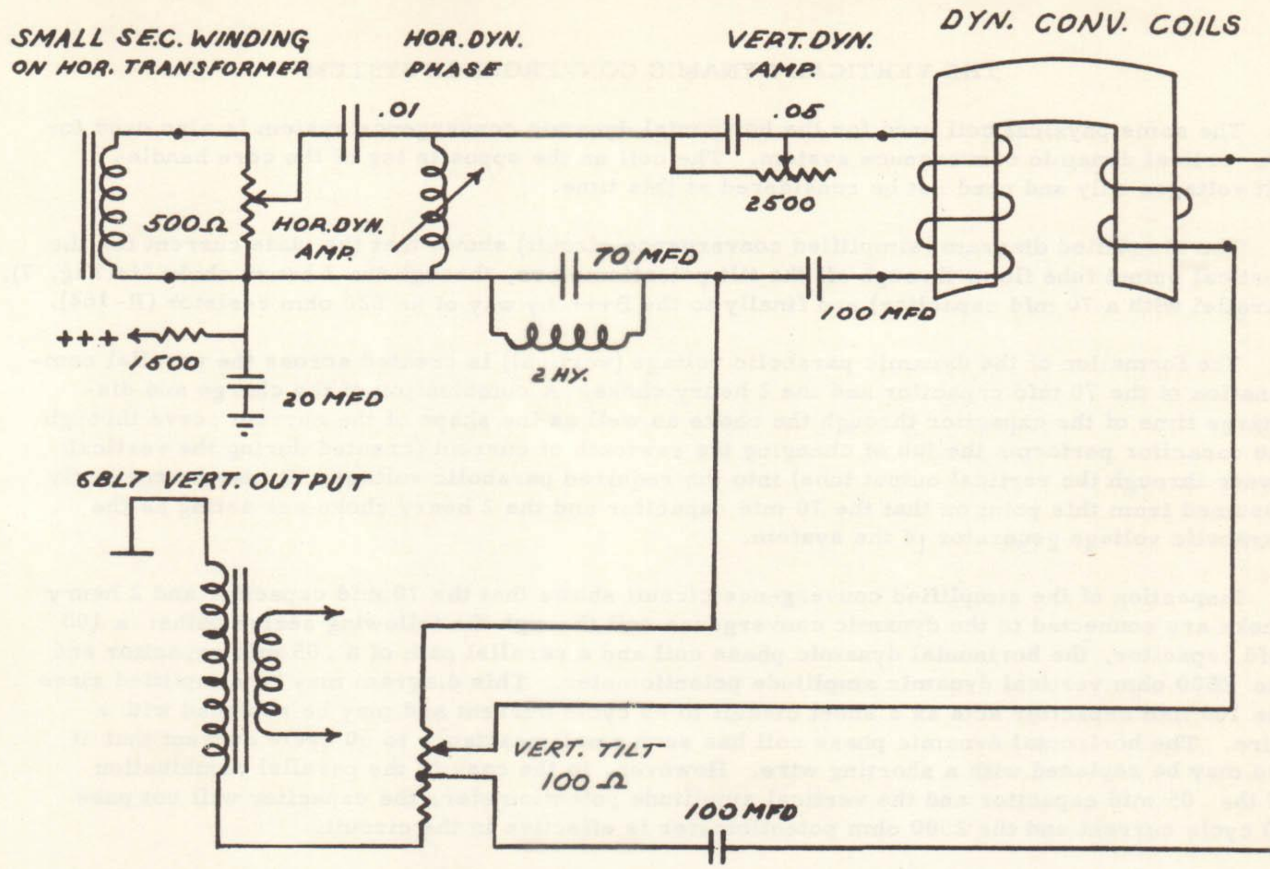
THE HORIZONTAL DYNAMIC CONVERGENCE SYSTEM

An independent secondary winding of the horizontal output transformer supplies a voltage pulse to the horizontal dynamic convergence system during each retrace of the horizontal sweep. The pulse occurs at a repetition rate of 15, 750 times a second and represents a 15, 750 cycle frequency.

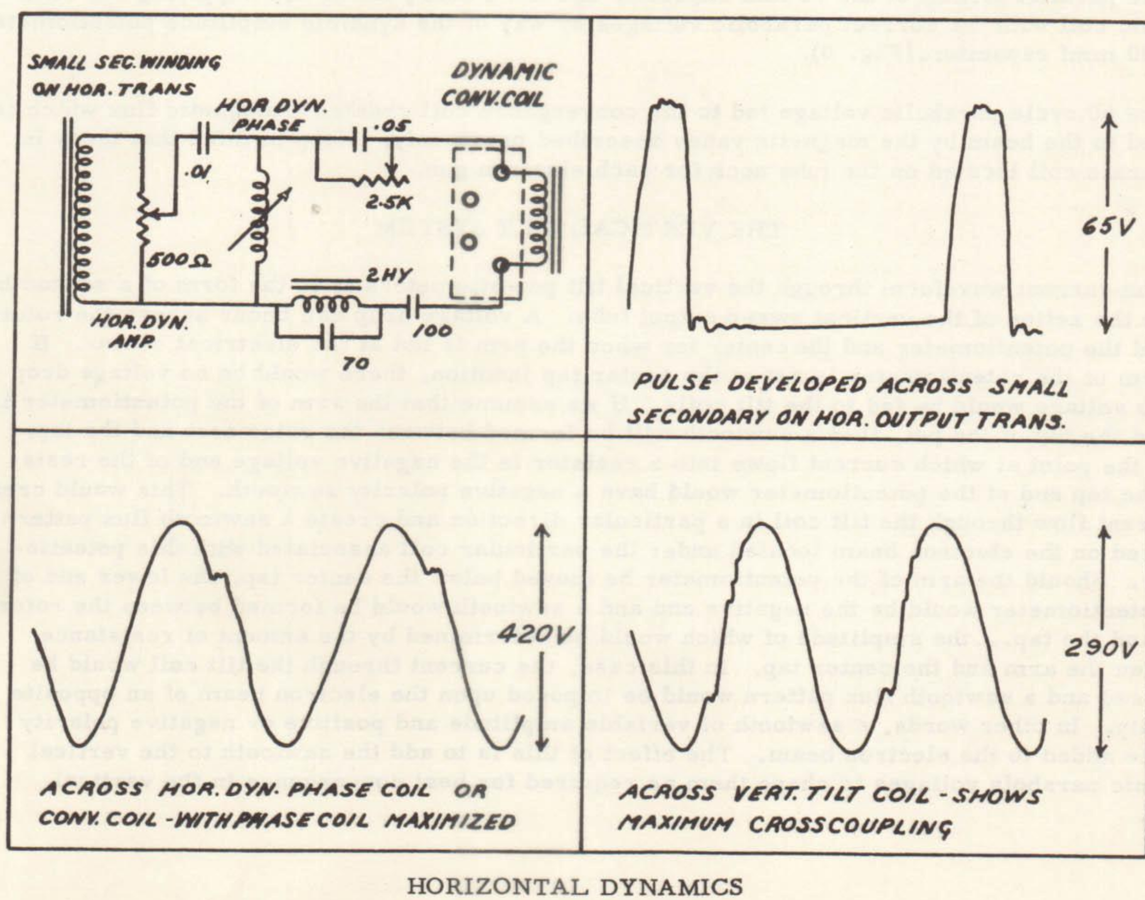
The equivalent electrical circuit of the horizontal dynamic system is shown in the horizontal dynamics drawing (Figure 7). It consists of the 500 ohm horizontal dynamic amplitude potentiometer, a .01 mfd capacitor and the horizontal dynamic phase coil (which form a series resonant circuit) and the horizontal dynamic convergence coil. The 70, 100 and .05 mfd capacitors may be ignored in the equivalent drawing, since the reactance of these capacitors is negligible.

The amount of retrace pulse fed to the convergence circuit from the horizontal output transformer is determined by the 500 ohm horizontal dynamic amplitude potentiometer. The output of the potentiometer feeds into the series resonant circuit composed of the .01 mfd capacitor and the horizontal dynamic phase coil. For the sake of simplicity, it may be considered that the series resonant circuit is excited by the retrace pulse and will then oscillate at its resonant frequency. Since the series circuit must be tuned to 15, 750 cycles (the repetition rate of the retrace pulse) it will produce a sine wave of 15, 750 cycles (see Fig 7 "Across Horizontal Dynamic Phase Coil" drawing). When the series resonant circuit is tuned to this frequency by adjustment of the phase coil, maximum current will flow through the resonant circuit and maximum voltage will be produced across the phase coil. The phase coil now acts as an AC sine wave generator driving the horizontal dynamic convergence coil with a 15, 750 cycle sine wave. The magnetic field produced by the convergence coil penetrates the glass neck of the picture tube and couples the flux lines through the magnetic vanes on either side of the electron beam (see "Layout of Dynamic Convergence Coils"). (Fig. 5).

The electron beam is thus forced to change its deflection angle in accordance with the 15, 750 cycle sine wave and thus its convergence point with the other two beams as they move from left to right-hand sides of the screen for one horizontal scanning line. It is now possible to change the point of convergence of the beam on the left and right-hand sides of the screen as compared to the center of the screen and correct convergence of the beam may be maintained over the entire horizontal scan line.



SIMPLIFIED CONVERGENCE CIRCUIT



HORIZONTAL DYNAMICS

FIGURE 7.

THE VERTICAL DYNAMIC CONVERGENCE SYSTEM

The same physical coil used for the horizontal dynamic convergence system is also used for the vertical dynamic convergence system. The coil on the opposite leg of the core handles tilt voltages only and need not be considered at this time.

The simplified diagram (simplified convergence circuit) shows that the plate current for the vertical output tube flows through all the tilt potentiometers, through the 2 henry choke (in(Fig. 7). parallel with a 70 mfd capacitor) and finally to the B+++ by way of an 820 ohm resistor (R-164).

The formation of the dynamic parabolic voltage (vertical) is created across the parallel combination of the 70 mfd capacitor and the 2 henry choke. A combination of the charge and discharge time of the capacitor through the choke as well as the shape of the current curve through the capacitor performs the job of changing the sawtooth of current (created during the vertical sweep through the vertical output tube) into the required parabolic voltage. It may be correctly assumed from this point on that the 70 mfd capacitor and the 2 henry choke are acting as the parabolic voltage generator of the system.

Inspection of the simplified convergence circuit shows that the 70 mfd capacitor and 2 henry choke are connected to the dynamic convergence coil through the following series paths: a 100 mfd capacitor, the horizontal dynamic phase coil and a parallel path of a .05 mfd capacitor and the 2500 ohm vertical dynamic amplitude potentiometer. This diagram may be simplified since the 100 mfd capacitor acts as a short circuit to 60 cycle current and may be replaced with a wire. The horizontal dynamic phase coil has such small reactance to 60 cycle current that it too may be replaced with a shorting wire. However, in the case of the parallel combination of the .05 mfd capacitor and the vertical amplitude potentiometer, the capacitor will not pass 60 cycle current and the 2500 ohm potentiometer is effective in the circuit.

The completely simplified circuit is shown in the drawing "Vertical Dynamics" and we find that the parallel circuit of the 70 mfd capacitor and the 2 henry choke are supplying the vertical dynamic coil with the correct parabolic voltages by way of the dynamic amplitude potentiometer and 100 mmf capacitor. (Fig. 8).

The 60 cycle parabolic voltage fed to the convergence coil creates a magnetic flux which is coupled to the beam by the magnetic vanes described previously. Keep in mind that there is a separate coil located on the tube neck for each electron gun.

THE VERTICAL TILT SYSTEM

The current waveform through the vertical tilt potentiometers is in the form of a sawtooth due to the action of the vertical sweep output tube. A voltage drop can occur across the rotor arm of the potentiometer and the center tap when the arm is not at the electrical center. If the arm of the potentiometer is set at the center tap junction, there would be no voltage drop and no voltage would be fed to the tilt coils. If we assume that the arm of the potentiometer is toward the top of the pot, then a sawtooth will be formed between the rotor arm and the tap. Since the point at which current flows into a resistor is the negative voltage end of the resistor; the top end of the potentiometer would have a negative polarity sawtooth. This would create a current flow through the tilt coil in a particular direction and create a sawtooth flux pattern imposed on the electron beam located under the particular coil associated with this potentiometer. Should the arm of the potentiometer be moved below the center tap, the lower end of the potentiometer would be the negative end and a sawtooth would be formed between the rotor arm and the tap...the amplitude of which would be determined by the amount of resistance between the arm and the center tap. In this case, the current through the tilt coil would be reversed and a sawtooth flux pattern would be imposed upon the electron beam of an opposite polarity. In other words, a sawtooth of variable amplitude and positive or negative polarity may be added to the electron beam. The effect of this is to add the sawtooth to the vertical dynamic parabola voltages to shape them as required for best convergence in the vertical plane.

HIGH VOLTAGE POWER SUPPLY

The operating voltages which are used to establish beam intensity and shape (focus) in the tricolor picture tube originate in the retrace (kickback) power supply section. Three high voltage rectifiers (two 3A2's and 3A3) are employed in a voltage doubler network circuit. The horizontal transformer is similar to the conventional type of auto-transformer used in high voltage circuits of black and white receivers. Extra windings are provided, however, to supply pulse voltages to the burst amplifier and the horizontal dynamic convergence system and separate filament voltages to the high voltage rectifiers.

V-19 (3A2) and V-21 (3A3) conduct during retrace time. V-19 operates from a tap on the primary of T-13 so that the rectified output voltage at the filament of V-19 is approximately 8,000 volts. The focus circuit load drops that 8,000 volts so that approximately 6,000 volts is available at the plate of V-20. R-151 (2.5 meg) is used to adjust the voltage on the focus anode between 6,000 and 8,000 volts. The 6,000 volts at the plate of V-20 is coupled over to the plate of V-21 during the interval between pulses when V-20 conducts. This 6,000 volts plus approximately 19,000 volts, developed across the entire auto-transformer primary, appears at the plate of V-21 during retrace time. A voltage at the filament of V-21 equal to approximately 25,000 volts (developed across C-148) is available as the high voltage to the picture tube second anode.

Regulation of the 25,000 volt supply is obtained by using a regulator tube across the output circuit of the high voltage supply. Part of the output current is shunted through the regulator tube which offers a greater load to the high voltage system during the times when the high voltage tends to increase, with lessened picture tube loading (dark picture portions), and offers less load when the high voltage tends to decrease, due to increased picture tube loading (bright picture portions).

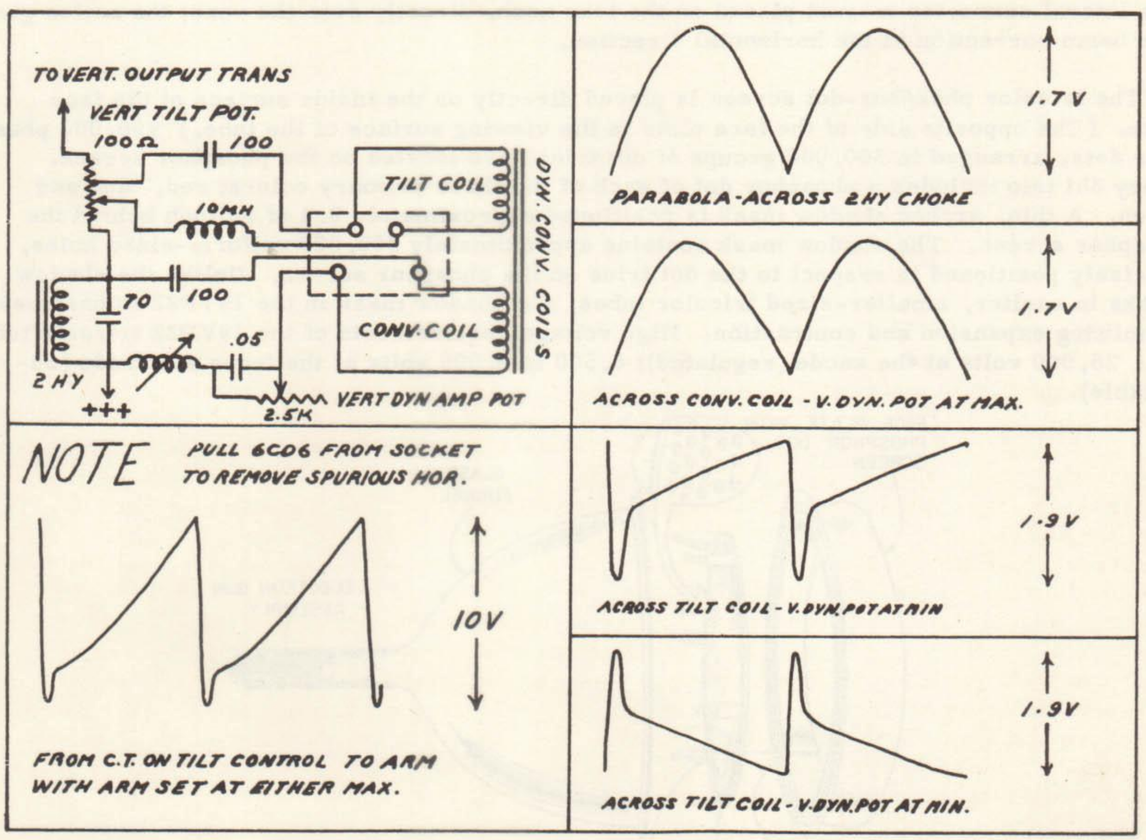


FIGURE 8. VERTICAL DYNAMICS

THE 19VP22 TRICOLOR PICTURE TUBE

The 19VP22 tricolor picture tube features an aluminized glass envelope, 62 degree deflection, electrostatic focusing; and is constructed for use with an electromagnetic convergence system. (Refer to diagrams of tricolor picture tube and gun assembly.)

Beam sources of the 19VP22 tricolor picture tube are supplied from a matched three-electron gun assembly. The three individual guns that make up the assembly are arranged 120 degrees apart in a triangular pattern. Each gun is tilted (approximately 1 degree) toward the common tube axis. This tilting of the guns is incorporated into the assembly with the intention of obtaining proper convergence of the beams at the center of the screen.

Aside from the yoke, which functions in the conventional manner, four external components are employed in conjunction with the tube's operation. They are: the purity device, the beam positioning magnets and convergence coils (one assembly) and the blue lateral corrector magnet. The purity device (two magnetic rings) is mounted on the neck of the tube between grid two and the focusing electrode. This device controls all beams simultaneously in an effort to provide color purity on the screen.

Three pairs of pole pieces are attached directly to the anodes of the guns (120 degrees apart). These pole pieces, or vanes, are used in conjunction with three permanent magnets (beam positioning magnets) and three electromagnetic coils (convergence coils), which are mounted directly over the pole pieces on the neck of the tube. In this manner, a means is provided for correction of center misconvergence (static adjustment) due to differences in the mechanical positions of the guns; and for correction of misconvergence at edges, top and bottom of the screen (dynamic adjustment), a natural development resulting from the particular shape of the shadow mask and phosphor-dot screen. A separate pair of pole pieces, or vanes, is attached to the focus electrode of the blue gun. This vane is used in conjunction with the blue lateral corrector magnet placed on the tube neck, directly over the vane; the action gives blue beam correction in the horizontal direction.

The tricolor phosphor-dot screen is placed directly on the inside surface of the face plate. (The opposite side of the face plate is the viewing surface of the tube.) 900,000 phosphor dots, arranged in 300,000 groups of dot trios, are located on the phosphor screen. Every dot trio includes a phosphor dot of each of the three primary colors; red, blue and green. A thin, arched shadow mask is positioned approximately 0.4 of an inch behind the phosphor screen. The shadow mask contains approximately 300,000 uniform-sized holes, precisely positioned in respect to the dot trios on the phosphor screen. Unlike the shadow masks in earlier, smaller-sized tricolor tubes, the shadow mask in the 19VP22 is unstressed, permitting expansion and contraction. High voltage requirements of the 19VP22 tricolor tube are: 25,000 volts at the anode (regulated); 6,500 to 8,000 volts at the focus electrode (adjustable).

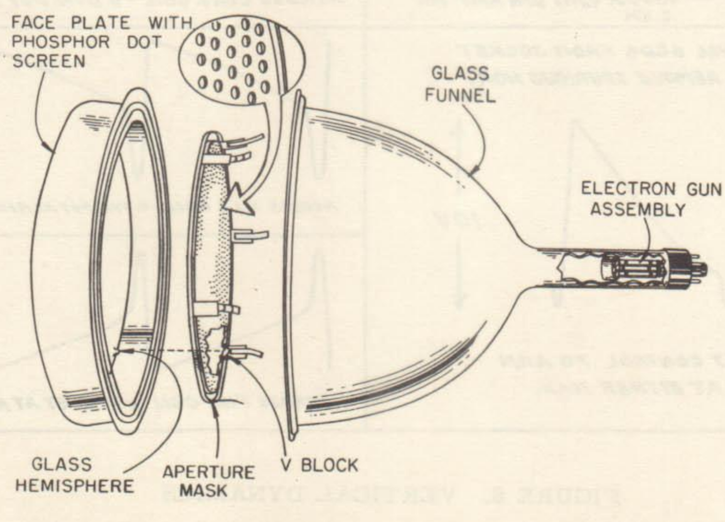
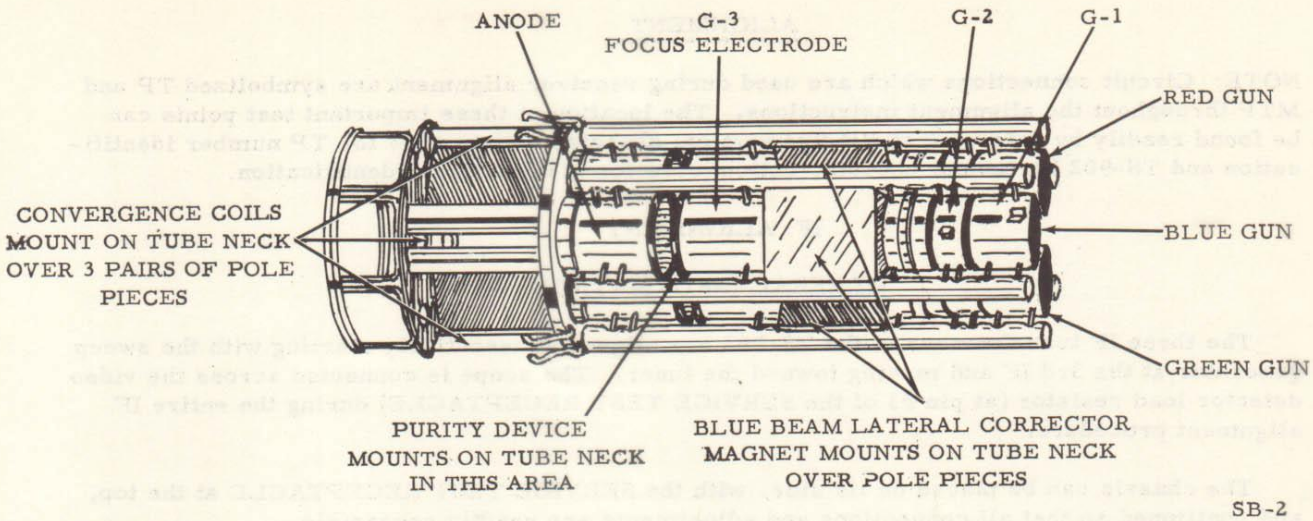
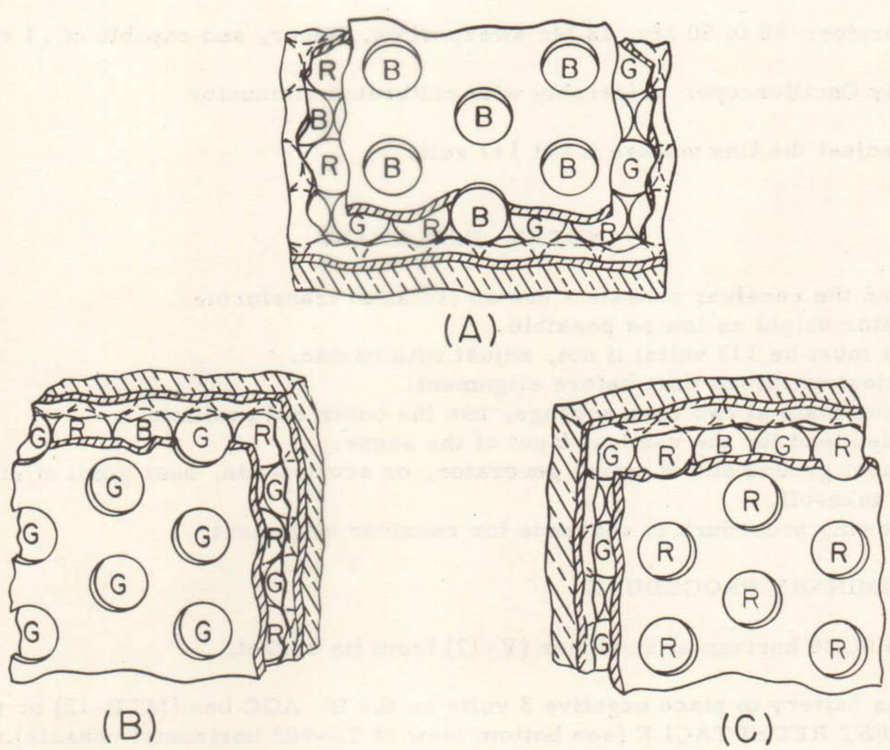


FIGURE 9. EXPLODED VIEW OF CBS COLORTRON



ELECTRON GUN ASSEMBLY - 19VP22



Views of mask-and-screen assembly as seen from the deflection points of the three beams. (A) View from deflection point of blue gun. (B) View from deflection point of green gun. (C) View from deflection point of red gun.

FIGURE 10.

ALIGNMENT

NOTE: Circuit connections which are used during receiver alignment are symbolized TP and MTP throughout the alignment instructions. The location of these important test points can be found readily by referring to BP-902 vertical chassis, bottom view for TP number identification and TS-902 horizontal chassis, bottom view for MTP number identification.

IF ALIGNMENT

GENERAL INFORMATION

The three IF transformers of the TS-902 are aligned consecutively starting with the sweep generator at the 3rd IF and moving toward the tuner. The scope is connected across the video detector load resistor (at pin #3 of the SERVICE TEST RECEPTACLE) during the entire IF alignment procedure.

The chassis can be placed on its side, with the SERVICE TEST RECEPTACLE at the top, and positioned so that all connections and adjustments are readily accessible.

The position of the generator and the curve produced for each connection is shown on the IF alignment detail drawing in steps. Follow the steps in sequence. (See Figure 11).

EQUIPMENT REQUIRED

A. Sweep Generator: 38 to 50 Mc, 12 Mc sweep width, linear, and capable of . 1 volt output.

B. Cathode-Ray Oscilloscope: preferably with calibrated attenuator

C. Variac: to adjust the line voltage if not 117 volts

NOTES: IMPORTANT

Do not ground the receiver chassis - use an isolation transformer.
Keep generator output as low as possible.
Line voltage must be 117 volts; if not, adjust with variac.
Allow sufficient warm-up time before alignment.
Some coils resonate at two core settings, use the outer end position.
Use a shielded lead for the vertical input of the scope.
Always connect ground end of signal generator, or scope leads, near point of signal input or take-off.
Use the following procedure in sequence for receiver alignment.

STEP #1 PRELIMINARY PROCEDURE

A. Remove the 6CD6 horizontal amplifier (V-17) from its socket.

B. Connect bias battery to place negative 3 volts on the IF AGC bus (MTP-12) or pin #1 of the SERVICE TEST RECEPTACLE (see bottom view of TS-902 horizontal chassis).(Fig. 12).

C. Terminate the sweep generator cable with a 56 or 75 ohm resistor, whichever is applicable. Also connect a 470 mmf capacitor in series with the hot lead of the generator to provide DC blocking.

D. Short RF secondary coils (in tuner) to ground through the hole in side of tuner shield (MTP-1).

OSCILLOSCOPE: Connects to the video detector output (MTP-6) through a 27K ohm isolation resistor or directly to pin #3 of the service test receptacle. Leave in this position for the entire IF procedure.

STEP #2
SWEEP GENERATOR: Connect to the grid of the 3rd IF. (Use the 3rd IF jack). (Refer to TS-902 horizontal chassis top view and bottom view during IF alignment.) (Fig. 11 & 12).

ADJUST

A. Top slug of 3rd IF (primary) to 41.25 Mc trap dip (minimum output)...... trap.

B. Bottom slug of 3rd IF (primary) so the 45.75 Mc marker falls at knee of the response curve.

C. Bottom slug of 3rd IF (secondary) for 41.85 Mc marker at lower knee of curve.

STEP #3
SWEEP GENERATOR: Connect to the grid of the 1st IF (Use the 1st IF test receptacle.)

ADJUST

A. Top slug of 1st IF for 47.25 Mc dip (minimum).............................trap.

B. Top slug of 2nd IF for 39.75 Mc dip (minimum).............................trap.

C. Bottom slug of 1st IF for 45.75 Mc marker at the 70% point.

D. Bottom slug of 2nd IF for 41.85 Mc marker at knee (peak) of curve. If it is not possible to position the marker exactly, make certain it is not more than 10% down from the peak.

STEP #4
SWEEP GENERATOR: Connect to the grid of the mixer. (Use the mixer test receptacle.)

ADJUST

A. The mixer primary (L-26) and secondary (L-31) (both are located on top of the chassis) so that 45.75 Mc falls at the 50% point, and 41.85 Mc falls no less than 10% down from maximum.

B. Trap slug in converter plate for the 41.25 Mc dip (minimum).................trap.
(Refer to TS-902 horizontal chassis top view for response curve information.)

If adjustment of the converter primary and secondary coils will not put the markers within the stated limits adjust either the 1st IF plate coil or the 2nd IF plate coil to bring the response within limits.

When alignment is completed, remove the 3 volt bias from the IF AGC bus. The curve on the scope should rise appreciably in amplitude. Reduce signal level of the sweep generator to produce approximately the same height curve as obtained with bias (do not change the vertical gain of the scope). Bandwidth must not change more than 200 kilocycles (.2 Mc). There must be no signs of regeneration.

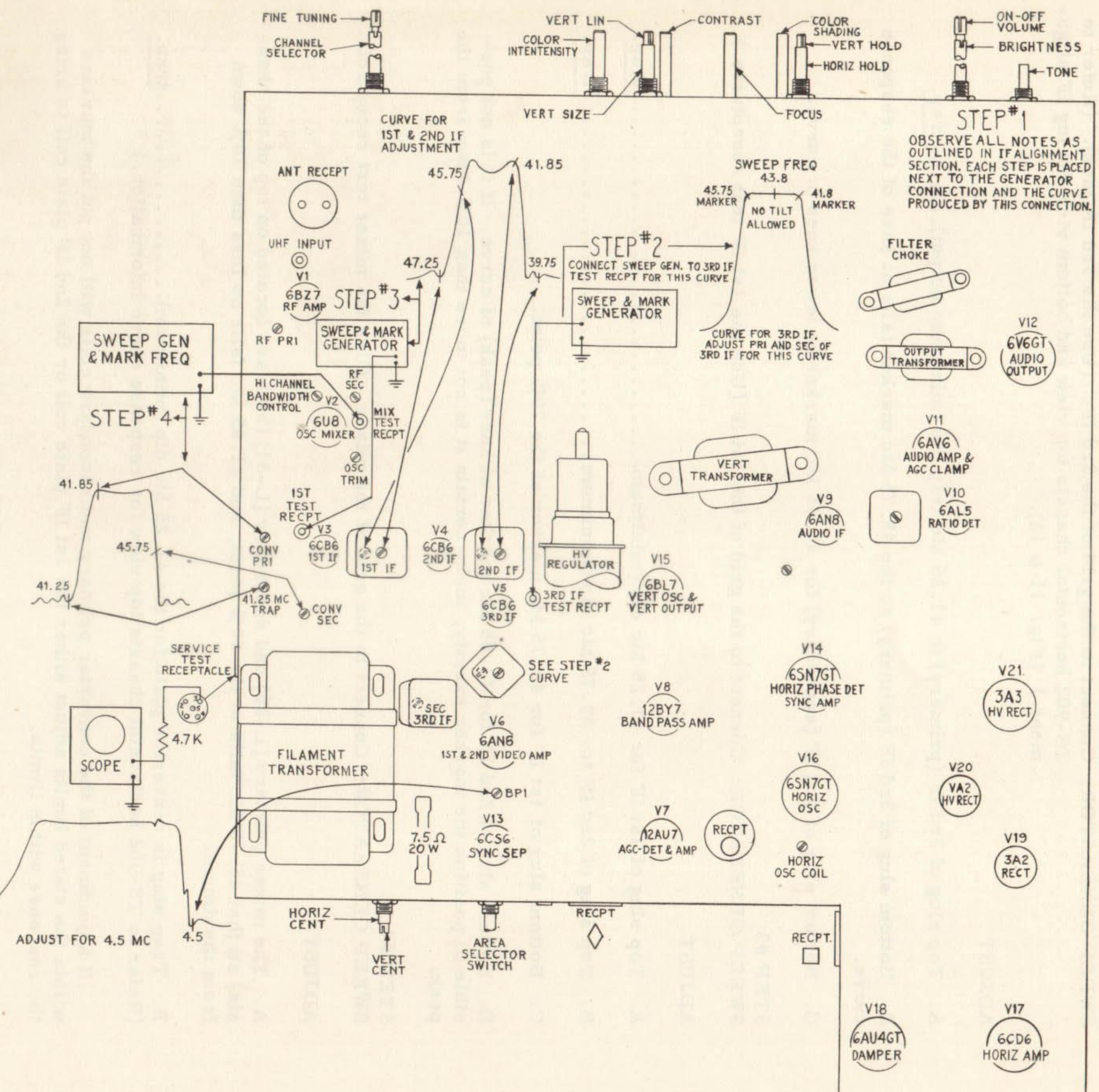


FIGURE 11. TS-902 HORIZONTAL CHASSIS (TOP VIEW)

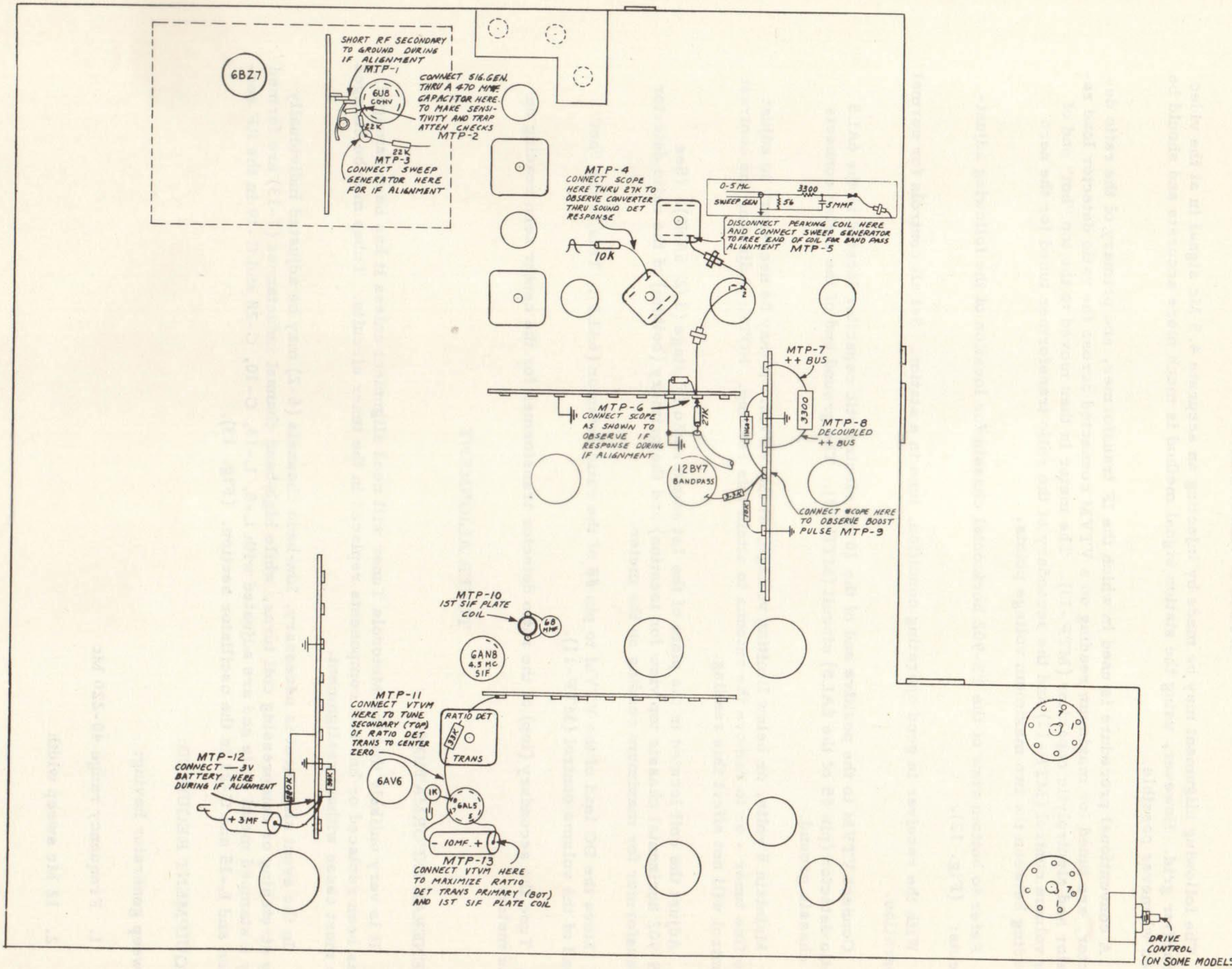


FIGURE 12. TS-902 HORIZONTAL CHASSIS (BOTTOM VIEW)

AUDIO IF ALIGNMENT

The following alignment may be made by injecting an accurate 4.5 Mc signal in at the video amplifier grid. However, using the station signal method is much more accurate and should be used whenever possible.

A conventional procedure is used in which the IF transformer, and primary of the ratio detector, are tuned for maximum reading on a VTVM connected across the ratio detector load resistor and electrolytic capacitor (MTP-13). The meter is then moved to the top "hot" end of the volume control (MTP-11) and the secondary of the ratio transformer tuned for the zero reading between the two maximum voltage points.

Refer to bottom view of the TS-902 horizontal chassis for location of the following adjustments: (Fig. 12).

1. With the receiver in good operating condition, tune in a station. Set all controls for normal operation.

2. Connect VTVM to the positive end of the 10 mf electrolytic capacitor located in the 6AL5 ratio detector (pin #5 of the 6AL5) circuit (MTP-13). The ground end of the meter connects to chassis ground.

3. Maintain 5 volts, or below limiting voltage, at the VTVM. It may be necessary to adjust the fine tuner - or to remove the antenna to attain this reading. NOTE: Adjusting the contrast control will not affect this reading.

4. Adjust the coil located in the plate of the 1st sound audio IF stage (1/2 6AN8). (See TS-902 horizontal chassis top view for location) and the primary (bottom) of the ratio detector transformer for maximum reading on the meter.

5. Move the DC lead of the VTVM to pin #8 of the ratio detector (6AL5). This is the "hot" lead of the volume control (MTP-11).

6. Tune the secondary (top) of the ratio detector transformer for the center zero reading on the meter.

TUNER ALIGNMENT

GENERAL INFORMATION

It is very unlikely that the Motorola Tuner will need alignment unless it has been damaged, has been replaced or has had components replaced in the tuner circuits. Tubes may be changed in most cases without realignment.

In the event alignment is necessary, low-band channels (6-2) may be adjusted individually by stretching or compressing coil turns, while high-band channel inductances (7-13) are formed by a stamped metal plate and are adjusted with L-8, L-13, C-10, C-28 and C-19 in the RF section and L-15 and C-21 in the oscillator section. (Fig. 13).

EQUIPMENT REQUIRED:

Sweep generator having:

1. Frequency range 40-220 Mc

2. 12 Mc sweep width

3. Adjustable linear output

4. Crystal calibrated video and sound carrier markers.

AM signal generator having:

1. Frequency range 40-220 Mc

2. Accurate frequency and attenuator calibration

3. 400 cycle modulation

Oscilloscope:

Wide-band, high gain type, preferably with a calibrated input attenuator.

PRE-ALIGNMENT PROCEDURE

1. Remove the horizontal output tube, V-17 (6CD6) to eliminate RF interference in the oscilloscope. Connect a 2500 ohm 25 watt resistor from B triple plus to ground to normalize the bus voltage.

2. Detune the oscillator by setting the fine tuner to minimum capacity.

3. Short the RF AGC bus to ground. (This is the third lug from left on rear of tuner - see main schematic.)

4. Remove the tuner cover.

5. Connect a 470 uuf capacitor from the converter plate to ground, as close as possible to the tube socket.

6. Keep the generator output as low as possible at all times to prevent overloading the receiver.

CONNECTIONS

Sweep generator - Remove the antenna lead-in from the chassis, and connect the sweep generator to the antenna receptacle. Keep the leads from the generator to the socket as short as possible.

Oscilloscope - Connect the scope lead to the mixer test receptacle. (See top view of the TS-902 horizontal chassis drawing.) (Fig. 11).

PROCEDURE

Antenna and RF alignment (high channels 7-13) (Refer to tuner alignment detail during following procedures.)

1. Switch the receiver channel selector to channel 8.

2. Center the sweep generator frequency at 185 Mc (center frequency of channel 8).

3. Adjust the trimmers C-10, C-28 and C-19 for the curve labeled HIGH BAND RF CURVE. (NOTE: C-10 positions the curve. C-19 acts as the jack and determines the tilt of the curve. C-28 adjusts bandwidth.) There should be no more than .05 volts peak-to-peak developed at the mixer test receptacle.

5. Center the sweep generator frequency at 213 Mc (center frequency of channel 13).

6. Adjust the channel 13 coils L-8 and L-13 by spreading or compressing the turns for symmetrical marker positions. (Use the peaks of the curve for reference.) The primary coil L-8 tends to position the curve, while the secondary coil L-13 affects the tilt of the curve.

7. Re-check channel 8 for proper response. Re-adjust trimmers C-10, C-28 and C-19 for correct curve on channel 8, if necessary.

8. Check all channels from 13 through 7 for proper curve with tuner shield on. See HIGH CHANNEL RESPONSE CURVE LIMITS. (Fig. 13).

Antenna and RF alignment (low channels 6-2)

1. Switch the receiver channel selector switch to channel 6.

2. Center the sweep generator frequency at 85 Mc (center frequency of channel 6).

3. Adjust the secondary coil L-12A to position the frequency of the curve and the primary L-9A for least tilt. Adjust for highest gain with least tilt and symmetrical skirts.

4. Adjust the antenna coil secondary L-4A or primary L-3C to remove tilt. Refer to LOW CHANNEL CURVE shown on TS-902 horizontal chassis top view. NOTE: It may be necessary to work between coils L-12A, L-9A, L-4A and L-3C to obtain the greatest gain with the least tilt and with symmetrical skirts.

FM trap

The FM trap L-1 may tune as low as channel 6, causing severe attenuation in part of the curve. Adjust the trap on channel 6 by spreading coil L-1 until no effect of attenuation is seen in the skirts of the response curve.

5. Adjust channel 5, 4, 3, and 2 in sequence by spreading or compressing the coil turns of the respective inductances. MAINTAIN CURVES WITHIN THE LOW CHANNEL RESPONSE LIMITS. (Fig. 13).

6. Re-examine curves on all channels for proper tracking with the tuner shield on.

Oscillator alignment

NOTE: The RF and mixer stages must be aligned before the oscillator is adjusted. Refer to tuner alignment detail during oscillator alignment.

1. Remove tuner shield and 470 uuf capacitor.

2. Set fine tuner to proper center position. (See tuner alignment detail for the fine tuner rotor position.) (Fig. 13).

3. Connect oscilloscope to pin 3 of the service test receptacle (across video load resistor). Connect sweep generator to antenna input socket and adjust for 12 Mc sweep width.

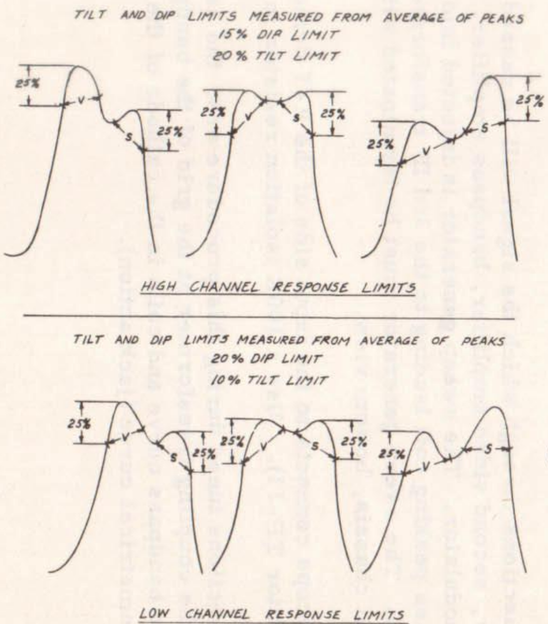
4. Set tuner to channel 8 and sweep generator to 183 Mc center frequency.

5. Adjust C-21 so that 185.75 sound marker falls into the trap dip.

6. Set tuner to channel 13 and sweep generator to 213 Mc center frequency.

7. Spread or compress L-15 so that 215.75 Mc sound marker falls into the trap dip.

FREQUENCY CHART			
CHANNEL NUMBER	SWEEP GENERATOR CENTER	SOUND MARKER (RF COILS)	PICTURE MARKER ANT COILS
2	57MC	59.75	55.25
3	63MC	65.75	61.25
4	69MC	71.75	67.25
5	79MC	81.75	77.25
6	85MC	87.75	83.25
7	177MC	179.75	175.25
8	183MC	185.75	181.25
9	189MC	191.75	187.25
10	195MC	197.75	193.25
11	201MC	203.75	199.25
12	207MC	209.75	205.25
13	213MC	215.75	211.25



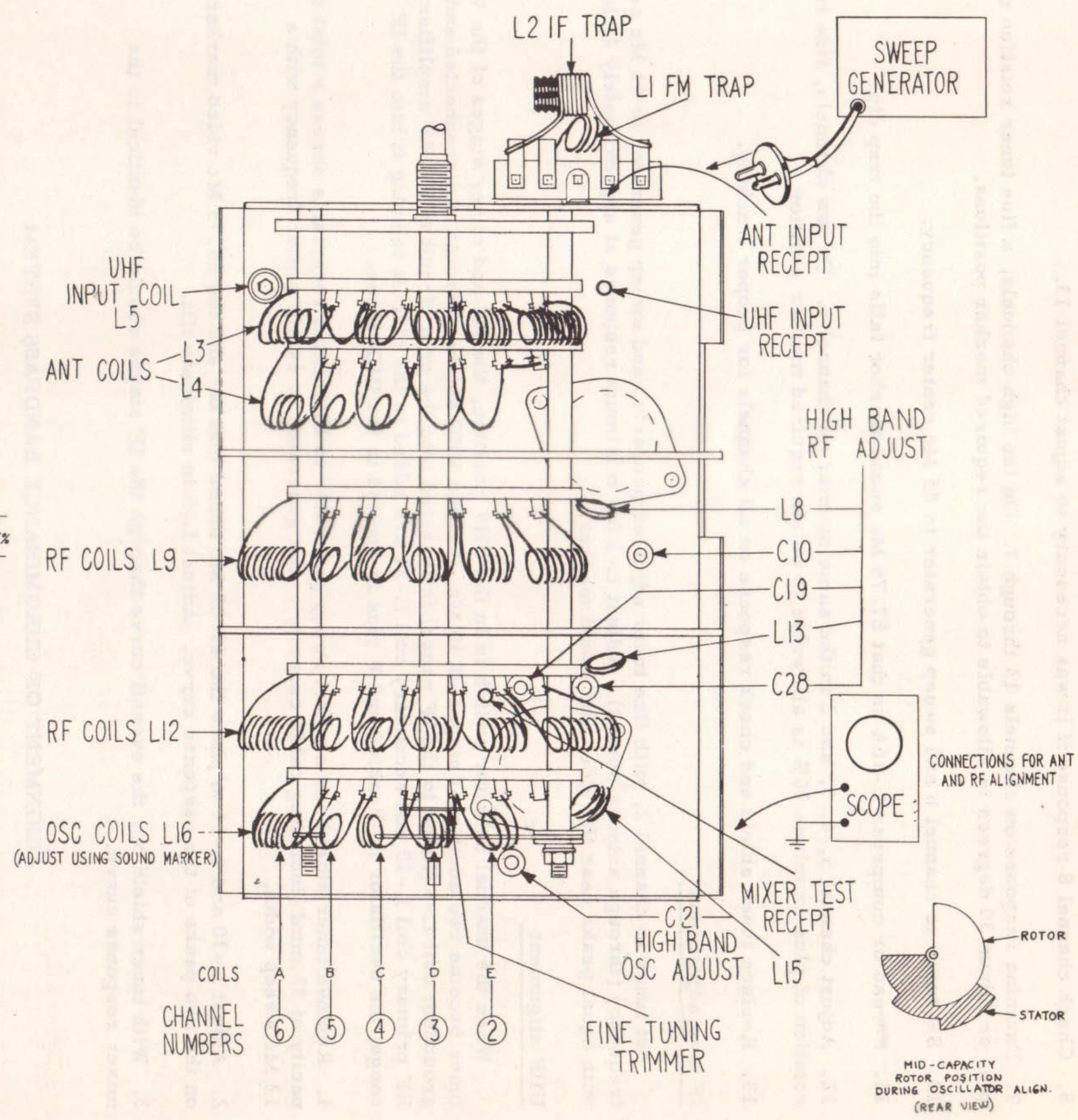


FIGURE 13. TUNER ALIGNMENT DETAIL

8. Check channel 8 response if it was necessary to adjust channel 13.

9. Examine response on channels 13 through 7. On the high channels, a fine tuner rotation of plus or minus 30 degrees is allowable to obtain the required marker positions.

10. Set tuner to channel 6 and sweep generator to 85 Mc center frequency.

11. Spread or compress L-16A so that 87.75 Mc sound marker falls into the trap dip.

12. Adjust channel 5, 4, 3, and 2 in the same manner as channel 6. On low channels, fine tuner rotation of plus or minus 10% is allowable to obtain required marker position.

13. Replace tuner shield and check response on all channels for proper tracking.

IF trap adjustment

Set tuner to channel 2, with fine tuner adjusted properly, and sweep generator to 44 Mc center frequency (through antenna socket). Adjust L-2 for minimum response at approximately 44 Mc, with equal peaks near the video and sound marker.

UHF alignment

When the channel selector switch is in the UHF position, the RF and mixer stages of the VHF tuner become two additional stages of 40 Mc IF: the VHF antenna circuit is disconnected and grounded; coil L-5 (tuned to the IF range) is inserted into the grid circuit of the RF amplifier; RF primary coil L-10 and secondary coil L-11 are added to the circuit to bring it into the IF range; the oscillator is disabled and B plus is applied to the UHF tuner.

1. Remove tuner shield and connect sweep generator to UHF input receptacle across a total capacity of 33 mmf (including cable capacity). Set generator to 44 Mc center frequency with a 12 Mc sweep width.

2. Adjust L-10 and L-11 to place the 41.25 Mc sound marker and the 45.75 Mc video marker on the two peaks of the response curve. Adjust L-5 to eliminate tilt.

3. With tuner shield on, the overall curve through the IF stages should be identical to the mixer response curve.

ALIGNMENT OF CHROMINANCE BANDPASS SYSTEM

The sections through which the signal will be passed for this alignment are: the first video amplifier, second video amplifier, bandpass amplifier, the bandpass cathode follower and the R-Y demodulator. The sweep generator is injected into 1st video amplifier by unsoldering the grid series peaking coil leading to the 3rd IF transformer and connecting the generator to the loose end. The sweep generator must be terminated with the network shown in diagram of horizontal chassis, bottom view.

The scope connects to the input side of the R-Y demodulator (junction of 33 mmf and 10K ohm resistor TP-11). Use a 100K isolation resistor in vertical input lead. (Fig. 15).

The sections tuned during this procedure are: the 1st video amp 4.5 Mc plate trap coil (L-39), the coupling transformer at the grid of the bandpass cathode follower (T-201) for 2.5 Mc on the bandpass curve and coils in the cathode of the bandpass cathode follower (T-202) for a symmetrical curve (jack action).

PROCEDURE

1. Remove 3.58 Mc color oscillator tube (V-28B, 12AT7).

2. Connect a bypass capacitor of .05 mfd 400V from junction of the 2200 ohm resistor and the delay line to ground (TP-7).

3. Set channel selector switch to channel #1 or unused channel.

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

5. Set color intensity control to maximum (fully clockwise).

6. Connect scope to pin #1 of the R-Y demodulator (V-25, 6AL5) at the junction of the 10K ohm resistor and 33 mmf capacitor (TP-11) through a 100K ohm resistor.

7. Disconnect peaking coil from lug #4 of 3rd IF transformer (MTP-5). Connect sweep generator to loose end of peaking coil. Use decoupling network illustrated in diagram of horizontal chassis, bottom view.

8. Set sweep center frequency to 3 Mc and sweep width for 10 Mc.

9. Set marker generator to 4.5 Mc and adjust 4.5 Mc trap located in the plate circuit (pin #1) of the first video amplifier for the trap dip. (See TS-902 horizontal chassis top view.)(Fig. 11).

10. Set marker generator to 2.5 Mc.

11. Adjust coil in grid circuit of bandpass cathode follower (T-201) to place 2.5 Mc marker at the knee of the curve. (See BP-902 vertical chassis top view.)(Fig. 14).

12. Adjust the coil in the cathode circuit of the bandpass cathode follower (T-202) for least tilt and symmetrical response curve.

Refer to BP-902 vertical chassis top view for curve and slug locations. (Fig. 14)

ADJUSTMENT OF 3.58 MC TRAP IN BRIGHTNESS AMP PLATE

13. Remove .05 mfd capacitor at input to delay line. This is used only in bandpass alignment procedure.

14. Leave sweep generator connected to loose end of peaking coil as before. Move scope lead to cathodes of picture tube (pins #4, 5, and 13). Use crystal detector in scope input lead.

15. Set marker generator to 3.58 Mc and adjust 3.58 Mc trap (plate of the brightness amplifier) for dip.

NOTE: a. Traps must be aligned within + or - 50 Kc of specified frequency.

b. The response curve must show no sign of regenerative peaks.

c. If picture tube is not connected, curve may appear slightly different.... with small peaks showing.

ALIGNMENT OF THE 3.58 MC TRAPS IN GRIDS OF THE R-Y and B-Y AMPLIFIER

The series tuned shunt traps located in the grid to ground circuits of the R-Y and B-Y amplifiers are tuned for maximum attenuation (minimum signal) using the normal leakage signal from the 3.58 Mc local color oscillator. A wide band scope must be used as the indicator and

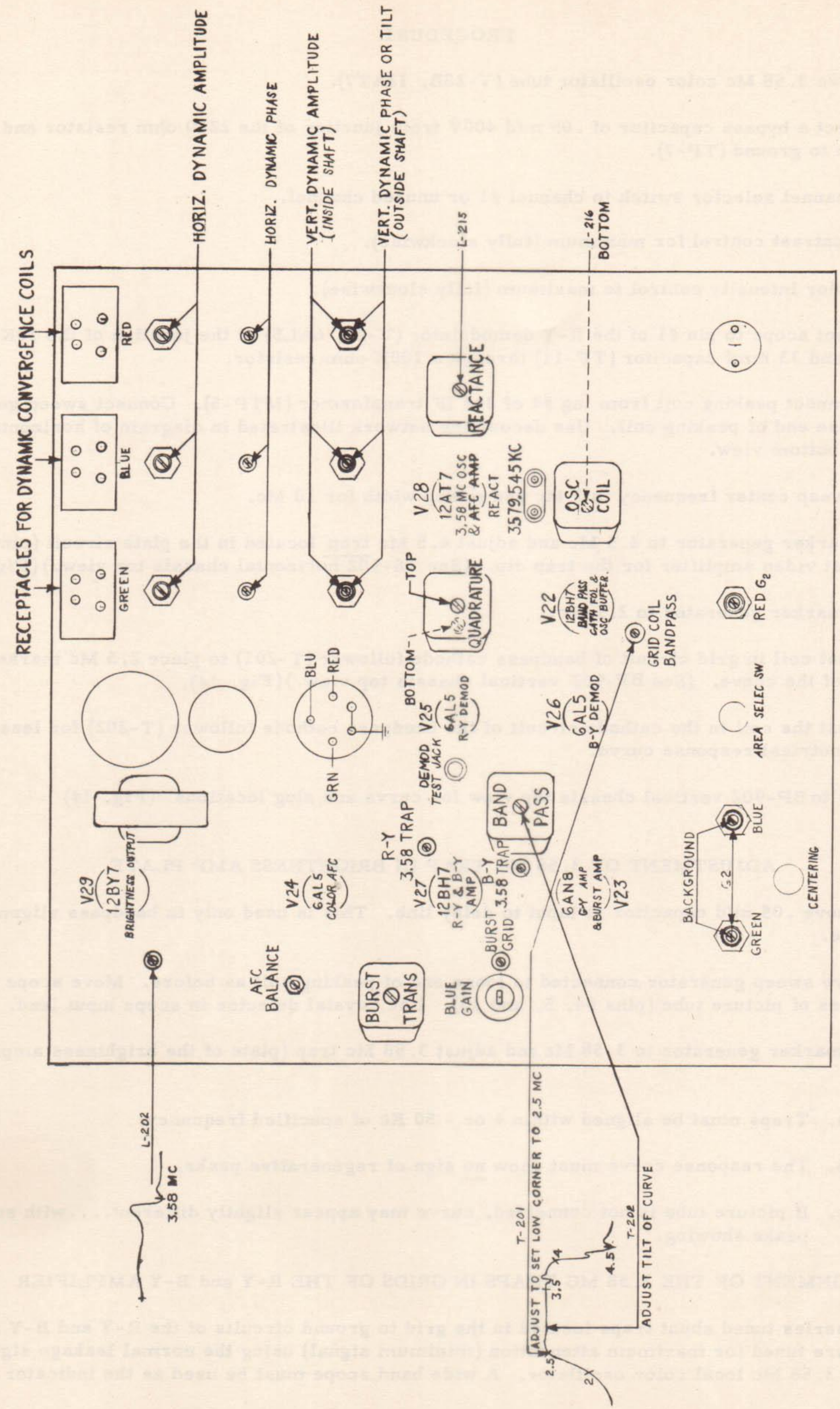


FIGURE 14. BP-902 VERTICAL CHASSIS (TOP VIEW)

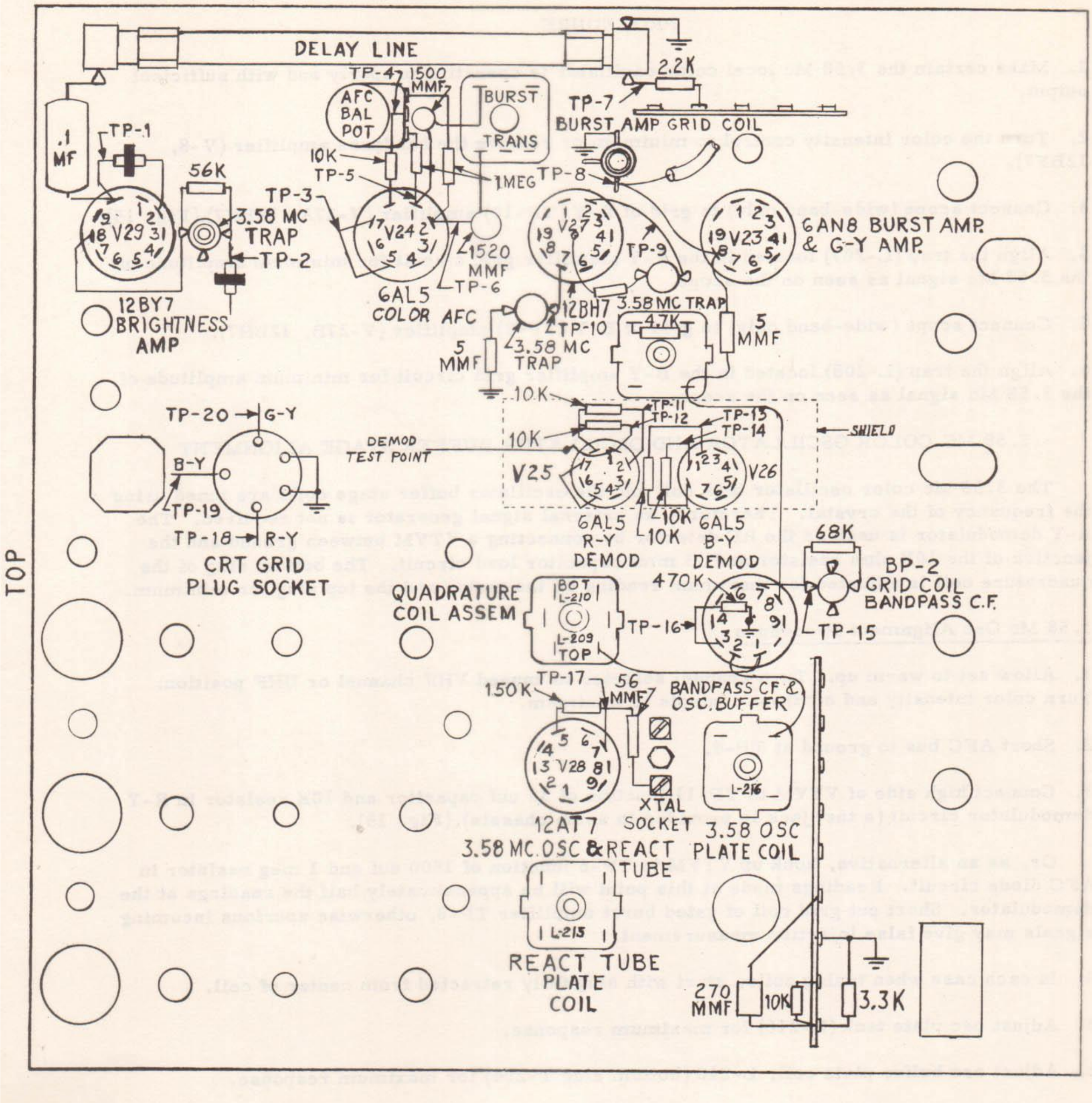


FIGURE 15. BP-902 VERTICAL CHASSIS (BOTTOM VIEW)

may be connected to the control grid of R-Y and B-Y amplifiers consecutively.

PROCEDURE

1. Make certain the 3.58 Mc local color oscillator is operating properly and with sufficient output.

2. Turn the color intensity control to minimum or remove the bandpass amplifier (V-8, 12BY7).

3. Connect scope (wide-band only) to grid of R-Y (TP-10) amplifier (V-27A, 12BH7).(Fig. 15).

4. Align the trap (L-207) located in the R-Y amplifier grid circuit for minimum amplitude of the 3.58 Mc signal as seen on the scope.

5. Connect scope (wide-band only) to grid of B-Y (TP-9) amplifier (V-27B, 12BH7).

6. Align the trap (L-208) located in the B-Y amplifier grid circuit for minimum amplitude of the 3.58 Mc signal as seen on the scope.

3.58 MC COLOR OSCILLATOR AND OSCILLATOR BUFFER STAGE ALIGNMENT

The 3.58 Mc color oscillator tank coil and the oscillator buffer stage coils are tuned using the frequency of the crystal. Therefore, an external signal generator is not required. The R-Y demodulator is used as the RF detector by connecting a VTVM between ground and the junction of the 10K ohm resistor and 33 mmf capacitor load circuit. The bottom slug of the quadrature coil is adjusted for maximum reading on the meter and the top slug for minimum.

<u>3.58 Mc Osc Alignment Procedure</u>

1. Allow set to warm up. Turn channel selector to unused VHF channel or UHF position. Turn color intensity and contrast controls to minimum.

2. Short AFC bus to ground at TP-4.

3. Connect high side of VTVM to TP-11 junction of 33 uuf capacitor and 10K resistor in R-Y demodulator circuit (a test jack is provided in some chassis).(Fig. 15).

Or, as an alternative, hook up VTVM to TP-6 junction of 1500 uuf and 1 meg resistor in AFC diode circuit. Readings made at this point will be approximately half the readings at the demodulator. Short out grid coil of gated burst amplifier TP-8, otherwise spurious incoming signals may give false injection measurement.

4. In each case when tuning coils, start with slug fully retracted from center of coil.

5. Adjust osc plate tank (L-216) for maximum response.

6. Adjust osc buffer plate coil, L-210 (bottom slug T-204) for maximum response.

7. Adjust quadrature coil, L-209 (top slug of T-204) for minimum response.

8. It may be necessary to repeat steps 5, 6 and 7 for best results.

9. Retune osc plate coil (L-216) turning screw (out) so as to retract slug from coil so that 25 volts of injection is measured at R-Y demodulator (TP-11).

or So that approximately 12 volts of injection is measured at AFC diode (TP-6).

ALIGNMENT OF THE COLOR OSCILLATOR AFC SYSTEM

The burst amplifier tube (V-23A, 1/2 6AN8) receives the entire color signal from the output of the bandpass cathode follower. Its screen voltage, however, is keyed from a winding on the horizontal output transformer; the tube operates only during the color burst. The output of the burst amplifier is fed to the color AFC phase detector and the phase and frequency of the burst reference signal is compared with that of the local 3.58 Mc color oscillator. Tuned to the 3.58 Mc burst signal are: a resonant tank in the burst amplifier grid (L-204), the coupling transformer to the AFC phase detector, the plate coil in the reactance tube circuit. An actual transmitted burst signal is used for the alignment; a VTVM is used for the output indicator. The VTVM is connected to either color AFC diode (V-24, 6AL5) at the junction of the 1 meg resistor and 1500 mmf capacitor. Connected at this point, the meter reads the rectified resultant 3.58 Mc burst voltage and the color oscillator injection voltage.

PROCEDURE

1. Allow receiver to warm up. Check the 3.58 Mc oscillator alignment and injection to insure normal operation. To check the injection, connect the VTVM to the junction of the 1500 mmf capacitor and 1 meg resistor in the color AFC phase detector circuit (TP-6). Connect the VTVM ground lead to chassis. Temporarily short the control grid of the burst amplifier (V-23A) to ground to eliminate readings from spurious incoming signals. The VTVM should read approximately 12 volts of injection. (Remove short grom grid of burst amp.)

2. Tune in a transmission supplying the standard burst of color sync. Set color intensity control for a normal color picture or near maximum CW rotation.

3. Set the fine phase trimmer (color shading control) at mid-range (on half mesh).

4. Connect a VTVM to TP-6 (jct of a 1500 mmf and 1 meg resistor) at AFC diode circuit.

5. Begin with the slugs fully retracted from the coils and tune the burst amplifier grid coil L-204 and plate transformer T-203 for maximum reading on VTVM.

6. Connect VTVM to the AFC bus at TP-4.

7. Adjust reactance tube plate coil L-215 (to bring oscillator into sync, if necessary) so that VTVM reads 0 volts on AFC bus.

8. Reduce chrominance signal so that it is just barely visible on the screen, by turning fine tuning control (front panel on RF tuner). This is done so that an extremely weak burst signal is supplied to the AFC diodes. The color oscillator may now possibly be out of sync.

9. Adjust AFC balance pot so that 3.58 Mc osc is in sync.

10. Reset RF fine tuning for normal picture so that adequate burst is supplied to the AFC diodes.

11. Connect an oscilloscope to the plate of the R-Y amplifier and retune L-204 the burst amplifier grid coil so that the burst pulse is zero volts as shown on the scope screen.

MEASUREMENTS

IF SENSITIVITY

1. Set channel selector to channel #1.

2. Short the RF secondary coils of the tuner to ground. These coils may be reached through the hole in the tuner cover.

3. No external bias is applied to the AGC line. The AGC is left wide open with normal or residual bias only.

4. Connect VTVM across the video detector load resistor (4700 ohms).

5. Feed a 44 Mc unmodulated signal through a 470 mmf capacitor into the grid of the mixer tube (pin #2 of the 6U8).

6. Less than 300 microvolts should be required for a 1 volt rise above the residual noise voltage at the video detector... as indicated on the meter.

SOUND SENSITIVITY

1. Feed an accurate 4.5 Mc signal across the 10K ohm sound detector load resistor through a 100 uuf capacitor. (Use a terminated Measurements Corp. Model 80 generator or equivalent.)

2. Connect the VTVM through a decoupling resistor to the positive side of the 10 mfd electrolytic capacitor at the ratio detector output. (The VTVM ground lead connects to chassis.)

3. Less than 3500 microvolts should be required for a 4 volt reading on the VTVM.

BANDPASS SENSITIVITY

1. Set the CONTRAST and COLOR INTENSITY controls to maximum.

2. Remove the 6CD6 horizontal amplifier tube (V-17) and the 12AT7, 3.58 Mc oscillator tube (V-28B) from their sockets.

3. Connect the high side of the VTVM through an isolation resistor of 100K ohms to junction of the 33 mmf capacitor and the 10K ohm resistor in the R-Y demodulator circuit. (Set for correct polarity.)

4. Disconnect the video peaking coil, located between lug on 3rd IF can and pin #2 of the 1st video amplifier, at the can end.

5. Connect generator through coupling network (shown on bottom view of horizontal chassis) into the loose end of the peaking coil (MTP-5) and into the first video amplifier grid. Adjust the generator for 3 Mc output. (Fig. 15).

6. Approximately a 15,000 microvolt signal should produce a rise of 1 volt on the VTVM.

VIDEO IF TRAP ATTENUATION MEASUREMENT

1. Set tuner to an unused channel or disable tuner by shorting out the RF secondary coil to ground at the junction of the RF coil and the 22 mmf capacitor.

2. Connect a terminated CW signal generator (such as Measurements Corp. Model 80) through a 470 mmf blocking capacitor directly to the grid of the mixer tube (MTP-2) pin #2 of the 6U8. (Fig. 12).

3. Apply minus 3 volts to the IF AGC bus (pin #1 of service test receptacle). (Fig. 11).

4. Connect VTVM across the video detector load resistor (4700 ohms).

5. Record the signal generator output voltage required to produce 1 volt across the video detector load resistor at the following frequencies: 39.75 Mc, 41.25 Mc, 47.25 Mc and 44 Mc.

6. Calculate the attenuation for each trap, using the following formula:

$$\frac{\text{Generator output at trap frequency}}{\text{Generator output at 44 Mc}} = \text{Attenuation}$$

7. Approximate trap attenuation should be:

   At 39.75 Mc - 80
   At 41.25 Mc - greater than 300
   At 47.25 Mc - 65

MEASUREMENT OF THE SOUND CARRIER TO PICTURE CARRIER RATIO AT THE SOUND DETECTOR

1. Short the RF amplifier secondary coil to ground at the junction of the secondary coil and the 22 mmf capacitor (MTP-1).(Fig. 12).

2. Connect a terminated signal generator (such as Measurements Corp. Model 80) to the grid, pin #2 of the 6U8 (MTP-2).

3. Connect VTVM across the 10K ohm sound detector load resistor (MTP-4).

4. Apply minus 3 volts to the IF AGC bus at pin #1 of the service test receptacle.

5. Record the signal generator output voltage required to produce 1 volt across the sound detector load resistor at 41.25 Mc and 45.75 Mc.

6. Calculate the ratio, using the following formula:

$$\frac{\text{Generator output at 41.25 Mc}}{\text{Generator output at 45.75 Mc}} = \text{Sound to picture carrier ratio}$$

7. The ratio should be no greater than 20.

REPLACEMENT PARTS LIST

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

ELECTRICAL PARTS

Capacitors (Cer = Ceramic; Tub = Tubular; Mld = Molded; Lytic = Electrolytic)

Ref. No.	Part Number	Description	List Price
C-1	21R400937	Cer Disc: dual .001 mf 500V	.40
C-2	21R115905	Cer Tub: 220 mmf 500V......	.25
C-3	21R115955	Mld Phenolic: 4.7 mmf 500V.	.25
C-4	21R119896	Cer Disc: 27 mmf 150V......	.25
C-5	21R115905	Cer Tub: 220 mmf 500V......	.25
C-6	21R119912	Cer Disc: 33 mmf 150V......	.25
C-7	21R115386	Cer Disc: .001 mf 500V.....	.25
C-8	21R115386	Cer Disc: .001 mf 500V.....	.25
C-9	21R115386	Cer Disc: .001 mf 500V.....	.25
C-10	21K710943	Trimmer, cer: .5-3 mmf with screw & mtg nut............	.25
C-11	21R120204	Cer Tub: 56 mmf 500V.......	.25
C-12	21R115959	Mld Phenolic: 1.5 mmf 500V.	.25
C-13	21R120203	Cer Tub: 22 mmf 500V.......	.25
C-14	21R115959	Mld Phenolic: 1.5 mmf 500V.	.25
C-15	21R115386	Cer Disc: .001 mf 500V.....	.25
C-16	21R115386	Cer Disc: .001 mf 500V.....	.25
C-17	21R115386	Cer Disc: .001 mf 500V.....	.25
C-18	21R114071	Cer Tub: 1 mmf 500V........	.25
C-19	21K710943	Trimmer, cer: .5-3 mmf with screw & mtg nut............	.25
C-20	21R115386	Cer Disc: .001 mf 500V.....	.25
C-21	21K710943	Trimmer, cer: .5-3 mmf with screw & mtg nut............	.25
C-22	21R400050	Cer Tub: 10 mmf 1500V......	.25
C-23	-	Trimmer, fine tuning (part of switch)................	-
C-24	21R115386	Cer Disc: .001 mf 500V.....	.25
C-25	21R410124	Cer Disc: 680 mmf 500V.....	.25
C-26	21R410124	Cer Disc: 680 mmf 500V.....	.25
C-27	21R410124	Cer Disc: 680 mmf 500V.....	.25
C-28	21K710943	Trimmer, cer: .5 to 3 mmf...	.25
C-29	21R115953	Mld Phenolic: 3.9 mmf 500V.	.25
C-30	21R115959	Mld Phenolic: 1.5 mmf 500V.	.25
C-51	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-52	8K490263	Mld Tub: .1 mf 600V........	.45
C-53	21R410036	Cer Disc: 100 mmf 500V.....	.25
C-54	21R482726	Cer Disc: .01 mf 500V......	.35
C-55	21R410036	Cer Disc: 100 mmf 500V.....	.25
C-56	21R115312	Cer Disc: .005 mf 500V.....	.25
C-57	21R482726	Cer Disc: .01 mf 500V......	.35
C-58	21R482726	Cer Disc: .01 mf 500V......	.35
C-59	21R115856	Cer Tub: 470 mmf 500V......	.25
C-60	23A90205	Lytic: 10 mf/50V...........	.90
C-61	21R410127	Cer Disc: .001 mf 500V.....	.25
C-62	21R115867	Cer Tub: .0047 mf 500V.....	.25
C-63	21R482726	Cer Disc: .01 mf 500V......	.35
C-64	21R115867	Cer Tub: .0047 mf 500V.....	.25
C-65	21R115867	Cer Tub: .0047 mf 500V.....	.25
C-66	*23B734516	Lytic: 30-20 mf/400V; 50 mf/250V; 200 mf/150V....	2.85
C-67	21R120149	Cer Disc: .0047 mf 500V....	.25
C-68	23B721874	Lytic: 150-20 mf/300V; 10 mf/250V; 250 mf/50V.....	5.70
C-69	*23A734545	Lytic: 50-50 mf/50V........	1.25
C-70	*23A732739	Lytic: 450 mf/10V..........	1.50
C-71	23B722771	Lytic: 200 mf/150V.........	2.80
C-72	23K732636	Lytic: 500 mf/25V..........	2.40
C-73	*23B734515	Lytic: 30-20 mf/400V; 50 mf/250V; 200 mf/150V....	4.85
C-74	23B722771	Lytic: 200 mf/150V.........	2.80
C-75	23B733207	Lytic: 150-150 mf/250V.....	5.50
C-76	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-77	*21R121598	Cer Disc: 62 mmf 500V......	.25
C-78	21R121598	Cer Disc: 62 mmf 500V......	.25
C-79	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-80	21R120151	Cer Tub: 47 mmf 500V.......	.25
C-81	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-82	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-83	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-85	21R120152	Cer Tub: 56 mmf 500V.......	.25
C-86	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-87	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-88	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-100	21R121114	Cer Disc: 10 mmf 500V......	.25
C-101	21R115730	Cer Disc: 120 mmf 500V.....	.25
C-102	8K490236	Mld Tub: .1 mf 400V........	.35
C-103	21R115312	Cer Disc: .005 mf 500V.....	.25
C-104	21R121114	Cer Disc: 10 mmf 500V......	.25
C-105	21R482726	Cer Disc: .01 mf 500V......	.35
C-106	21R121106	Cer Disc: .002 mf 500V.....	.25
C-107	21R482726	Cer Disc: .01 mf 500V......	.35
C-109	21R482726	Cer Disc: .01 mf 500V......	.35
C-110	8K490236	Mld Tub: .1 mf 400V........	.35
C-111	21R482726	Cer Disc: .01 mf 500V......	.35
C-113	23A690543	Lytic: 3 mf/50V............	.90
C-114	23A690543	Lytic: 3 mf/50V............	.90
C-115	8K490228	Mld Tub: .022 mf 400V......	.40
C-116	21R115856	Cer Tub: 470 mmf 500V......	.25
C-117	8K490236	Mld Tub: .1 mf 400V........	.35
C-118	8K119350	Mld Tub: .047 mf 400V......	.25
C-119	21R115856	Cer Tub: 470 mmf 500V......	.25
C-120	21R118749	Cer Tub: .001 mf 500V......	.25
C-121	21R118749	Cer Tub: .001 mf 500V......	.25
C-122	8K490249	Mld Tub: .0047 mf 600V.....	.40
C-123	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-124	21R115856	Cer Tub: 470 mmf 500V......	.25
C-125	8K119333	Mld Tub: .015 mf 200V......	.25
C-126	8K490222	Mld Tub: .0047 mf 400V.....	.25
C-127	8K490247	Mld Tub: .0033 mf 600V.....	.40
C-128	21R410115	Cer Disc: 220 mmf 500V.....	.25
C-129	21R115867	Cer Tub: .0047 mf 500V.....	.25
C-130	8K490222	Mld Tub: .0047 mf 400V.....	.25
C-131	21R114781	Mica: 680 mmf 500V.........	.25
C-132	21R6673	Mica: 470 mmf 500V.........	.25
C-133	8K119350	Mld Tub: .047 mf 400V......	.25
C-134	8K119350	Mld Tub: .047 mf 400V......	.25
C-135	8K119354	Mld Tub: .15 mf 400V.......	.35
C-136	8K490222	Mld Tub: .0047 mf 400V.....	.25
C-137	8K490236	Mld Tub: .1 mf 400V........	.35
C-138	21R120561	Cer Tub: 6.8 mmf 500V......	.25
C-139	8K490268	Mld Tub: .001 mf 1000V.....	.35
C-140	21R114207	Cer Disc: 47 mmf 500V......	.25
C-141	8K119346	Mld Tub: .01 mf 400V.......	.35
C-142	21R121252	Cer Disc: 130 mmf 5000V....	.45
C-143	8K490212	Mld Tub: .22 mf 200V.......	.40
C-144	8K490284	Mld Tub: .047 mf 1000V.....	.35
C-145	*21A733777	Cer: 500 mmf 20KV..........	1.40
C-146	*21A732365	Cer: 500 mmf 10KV; threaded on one end................	1.30
C-147	*21A733779	Cer: 500 mmf 10KV; threaded on both ends..............	1.30
C-148	*21A732370	Cer: 500 mmf 30KV..........	3.35
C-149	21R120916	Cer Disc: .005 mf 3000V....	.45

Ref. No.	Part Number	Description	List Price
C-150	21R482726	Cer Disc: .01 mf 500V......	.35
C-151	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-152	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-153	21R115312	Cer Disc: .005 mf 500V.....	.25
C-154	21R120916	Mld Tub: .01 mf 600V.......	.45
C-155	8K490253	Mld Tub: .01 mf 600V.......	.30
C-156	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-157	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-158	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-159	21R114554	Cer Disc: 470 mmf 500V.....	.25
C-160	21R115856	Cer Tub: 470 mmf 500V......	.25
C-161	*20A734484	Color Shading Control (fine phase): 3.5 to 25 mmf.....	3.10
C-201	21R6624	Mica: 270 mmf 500V.........	.25
C-202	21R482726	Cer Disc: .01 mf 500V......	.35
C-203	21R121481	Cer Disc: 270 mmf 500V.....	.25
C-204	21R121114	Cer Disc: 10 mmf 500V......	.25
C-205	21R482726	Cer Disc: .01 mf 500V......	.35
C-207	21R121548	Cer Disc: 33 mmf 500V......	.25
C-208	21R121548	Cer Disc: 33 mmf 500V......	.25
C-209	21R121548	Cer Disc: 33 mmf 500V......	.25
C-210	21K121548	Cer Disc: 33 mmf 500V......	.25
C-211	21K121698	Cer Disc: 220 mmf 500V.....	.25
C-212	21R121251	Cer Disc: 180 mmf 500V.....	.25
C-213	21K121836	Cer Disc: .002 mf 500V.....	.25
C-214	21R482726	Cer Disc: .01 mf 500V......	.35
C-215	21R115955	Phenolic: 4.7 mmf 500V.....	.25
C-216	21R115955	Phenolic: 4.7 mmf 500V.....	.25
C-217	8K490236	Mld Tub: .1 mf 400V........	.35
C-218	*23B734486	Lytic: 10 mf/300V; 500 mf/15V................	3.75
C-219	21R121468	Cer Disc: 39 mmf 500V......	.25
C-220	8K490236	Mld Tub: .1 mf 400V........	.35
C-221	21R115948	Mld Phenolic: 2.2 mmf 500V.	.25
C-222	8K490255	Mld Tub: .022 mf 600V......	.40
C-223	8K490255	Mld Tub: .022 mf 600V......	.40
C-224	8K490255	Mld Tub: .022 mf 600V......	.40
C-225	21R120916	Mld Tub: .01 mf 600V.......	.45
C-226	21R115955	Phenolic: 4.7 mmf 500V.....	.25
C-227	21R482726	Cer Disc: .01 mf 500V......	.35
C-229	21R120100	Cer Disc: .0015 mf 500V....	.25
C-230	21R120100	Cer Disc: .0015 mf 500V....	.25
C-231	21R482726	Cer Disc: .01 mf 500V......	.35
C-232	8K490226	Mld Tub: .01 mf 400V.......	.25
C-233	8K490212	Mld Tub: .22 mf 200V.......	.40
C-234	21R482726	Cer Disc: .01 mf 500V......	.35
C-235	21R482726	Cer Disc: .01 mf 500V......	.35
C-236	21R115900	Cer Tub: 100 mmf 500V......	.25
C-237	21R115641	Cer Tub: 56 mmf 500V.......	.25
C-238	21R482726	Cer Disc: .01 mf 500V......	.35
C-239	21R482726	Cer Disc: .01 mf 500V......	.35
C-240	21R482726	Cer Disc: .01 mf 500V......	.35
C-241	21R482726	Cer Disc: .01 mf 500V......	.35
C-242	21R121251	Cer Disc: 180 mmf 500V.....	.25
C-243	8K490226	Mld Tub: .01 mf 400V.......	.25
C-244	*23K734273	Lytic: 100 mf/15V..........	1.45
C-245	8K490206	Mld Tub: .047 mf 200V......	.25
C-246	8K490226	Mld Tub: .01 mf 400V.......	.25
C-247	23K734273	Lytic: 100 mf/15V..........	1.45
C-248	8K490206	Mld Tub: .047 mf 200V......	.25
C-249	8K490226	Mld Tub: .01 mf 400V.......	.25
C-250	8K490206	Mld Tub: .047 mf 200V......	.25
C-251	23K734273	Lytic: 100 mf/15V..........	1.45
C-252	*23B734496	Lytic: 100-70 mf/25V.......	1.80
C-253	21R482726	Cer Disc: .01 mf 500V......	.35
C-254	21R120916	Cer Disc: .01 mf 500V......	.45
C-255	21R115948	Phenolic: 2.2 mmf 500V.....	.25
C-256	21R115955	Phenolic: 4.7 mmf 500V.....	.25
CR-1	*48B733746	Rectifier, selenium: 600 ma	3.80
CR-2	*48B733961	Rectifier, selenium: 250 ma	2.65

Ref. No.	Part Number	Description	List Price
CR-3	48C711052		
or	48K711077	Crystal, diode (1N60).......	1.00
CR-4	48C711052		
or	48K711077	Crystal, diode (1N60).......	1.00
CR-5	48C711052		
or	48K711077	Crystal, diode (1N60).......	1.00
CR-6	*80B733741	Regulator, voltage..........	18.00
CR-7	*48B732230	Crystal, 3.58 Mc............	7.70
CR-8	*48B733746	Rectifier, selenium: 600 ma	3.80
L-1	24A721862	Coil, FM trap...............	.10
L-2	24A731357	Coil, IF trap: 40 Mc.......	.10
L-3	24K722232	Coil, ant pri: incl L-3A thru L-3H..................	.10
L-4	24K722265	Coil, ant sec: incl L-4A thru L-4F..................	.20
L-5	24A730748	Coil, UHF input matching....	.10
L-6	24A721274	Choke, RF...................	.10
L-7	24C722228	Coil, neutralization........	.10
L-8	24K722231	Coil, RF pri................	.10
L-9	24C722262	Coil, RF pri: chan 2 thru 6	.25
L-10	24K722229	Coil, RF pri (UHF position).	.10
L-11	24A721855	Coil, RF sec (UHF position).	.10
L-12	24K722263	Coil, RF sec: chan 2 thru 6	.25
L-13	24A730100	Coil, RF sec: chan 13......	.10
L-14	24A721274	Choke, RF	.10
L-15	24K722233	Coil, osc: chan 13.........	.05
L-16	24K722264	Coil, osc: chan 2 thru 6...	.25
L-26	*24K732820	Coil, conv pri: with core..	.70
L-27	*1V733254	Coil, interstage: with core	.40
L-28	*25B734495	Choke, filter	3.85
L-29	*25B734908	Choke, filter	1.60
L-30	*24K731893	Coil, 41.25 Mc trap.........	
L-31	24K732820	Coil, conv sec: with core..	.70
L-37	*24R119847	Coil, comp: blk-org code...	.55
L-38	*24R119855	Coil, comp: org-blk code...	.70
L-39	*24B731883	Coil, 4.5 Mc trap: with core	.75
L-42	24R119855	Coil, comp: org-blk code...	.70
L-43	*24K721065	Coil, horiz osc.............	.55
L-44	*24D734997	Yoke, defl: yel code.......	46.95
L-47	*24B733751	Coil, horiz size & shunt: incl R-156.................	1.80
L-48	24A721274	Choke, RF filter............	.10
L-49	24A721274	Choke, RF filter............	.10
L-201	*24R121805	Coil, comp: wound on 10K res; red-wht code..........	.55
L-202	*1V732586	Coil, 3.58 Mc trap: with core; red code.............	.80
L-203	*24R119856	Coil, comp: org-org code...	.60
L-204	*24B734843	Coil, burst take off: grn code......................	.75
L-205	*24B732672	Coil, comp: wht-blk code...	.90
L-206	24B732672	Coil, comp: wht-blk code...	.90
L-207	*1V732207	Coil, 3.58 Mc trap: with core; blue code............	.85
L-208	1V732207	Coil, 3.58 Mc trap: with core; blue code............	.85
L-211	24K733200	Coil, comp: wht-blk code...	.70
L-212	24K733200	Coil, comp: wht-blk code...	.70
L-213	24R119855	Coil, comp: org-blk code...	.70
L-214	*24R121453	Coil, comp: wound on 560 res; red-vio code..........	.50
L-215	*24B732205	Coil, reactance.............	1.50
L-216	*1V734277	Coil, 3.58 Mc osc: incl C-241 & 242.....................	1.90
L-217	*24B734745	Coil, convergence...........	4.35
L-218	*24K733734	Coil, horiz dyn phase.......	1.30
L-219	*24B734745	Coil, convergence...........	4.35
L-220	24K733734	Coil, horiz dyn phase.......	1.30
L-221	24B734745	Coil, convergence...........	4.35
L-222	24K733734	Coil, horiz dyn phase.......	1.30
L-223	*25B734494	Choke, filter: 2 hy........	1.75

Ref. No.	Part Number	Description	List Price
Resistors - Note:		All resistors are insulated carbon type unless otherwise specified	
R-1	6R3964	1800 10% 2W..............	.25
R-2	6R5687	2200 10% 2W..............	.25
R-3	6R6397	22,000 10% 1/2W........doz	1.20
R-4	6R6056	47,000 20% 1/2W........doz	1.20
R-5	6R6429	820,000 10% 1/2W.......doz	1.20
R-6	6R6475	680,000 10% 1/2W.......doz	1.20
R-7	6R6229	1000 10% 1/2W..........doz	1.20
R-8	6R5659	3900 10% 1/2W..........doz	1.20
R-9	6R6269	820 10% 1/2W...........doz	1.20
R-10	6R6393	1200 10% 1/2W..........doz	1.20
R-11	6R6028	22,000 20% 1/2W........doz	1.20
R-12	6R6028	22,000 20% 1/2W........doz	1.20
R-13	6R6414	270,000 10% 1/2W.......doz	1.20
R-14	6R6477	15,000 10% 1/2W........doz	1.20
R-15	6R6054	10,000 20% 1/2W........doz	1.20
R-16	6R6229	1000 10% 1/2W..........doz	1.20
R-17	6R5766	12,000 10% 2W.............	.25
R-51	6R6477	15,000 10% 1/2W........doz	1.20
R-52	*6K121897	820 10% 2W................	.25
R-53	6R6398	150,000 10% 1/2W.......doz	1.20
R-54	6R6326	100 10% 1/2W...........doz	1.20
R-55	6R2004	8200 10% 1/2W..........doz	1.20
R-56	6R6229	1000 10% 1/2W..........doz	1.20
R-57	6R2035	82 10% 1/2W............doz	1.20
R-58	6R6398	150,000 10% 1/2W.......doz	1.20
R-59	6R5660	180 10% 1/2W...........doz	1.20
R-60	6R6428	6800 10% 1/2W..........doz	1.20
R-61	6R6428	6800 10% 1/2W..........doz	1.20
R-62	6R6410	33,000 10% 1/2W........doz	1.20
R-63	6R6074	68,000 10% 1/2W........doz	1.20
R-64	18A733887	Tone Control: 1 meg........	.55
R-65	*18B732228	Dual Control & Switch: vol - 1 meg tapped at 250K & brightness - 100K..........	1.35
R-66	6R2122	4.7 meg 20% 1/2W.......doz	1.20
R-67	6R6032	470,000 20% 1/2W.......doz	1.20
R-68	6R6032	470,000 20% 1/2W.......doz	1.20
R-69	6R6090	470 10% 1/2W...........doz	1.20
R-70	*6K121896	1500 10% 2W...............	.25
R-71	*18B731827	Dual Control: horiz centering - 20 ohms; vert centering - 20 ohms...............	4.00
R-72	*17K731896	Wire Wound: 1500 10% 5W..	.45
R-73	*17A732655	Special, wire wound: 7.5 ohm (CAUTION - use only special fusing res as replacement.)................	1.00
R-74	6R6320	10,000 10% 1/2W........doz	1.20
R-75	6R5550	47 10% 1/2W............doz	1.20
R-76	6R3949	470 20% 1/2W...........doz	1.20
R-77	6R3949	470 20% 1/2W...........doz	1.20
R-78	6R6394	12,000 10% 1/2W........doz	1.20
R-79	6R5550	47 10% 1/2W............doz	1.20
R-80	6R3949	470 20% 1/2W...........doz	1.20
R-81	*6K121901	27,000 10% 1W.............	.20
R-82	6R3949	470 20% 1/2W...........doz	1.20
R-83	6R5551	120 10% 1/2W...........doz	1.20
R-84	6R3949	470 20% 1/2W...........doz	1.20
R-85	6R6229	1000 10% 1/2W..........doz	1.20
R-86	6R6397	22,000 10% 1/2W........doz	1.20
R-87	6R6080	4700 10% 1/2W..........doz	1.20
R-88	6R6475	680,000 10% 1/2W.......doz	1.20
R-89	6R6434	27,000 10% 1/2W........doz	1.20
R-90	6R6394	12,000 10% 1/2W........doz	1.20
R-91	*6K121895	15,000 10% 1W.............	.20
R-92	6R6269	820 10% 1/2W...........doz	1.20
R-93	*6K121899	3300 10% 2W...............	.25
R-94	6R6046	1 meg 10% 1/2W.........doz	1.20
R-95	6R6048	47,000 10% 1/2W........doz	1.20
R-96	6R6393	1200 10% 1/2W..........doz	1.20

Ref. No.	Part Number	Description	List Price
R-97	*18B731886	Contrast Control: dual; front 500, rear 1K.........	1.90
R-100	6R6046	1 meg 10% 1/2W.........doz	1.20
R-101	6R5581	3300 10% 1/2W..........doz	1.20
R-102	6R6320	10K 10% 1/2W...........doz	1.20
R-103	6R2035	82 10% 1/2W............doz	1.20
R-104	18B732223	Color Intensity Control (chroma): 10K..............	.85
R-105	6K120474	22,000 10% 2W.............	.25
R-106	6R6032	470,000 20% 1/2W.......doz	1.20
R-107	6R6031	100,000 10% 1/2W.......doz	1.20
R-109	6K121894	22,000 10% 1W.............	.20
R-110	6R2061	180,000 5% 1/2W........doz	1.75
R-111	6R5587	1 meg 5% 1/2W..........doz	1.75
R-112	6R400067	330,000 5% 1/2W........doz	1.75
R-113	*6K121894	22,000 10% 1W.............	.20
R-114	6R400076	39,000 5% 1/2W.........doz	1.75
R-115	6R6229	1000 10% 1/2W..........doz	1.20
R-116	6R6429	820,000 10% 1/2W.......doz	1.20
R-117	6R6031	100,000 10% 1/2W.......doz	1.20
R-118	6R6320	10,000 10% 1/2W........doz	1.20
R-119	6R6407	220,000 10% 1/2W.......doz	1.20
R-120	6R6428	5600 10% 1/2W..........doz	1.20
R-121	6R5768	33,000 10% 2W.............	.25
R-122	6R6410	33,000 10% 1/2W........doz	1.20
R-123	6R6031	100,000 10% 1/2W.......doz	1.20
R-124	6R6407	220,000 10% 1/2W.......doz	1.20
R-125	6R6069	2200 10% 1/2W..........doz	1.20
R-126	6R6428	6800 10% 1/2W..........doz	1.20
R-127	6R6069	2200 10% 1/2W..........doz	1.20
R-128	6R6397	22,000 10% 1/2W........doz	1.20
R-129	6R6080	4700 10% 1/2W..........doz	1.20
R-130	6R6031	100,000 10% 1/2W.......doz	1.20
R-131	6R6031	100,000 10% 1/2W.......doz	1.20
R-132	6R6031	100,000 10% 1/2W.......doz	1.20
R-133	6R5659	3900 10% 1/2W..........doz	1.20
R-134	6R2122	4.7 meg 20% 1/2W.......doz	1.20
R-135	*18B733738	Dual Control: vert hold - 200K; horiz hold - 100K....	1.70
R-136	6R5646	390,000 10% 1/2W.......doz	1.20
R-137	6R6320	10,000 10% 1/2W........doz	1.20
R-138	6R6229	1000 10% 1/2W..........doz	1.20
R-139	6R6117	5600 10% 1/2W..........doz	1.20
R-140	*18B731880	Dual Control: vert lin - 2K; vert size - 2 meg..........	1.70
R-141	6R6074	68,000 10% 1/2W........doz	1.20
R-142	6R5646	390,000 10% 1/2W.......doz	1.20
R-143	6R6031	100,000 10% 1/2W.......doz	1.20
R-144	6R6320	10,000 10% 1/2W........doz	1.20
R-145	6R5581	3300 10% 1/2W..........doz	1.20
R-146	6R6046	1 meg 10% 1/2W.........doz	1.20
R-147	*18K734928	Horiz Drive Control: 5000..	1.65
R-148	6R6007	68 20% 1/2W............doz	1.20
R-149	17R121123	5000 10% 5W...............	.80
R-150	6R6397	22,000 10% 1/2W........doz	1.20
R-151	*18K733743	Focus Control: 2.5 meg.....	3.95
R-152	6R6394	12,000 10% 1/2W........doz	1.20
R-153	6R6048	47,000 10% 1/2W........doz	1.20
R-154	6R6433	2.2 meg 10% 1/2W.......doz	1.20
R-155	6R2035	82 10% 1/2W............doz	1.20
R-156	6R476012	3900 10% 2W...............	.25
R-157	6R6048	47,000 10% 1/2W........doz	1.20
R-158	6K120580	Wire Wound: 6.8 10% 1W...	.20
R-159	6R6326	100 10% 1/2W...........doz	1.20
R-160	6R6410	33,000 10% 1/2W........doz	1.20
R-161	6K121900	47,000 10% 1W.............	.20
R-162	6K121893	470,000 10% 1W............	.20
R-163	6K121893	470,000 10% 1W............	.20
R-164	6R2046	820 10% 2W................	.25
R-165	17K488266	Wire Wound: .47 10% 1/2W.	.15
R-166	6R5591	18,000 10% 1/2W........doz	1.20
R-167	6R5701	820 10% 1W................	.20

Ref. No.	Part Number	Description	List Price
R-168	6R3949	470 20% 1/2W..........doz	1.20
R-169	6R5591	18,000 10% 1/2W........doz	1.20
R-170	6R6320	10,000 10% 1/2W........doz	1.20
R-171	6R6075	100,000 20% 1/2W........doz	1.20
R-172	6R5550	47 10% 1/2W...........doz	1.20
R-201	6R6430	10,000 10% 1W.............	.20
R-202	6R6074	68,000 10% 1/2W........doz	1.20
R-203	6R6229	1000 10% 1/2W..........doz	1.20
R-205	6R3949	470 20% 1/2W...........doz	1.20
R-206	6R3949	470 20% 1/2W...........doz	1.20
R-207	6R5556	10,000 5% 1/2W.........doz	1.20
R-208	6R5556	10,000 5% 1/2W.........doz	1.20
R-209	*18B731834	Dual Control: blue G-2 - 3 meg; blue bkgd - 100.......	1.70
R-210	*6A733145	Special: 33,000 10% 4W; with heat dissapating band.	.50
R-211	*18K732740	Blue Gain Control: 1000 ohms	.40
R-213	6R6393	1200 10% 1/2W..........doz	1.20
R-214	6R5591	18,000 10% 1/2W........doz	1.20
R-215	6R6046	1 meg 10% 1/2W.........doz	1.20
R-218	6R476014	18,000 10% 2W.............	.25
R-219	17R121123	5000 10% 5W...............	.80
R-220	6K121488	12,000 10% 2W.............	.25
R-221	6K121488	12,000 10% 2W.............	.25
R-222	6R6398	150,000 10% 1/2W.......doz	1.20
R-223	6R6414	270,000 10% 1/2W.......doz	1.20
R-224	6R6117	5600 10% 1/2W..........doz	1.20
R-225	6R6373	150 10% 1/2W...........doz	1.20
R-226	*18B731833	Dual Control: green G-2 - 3 meg; green bkgd - 500......	1.70
R-227	*6K733772	Special: 27,000 10% 4W; with heat dissapating band.	.50
R-228	6R5732	15,000 10% 2W.............	.25
R-229	6R6236	68,000 10% 1W.............	.20
R-230	6R6477	15,000 10% 1/2W........doz	1.20
R-231	6R6069	2200 10% 1/2W..........doz	1.20
R-232	6R6046	1 meg 10% 1/2W.........doz	1.20
R-233	*18A734485	AFC Control: 250K..........	.75
R-234	6R6046	1 meg 10% 1/2W.........doz	1.20
R-235	6R6320	10,000 10% 1/2W........doz	1.20
R-236	6R6477	15,000 10% 1/2W........doz	1.20
R-238	6R6022	330 10% 1/2W...........doz	1.20
R-239	6R5731	39,000 10% 2W.............	.25
R-240	6R6409	2200 10% 1W...............	.20
R-241	6R5556	10,000 5% 1/2W.........doz	1.20
R-242	6R5554	390 10% 1/2W...........doz	1.20
R-243	6R6075	100,000 20% 1/2W.......doz	1.20
R-246	6R6398	150,000 10% 1/2W.......doz	1.20
R-247	6R3949	470 20% 1/2W...........doz	1.20
R-248	6R3949	470 20% 1/2W...........doz	1.20
R-249	6R5721	150,000 10% 1W............	.20
R-250	*18A734621	Red G-2 Control: 3 meg.....	.85
R-251	6R2011	2.2 meg 10% 1W............	.20
R-254	*6K121893	470,000 10% 1W............	.20
R-255	*6K121893	470,000 10% 1W............	.20
R-256	6R6397	22,000 10% 1/2W........doz	1.20
R-257	6R6048	47,000 10% 1/2W........doz	1.20
R-258	*18B733740	Dual Control: vert dyn tilt 100, vert dyn amp 2.5K.....	1.75
R-259	*18K734497	Horiz Dyn Conv Control: 500	.75
R-260	*18B733740	Dual Control: vert dyn tilt 100, vert dyn amp 2.5K.....	1.75
R-261	18K734497	Horiz Dyn Conv Control: 500	.75
R-262	18B733740	Dual Control: vert dyn tilt 100, vert dyn amp 2.5K.....	1.75
R-263	18K734497	Horiz Dyn Conv Control: 500	.75
R-265	*6R5556	10,000 5% 1/2W.........doz	1.20
R-267	6R5718	3300 10% 1W...............	.20
R-268	6R6069	2200 10% 1/2W..........doz	1.20
R-269	6R5577	2700 10% 1/2W..........doz	1.20
T-1	24K730677	Trans, ant: imp matching...	.85
T-2	24K730677	Trans, ant: imp matching...	.85
T-6	*24C734459	Trans, ratio det...........	2.10
T-7	*25K733208	Trans, audio output.........	2.20
T-8	*25B733226	Trans, filament.............	18.60
T-9	24B721953	Trans, 1st IF...............	2.20
T-10	*24B732201	Trans, 2nd IF...............	2.05
T-11	*24K734252	Trans, bandpass plate.......	1.00
T-12	*25K734747	Trans, vert blocking osc....	
T-13	*24D734487	Trans, hi-voltage & horiz output....................	22.95
T-14	*24C734522	Trans, 3rd IF (sound det)...	6.05
T-15	*24C734521	Trans, 3rd IF (video det)...	5.50
T-16	*25B734976	Trans, vert output..........	
T-201	*24B734844	Trans, bandpass cathode follower grid................	1.20
T-202	*24B733747	Trans, bandpass cathode follower cathode.............	1.60
T-203	*24C734483	Trans, burst amp............	1.70
T-204	*24B733760	Trans, quadrature: incl L-209, 210, C-211, 212 & 213.....................	2.60

MECHANICAL PARTS

Part Number	Description	List Price
1V733441	Arms & Link Assem, tone control...	.25
7B732855	Bracket, bearing (holds fine tuning - UHF shaft)................	.10
42A732663	Belt, UHF drive.................	.25
*75K731898	Bumper, rubber (on pic tube tilt brkt)..........................	.25
43A732660	Bushing, pulley: phenolic (on rear of fine tuning shaft).......	.20
43A735148	Bushing, sleeve: nylon (on rear of fine tuning shaft)...........	
*14A734482	Cap, plate insulating (V-20 mtg)..	
42A720008	Cap, plate: with lead (V-17).....	.20
*42K471194	Clip, electrolytic mtg (C-66, 75).	.05
*42K734748	Clip, electrolytic mtg (C-69).....	.05
*42A734655	Clip, grid & lead (V-19)..........	.35
42A730642	Clip, spring (dial light jewel ret)	.05
41A732715	Clip, spring (fine tuning rotor grounding)......................	.05
42K731600	Clip, tube shield (V-3, 4, 5, 25, 26)...........................	.05
*76K733748	Core, iron (L-47)................	.30
46A711360	Core, iron (L-2, 3)..............	.10
46A780344	Core, iron & screw (L-43, 218)....	.45
46K722164	Core, iron & screw (T-9, 10, L-26, 30, 31).......................	.10
*46K732255	Core, iron & screw (T-204)........	.15
46B790943	Core, iron & screw (L-39, 201, 202, 204, 208, 215, 216, T-12, 204)...	.15
58A702714	Coupling, shaft (couples contrast shaft & ext)..................	.10
*1B734488	Hi-Voltage Socket Assembly (V-21).	
*1V734197	Hi-Voltage Socket Assembly (V-19).	
*1V734198	Hi-Voltage Socket Assembly (V-20).	
14A733464	Insulator, core rod (L-47)........	.30
14K733202	Insulator, chassis mtg (on sides of chassis)...................	.20
14K712339	Insulator, control (insulates vol, tone & rear controls from chassis)	.05
*14B733742	Insulator, control (insulates front center suppl controls from chassis)........................	.30
14A731524	Insulator, pic tube (on front tube support brkts).................	.05
14A703228	Insulator, interlock.............	.10

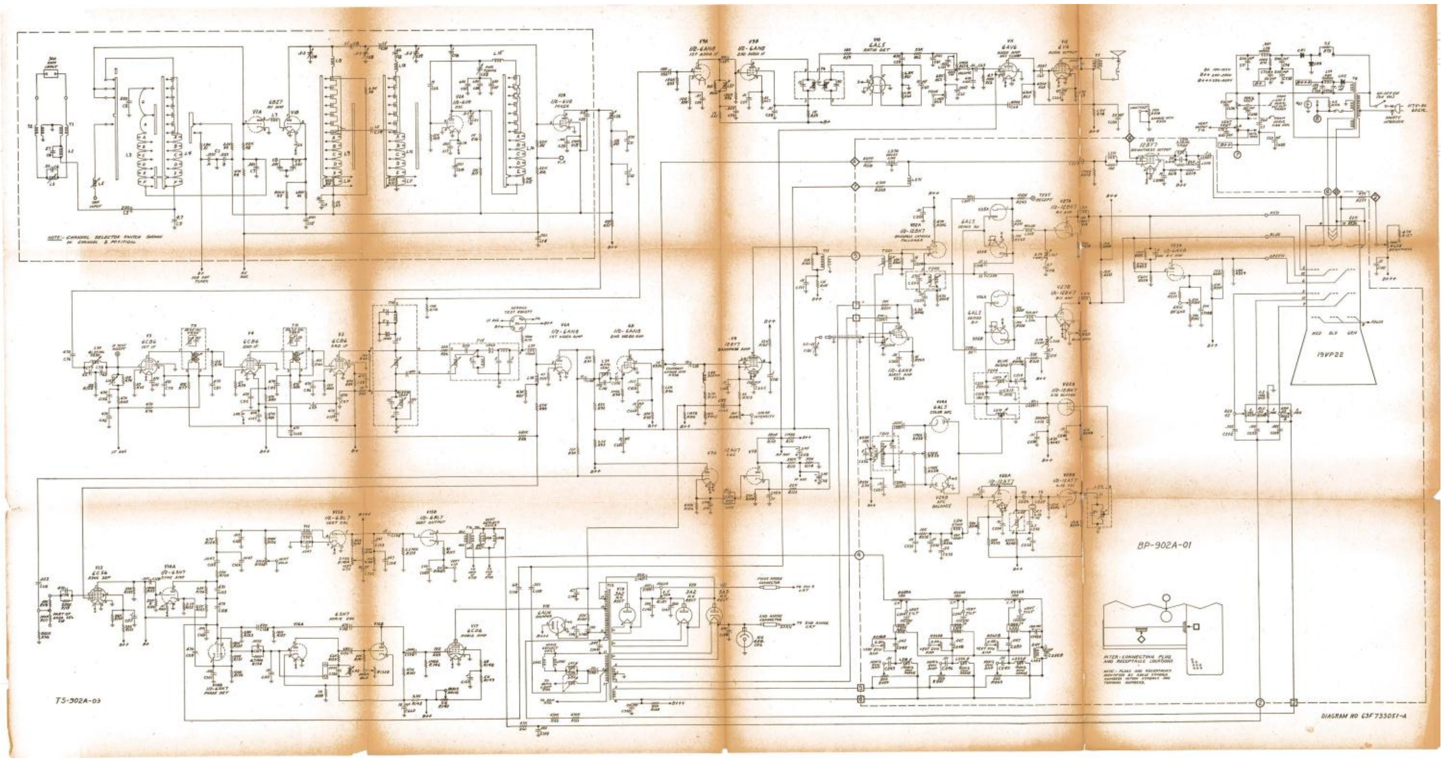
Part Number	Description	List Price
*14A732359	Insulator, shaft (insulates shaft from chassis)................doz	.50
43A722511	Insulator, sleeving (T-1, 2)...doz	.50
14K732687	Insulator, pilot light.........doz	.50
*14B733764	Insulator, pic tube (around pic tube)..........................	6.15
61B730644	Jewel, dial light...................	.10
*1V734867	Magnet, beam positioning: incl magnet retaining arm............	1.55
*59A733739	Magnet, blue beam (around neck of picture tube)...................	2.10
*59A734620	Magnet, purity control (around neck of picture tube)...........	2.15
2K791404	Nut, coil & core mtg (L-47)....doz	.50
*2K721967	Nut, core mtg (T-204)...........	.05
*2K721856	Nut, core mtg (L-215, 216, T-12)..	.05
2S7051	Nut, hex: palnut; 3/8-32 x 9/16 (control mtg)................doz	.15
2S400482	Nut, palnut (C-10, 19, 21, 28).doz	.15
*75K731897	Pad, cushion (on front pic tube support brkt)...................	.10
29A732247	Pin, contact (grids of pic tube)..	.10
29A5400	Pin, terminal (on spkr lead)...doz	.20
9A484098	Plate, electrolytic mtg: 3 lug (C-74, 252)......................	.05
64A90034	Plate, electrolytic mtg: 4 lug (C-73)........................	.05
*64A733762	Plate, coil mtg (T-6, 14).........	.05
29K712319	Plug, line cord (interlock on chassis)......................	.15
28A721864	Plug, ant: 2-prong (on ant lead).	.05
28A731387	Plug, defl yoke: 4 pin...........	.10
29K730036	Plug, defl yoke: 1 pin...........	.05
*28A734765	Plug, second anode...............	.55
28K731154	Plug, 1 pin (L-204)..............	.10
28A11368	Plug, 4 pin (L-217, 219, 221).....	.10
*28K732702	Plug, 8-prong (connects BP chassis to main chassis)...............	.35
1V732877	Pulley Assem (on rear of tuner)...	.40
9K730388	Receptacle, five pin (service test recept)......................	.15
9A731389	Receptacle, six pin (defl yoke)...	.15
9A730031	Receptacle, inter-chassis connecting: 1-1/2" MC.................	.25
9A720006	Receptacle, two pin (for L-43 adj)	.10
9A701065	Receptacle, inter-chassis connecting: 1-5/16" MC................	.20
*9K734489	Receptacle, second anode..........	.60
9A721859	Receptacle, fusing resistor........	.15
*9K732674	Receptacle, hi-voltage............	.65
*9K733778	Receptacle, four pin (L-217, 219, 222 plug in).....................	.15
*9A6729	Receptacle, five pin (color grid test)...........................	.20
9A722758	Receptacle, test (R-Y demodulator & IF)...........................	.10
9A702469	Receptacle, plug in (fine phase)..	.15
*3S121890	Screw, machine: 4-40 x 1/4"; pl hex hd; stl; brass pl (convergence coil clamp retaining)...doz	.20
3S9650	Screw, machine: 6-32 x 3/4"; sl rd hd (C-10, 19, 21, 28 adj)..doz	.15
47A732384	Shaft, extension (contrast control)	.10
*47K732337	Shaft, fine tuning...............	.45
1A722216	Shaft & Sprocket Assem, UHF dial drive..........................	.80
26A720284	Shield, dial light...............	.05
*26C734499	Shield, magnetic (around pic tube)	36.05
26K730395	Shield, tube (V-1, 2)............	.10
26A522403	Shield, tube (V-3, 4, 5, 24, 25)..	.05
9R119872	Socket, tube: miniature; 7-prong; 1" MC; wafer type...............	.15

Part Number	Description	List Price
9R119873	Socket, tube: miniature; 7-prong; 1-5/16" MC; wafer type...........	.15
9R119881	Socket, tube: noval (V-1, 2).....	.20
9B730640	Socket, pilot light & brkt assem..	.30
9R119883	Socket, tube: noval..............	.20
1X790307	Socket, tube: octal; cushioned type (V-13)......................	.40
*9A731818	Socket, crystal..................	.35
*9B733794	Socket, pic tube: 14 contact - 12 leads..........................	6.40
*41A734508	Spring, tension (for convergence coil assem).....................	.05
*1V734239	Strap, tube retaining assem.......	.90
31A21990	Strip, terminal: 2 screw (ant term).........................	.15
4B592098	Washer, "C" (on contrast control shaft ext).....................	.05
4A11722	Washer, "C" (belt pulley ret on rear of VHF tuner)...........doz	.20
4K77577	Washer, insulator (horiz size insulating)..................per/c	.50
4A730195	Washer, rubber (on pic tube support rod)...................doz	.35
4K730095	Washer, shoulder: fibre (control mtg).........................doz	.30

VHF TUNERS

Part Number	Description	List Price
*1U733177	VHF Tuner WTT-67..................	41.20** exch 30.90
*1U733178	VHF Tuner WTT-67Y.................	

PRICES SUBJECT TO CHANGE WITHOUT NOTICE
*New Item, Appears in any List for First Time
**Plus Federal Excise Tax at Current Rate
***Prices Furnished Upon Request


TS-302A-03
BP-902A-01
19VP22
INTER-CONNECTING PLUG AND RECEPTACLE LOCATIONS
DIAGRAM NO 63F733051-A