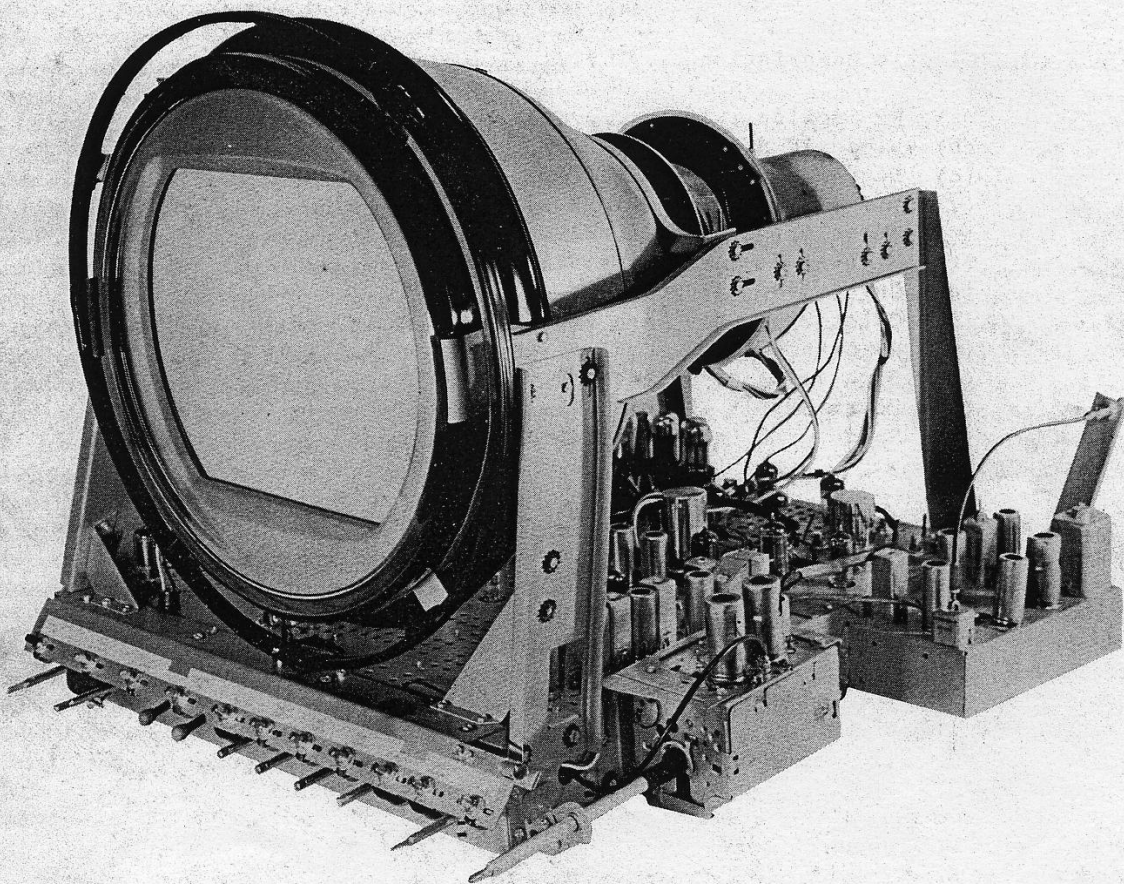


# Westinghouse

## COLOR TELEVISION SERVICE SCHOOL



PRESENTED BY SERVICE DEPARTMENT,

WESTINGHOUSE ELECTRIC CORPORATION,

TELEVISION-RADIO DIVISION,

METUCHEN, N. J.

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## COLOR FUNDAMENTALS

In order to understand the basic principles of the color television system developed by the National Television System Committee (NTSC), it will be necessary to touch upon a subject that is very complex, namely the nature of light and color.

Light is a form of radiant energy and travels in a wave motion, differing from other forms in frequency and wavelength. We know that starting with Sound and proceeding on through the Radio Frequencies up to the Ultra-High Frequencies that as the frequency increases and the wavelength measurement decreases and throughout this range we speak of cycles, kilocycles, and megacycles in respect to measurements of miles, kilometers, meters, inches, centimeters and millimeters. Light falls in a much higher portion of the frequency spectrum and a correspondingly smaller wavelength (1/50,000 inch) and is measured in millimicrons with a range of 400 to 700 millimicrons. The color spectrum of light to which our eyes are responsive is from approximately 400 millimicrons, a deep blue or violet through blue (approximately 470 millimicrons), green (approximately 525 millimicrons), yellow (approximately 580 millimicrons), orange and on to a deep red at approximately 700 millimicrons. We now know that light changes its wavelength in accordance with color. When light is mixed in nearly equal proportions of Red, Green, and Blue we produce a colorless light or white. The system is called additive, that is the three primaries are added to produce white, and any two of the primaries can be added to produce a secondary, but the sum of any two primaries will not produce the third primary. This can be demonstrated by using three projectors, each with a different color slide and superimposing one upon the other.

When the light outputs are nearly equal, the screen will be white. Cutting off the blue projector, the color produced will be a combination of red and green or yellow. With the red turned off and the blue on, the combination of blue and green will produce a cyan, and by using the red and blue a magenta will be developed. If the amount of light output can be controlled, it is possible with the use of only three color sources to produce not only the entire color

spectrum and white, but the non-spectral colors of purple and magenta as well.

We are concerned with a three color reproduction system at this time, as the method of display uses a three gun picture tube having three types of phosphors, red, green, and blue producing three primary colors. By mixing or combining any two primaries, the secondary colors are produced, and by mixing nearly equal amounts of all three primaries, white will result.

The terms used in color television to denote color are Hue and Saturation. Hue denotes a particular color and Saturation denotes the departure of a particular hue from white. As the amount of saturation is increased, the hue will not change but the color becomes deeper, and the higher the brightness, the more vivid the color becomes. With less saturation the color becomes lighter tending toward the pastel shades as the saturation decreases. Let us take red for example; a red with a high degree of brightness will be a bright red and the greater amount of saturation the more red the color will appear, but the hue has not changed, only the proportions of brightness and saturation.

The term Chromaticity will apply to reproduction of color, and we find that part of the receiver will be called the Chrominance or Chroma section. This portion of the receiver will select from the composite video signal the sub-carrier containing the color information to be amplified, demodulated and passed on as the color difference signal.

The gain of the Chroma amplifier will control the saturation and the degree of brightness will be determined by the monochrome or "Y" signal. The "Y" signal and the color difference signal are added together, and the resultant video signal applied to each gun of the picture tube will be the algebraic sum of these two signals.

The N.T.S.C. system is capable of transmitting color information and at the same time is compatible for Black and White reception.

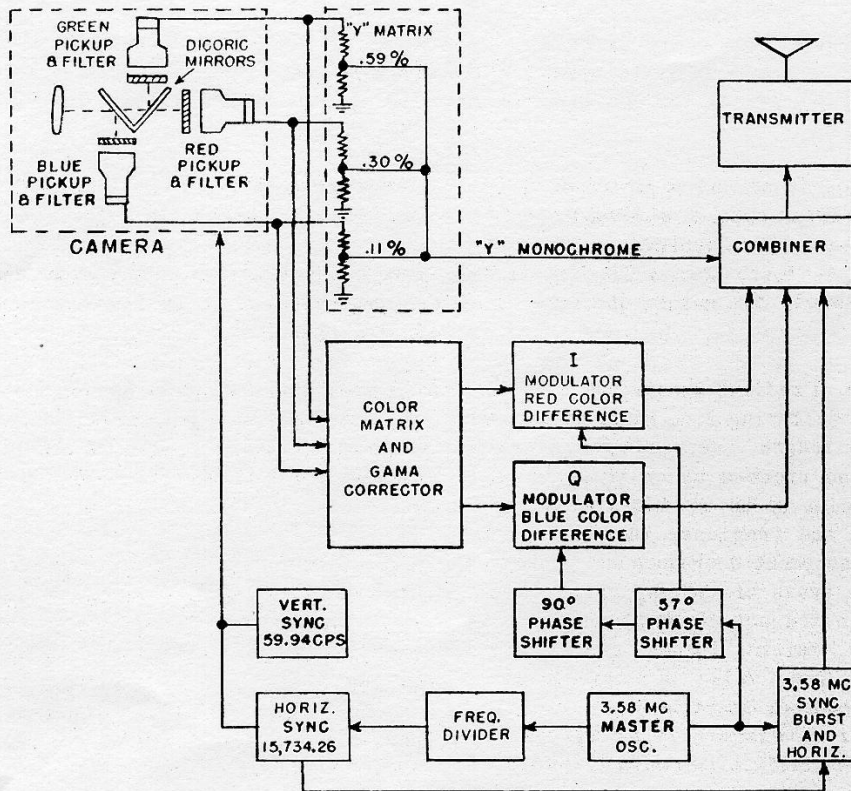


Fig. 1.

In color transmission, as shown in Fig. 1 the camera has three pickup tubes, each with a red, green, or blue filter. This makes each pickup tube sensitive to the light of its filter. All three of the pickup tubes, through the camera optical system, are in perfect alignment so they all pick up the same scene at any instance of scanning. Therefore, one pickup tube produces a video signal which is proportional to the color light passing through its filter at any one instance of scan. There is nothing really green, red or blue about these signals, they are just varying electrical voltages like any other video signal. But each are fed to their respective matrixing or mixing circuits to proportion the amounts of signal. To form the Monochrome or Brightness video signal the ratio 59% of Green, 30% of Red, and 11% of Blue is used. Again these signals are not amounts of color but video signals combined to form one video signal, the same as if a single pickup tube camera was used. The composite signal will be made up of sync pulses, blanking and video. This portion of the Composite Color Signal will be the same as the present black and white transmission.

To develop the Composite Color Signal, the fore mentioned portion will be used for brightness information and fine detail. The fine detail will be reproduced by the color receiver in monochrome and only larger objects will be in color as the band-pass of the Chroma circuits is only 500KC wide.

The video outputs of the camera pickup tubes will supply video signals to other matrixing and signal correcting circuits for conversion to the color difference signals. Two modulators will be used; one operating ninety degrees out of phase with the other. The outputs of the two modulators are combined to form the sub-carrier and its associated side-bands. The sub-carrier frequency is 3.579545 MC and is referred to as 3.58 MC.

It is necessary to transmit only two color difference signals, and each will amplitude modulate a separate 3.58 MC carrier. The two carriers are synchronized to each other, but they are not in phase, one is ninety degrees in phase from the other. The two color difference carriers are added together to form a single



3.58 MC Color Sub-carrier. The phase of this sub-carrier varies, and depends at any instant on the relative amplitudes of the red and blue color difference signals.

When the color being transmitted is white, both color difference signals become zero and the color sub-carrier becomes zero. Now we can see that the amplitude of the sub-carrier indicates saturation or the departure of the color of the picture from white. The Hue of the color is determined by the phase of the Color Sub-carrier.

The composite color signal is formed by combining the monochrome signal, the 3.58 MC sub-carrier, sync and blanking, and the 3.58 MC color sync burst.

With reference to Fig. 2 the resultant vectors and amplitudes of the color difference signals will indicate the phase angle for the fully saturated primary and secondary colors (Yellow, red, magenta, blue, cyan, and green). Now you can see that by varying the amplitude

and phase of the color difference signals any color can be reproduced, as it will be possible to swing the vector 360 degrees in reference to the sync burst.

In Fig. 3A, one horizontal line of a color bar test pattern shows the composite signal, containing the monochrome component, 3.58 MC sub-carrier, horizontal sync and 3.58 MC color sync burst, as seen on an oscilloscope at the video test point.

Fig. 3B shows the same horizontal line at the end of the delay line. Note the absence of the 3.58 MC sub-carrier that has been stripped by the trap in the line driver cathode circuit.

Fig. 3C shows one horizontal line at the grids of the R-Y and B-Y demodulators. This is the 3.58 MC color sub-carrier that has been selected from the composite color signal and amplified by the Chroma bandpass amplifier.

One horizontal line of the red color difference signal taken off at the R-Y test point is shown in Fig. 3D.

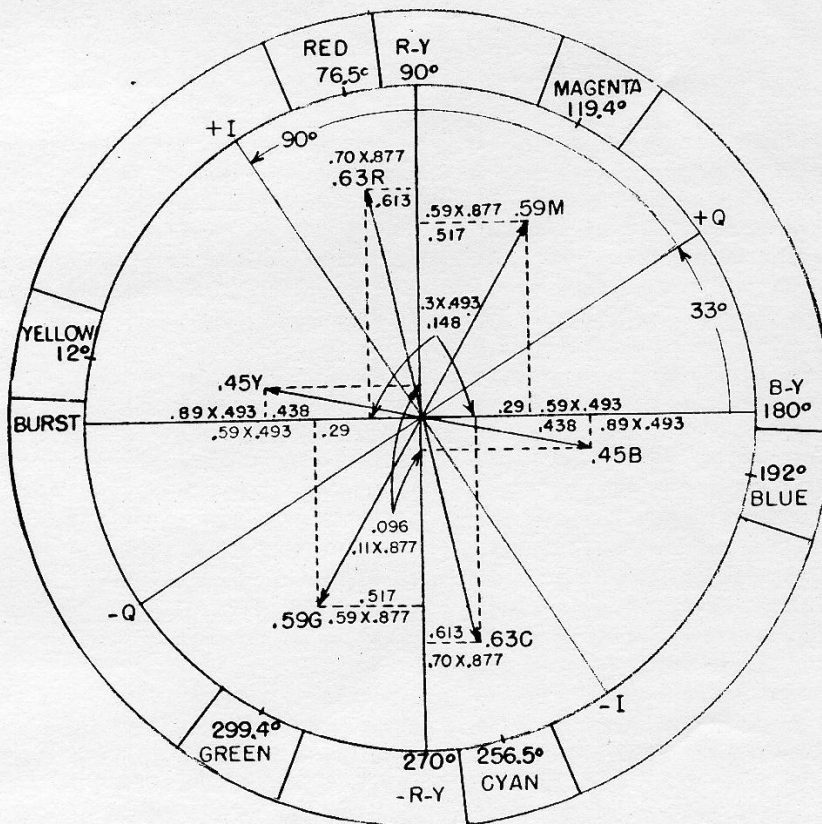


Fig. 2.

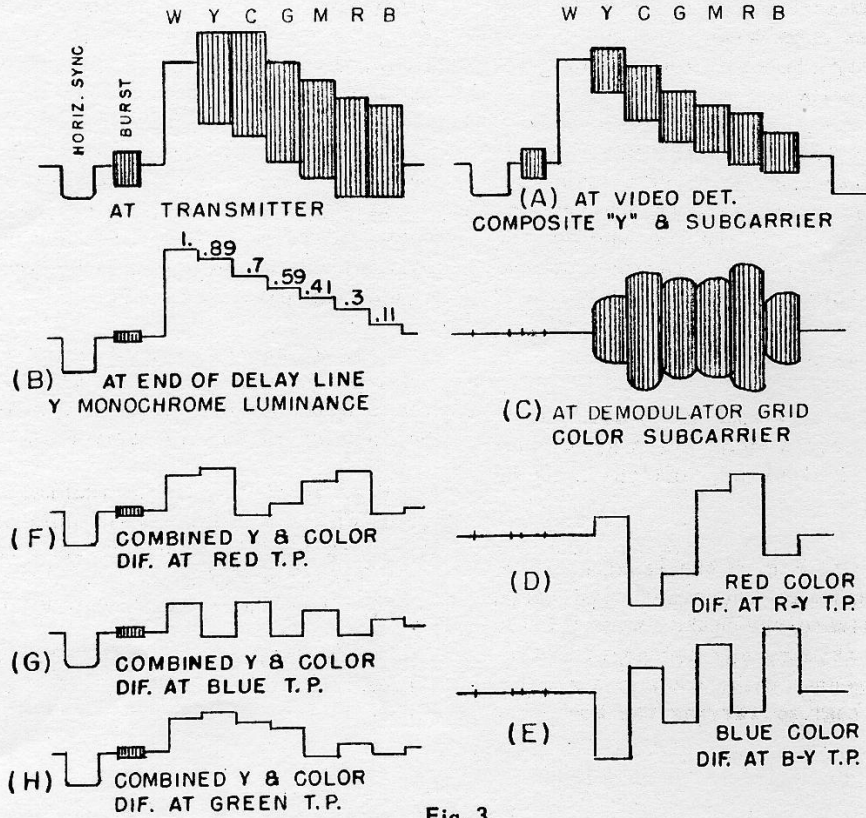


Fig. 3.

The blue color difference signal as shown by Fig. 3E is taken off at the B-Y test point.

The waveform shown in Fig. 3F and taken off at the Red test point is one horizontal line of the combined monochrome or luminance signal and the red color difference signal to produce that portion of the picture display containing mono-

chrome and red, or red combined with some other color.

The waveforms shown in Figs. 3G and 3H are taken from the Blue and Green test points respectively and show the result of combining the monochrome or luminance component and the blue and green color difference signals.



## CIRCUIT DESCRIPTION

The operation of a color television receiver is essentially the same as a black and white receiver, except for additional circuits. The block diagram, Fig. 4, shows the paths followed by the signal components and auxiliary circuits required by the reproduction of a color broadcast.

### RF Section (Fig. 14)

The tuner of a color television receiver cover VHF and can also be a combination type tuner covering UHF. The main difference between a black and white tuner and a color receiver tuner is that the tuner used in a color receiver has a flat broad band response.

The reason for the broad band response is that the 3.58 MC color sub-carrier is near the sound and the sidebands extend to the upper limits of video frequency response. A narrow bandpass would mean attenuation or complete loss of color information.

The reason for selecting a turret type of tuner for color is that each channel can have a broad band response and uniform response on all

channels. The adjustments of one channel will not affect the overall response of another channel.

### Video IF Section (Fig. 14)

The video IF of a color receiver differs from the conventional black and white in band-pass and sound attenuation.

Bandpass must be essentially flat up to 4.1 MC. A bandpass this broad is necessary to give full acceptance of the sidebands of the 3.58 MC color sub-carrier.

Sound attenuation is in the order of 200 to 1 as compared to 15 to 1 in a black and white receiver or approximately 38 db down. This is accomplished by four traps at 41.25 MC. The first trap is the top adjustment on the input (T500) of the IF strip. The second trap (L502) is located in the grid circuit of the 4th IF stage. The third and fourth traps are in the Z500 assembly, L504 as a series trap, and L506 as a parallel trap, all tuned to 41.25 MC.

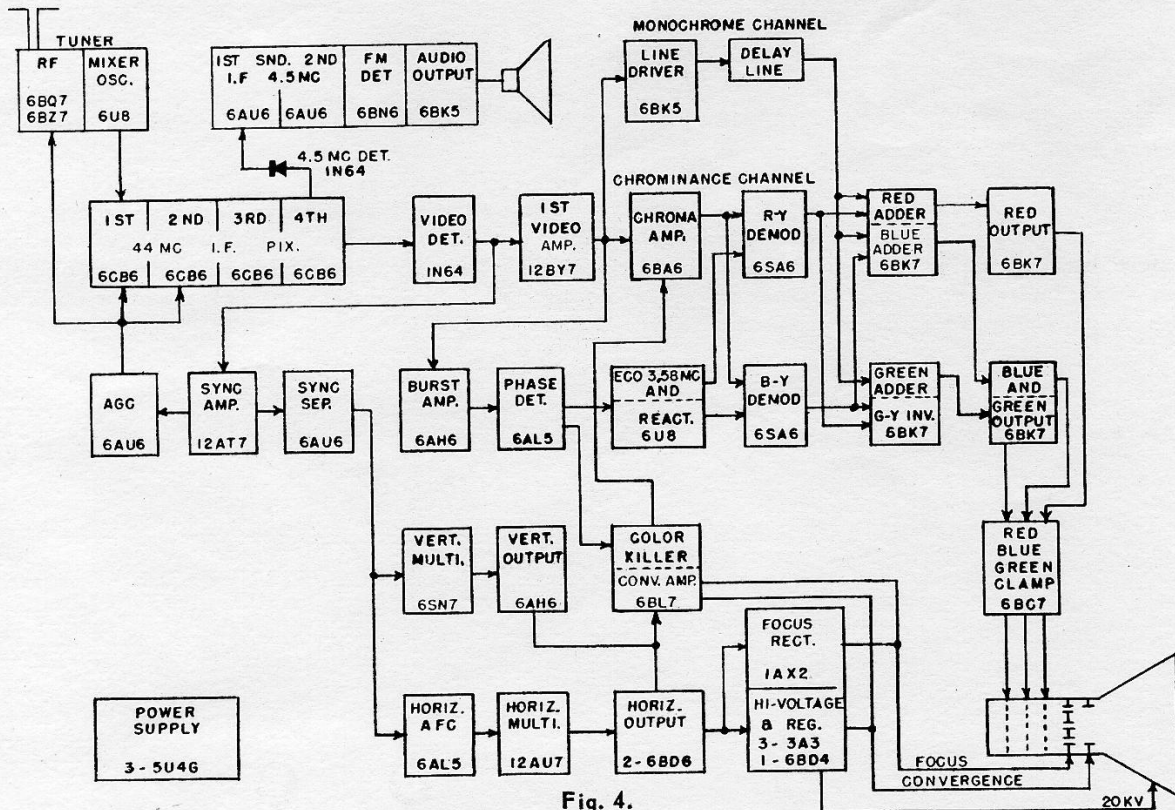


Fig. 4.

The four stages of IF are for the main purpose of getting a broad flat response rather than higher gain.

The Sound Carrier Level Control (R502) is set at the factory for a sound attenuation of 38 db. In areas where the sound is down, a resetting of this control will be necessary.

The reason for the great amount of 41.25 MC sound attenuation is that a 920KC beat would be developed between the 3.58 MC sub-carrier and the 4.5 MC sound carrier causing interference in the picture as it falls on the lower video frequencies. (4.5 MC - 3.58 MC = 920KC)

The sound is taken off at the plate of the 4th IF tube and a separate 1N64 crystal is used for conversion to the 4.5 MC sound IF.

Another 1N64 crystal is used as the video detector, with a negative video and sync signal taken off at this point. The amplitude of this signal is approximately 1.8 volts peak to peak.

**Sound IF (Fig. 14)**

The use of two stages of 4.5 MC sound IF is necessary to recover the sound signal, which

has been attenuated by the trap circuits, and amplify it to a high enough level for the FM detector (6BN6) to function properly. One stage of audio (6BK5) with its associated volume and tone controls completes the sound circuit.

**Video Amplifier (Fig. 5)**

All video, sub-carrier sidebands, and burst signals are amplified in the first video amplifier stage (12BY7). A trap (L605) in the cathode circuit is tuned to 4.5 MC to prevent a .92 MC beat mentioned previously from appearing on the picture tube. Burst signal which follows the horizontal sync pulse is taken off through a tuned circuit consisting of C602, L600, R604, and R603. A 30 mfd. (C605) capacitor is used for coupling to the Picture Control (R607), which controls the amount of video and color sub-carrier signals applied to the grid of the Line Driver tube (6BK5). In the cathode circuit of the Line Driver there is a trap (L601) tuned to 3.58 MC to trap out the color sub-carrier. This is a very high "Q" circuit with a sharp suckout to minimize loss of that portion of the monochrome signal that lies near the 3.58 MC sub-carrier. The signal path of the monochrome or "Y" component of the video signal is from

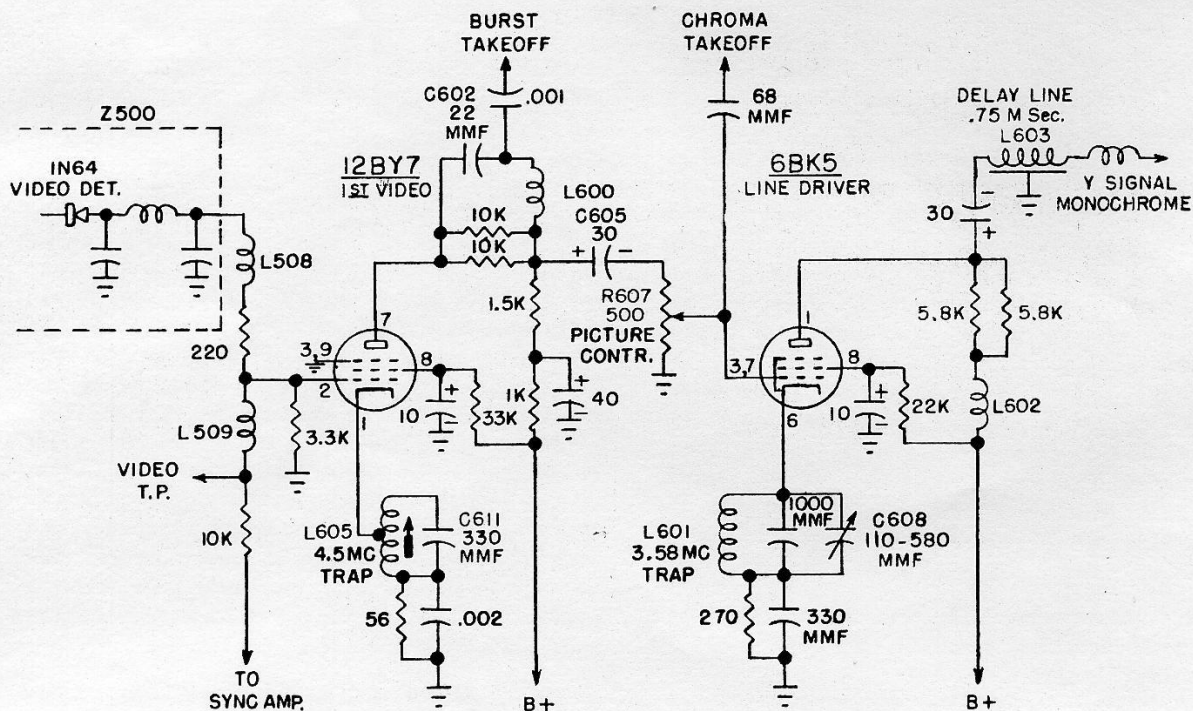


Fig. 5.



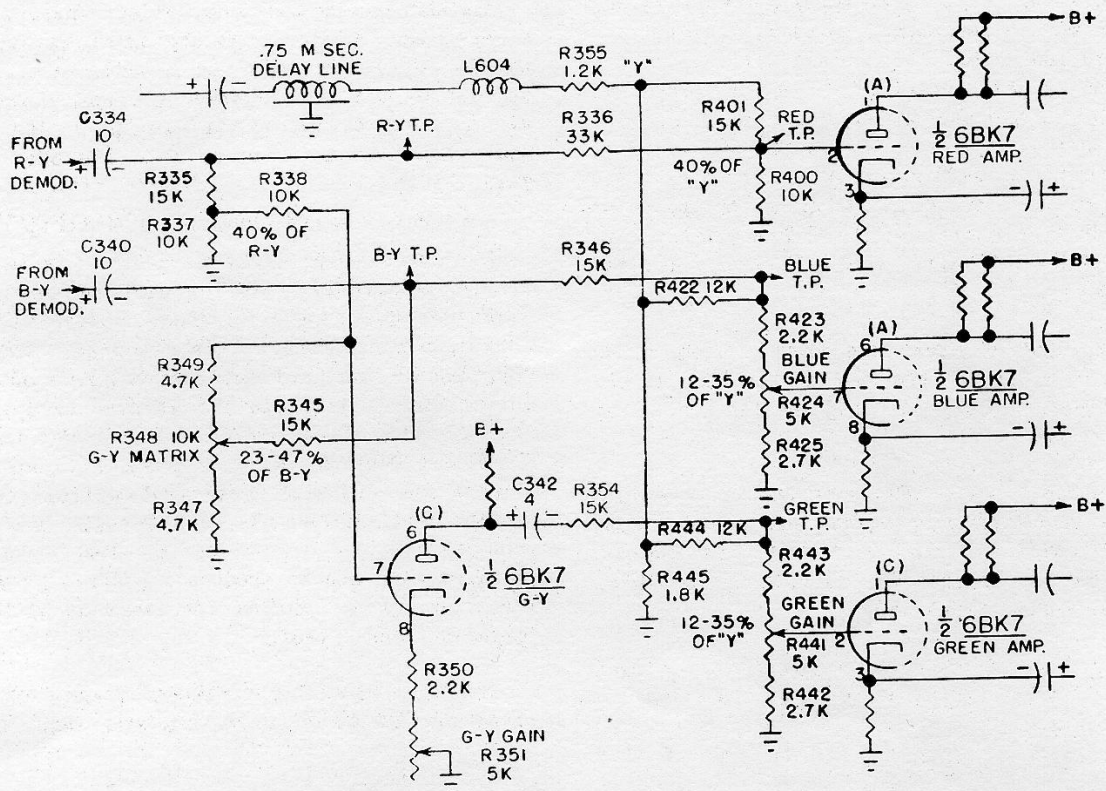


Fig. 6.

the plate of the Line Driver. A delay line (L603) is inserted in the circuit to cause a delay of .75 micro-seconds. This is necessary because of delays due to narrower bandpass tuned circuits of the Chroma Amplifier. The wide bandpass of the monochrome circuits would cause the monochrome detail to arrive ahead of the color information with poor registration as the result. That is, the makeup of the picture detail would not match with the color or the detail and outline would be followed by the coloring. This would be particularly noted when the lips are outlined in monochrome and offset to the right side would be the red color. Of course this would hold true on all detail and color if the delay was not introduced to the monochrome or "Y" signal.

#### Adder or Matrix Circuits (Fig. 6)

The inputs to the red, blue, and green adders are through rather complicated signal dividing or proportioning circuits.

From the output of the delay line, the monochrome or "Y" signal is fed through the peaking coil L604 to the voltage divider network con-

sisting of R355 and R445. The signal taken off at the junction of R355 and R455 is approximately 59% of the signal at the output of the delay line.

Each adder has a different ratio of input, and the monochrome signal is fed three ways, one to the Red adder, second to the Blue adder, and third to the Green adder. The Red amplifier has a higher signal level, because of the low efficiency of the red phosphor in the picture tube, and more drive is required on the red control grid. By dropping through resistor R401 (15K), the input signal to the red adder is approximately 40% of the monochrome signal at the junction of resistors R335 and R445. R401 not only acts as dropping resistor, but also acts as an isolation resistor for the color difference signal from the R-Y demodulator preventing the R-Y signal from affecting the blue and green adders.

The input of the monochrome signal to the Blue adder is through resistors R422 (12K) and R423 (2.2K) to the top of the blue gain control R424 (5K). The blue gain control varies the

signal input to the blue adder from 12% to 35% of the monochrome signal level at the junction of R445 and R355. The correct setting of this control is made during the setup of Monochrome Balance to produce the correct amount of blue necessary in proportion with red and green to produce white. R423 not only acts as a dropping resistor but also as an isolation for the color difference signal from the B-Y demodulator to prevent the B-Y signal from affecting the other two adders.

The input of monochrome signal to the green adder is a circuit the same as the blue input. All the parts are duplicated and the conditions are the same.

The red video output tube (6BK7) is a dual triode connected in parallel and operated from the 400 Volt "B" supply. Again the red gun requires more signal to the grid and a higher grid drive is necessary.

The blue and green video output stages, each use half of a 6BK7, and have the same values of components.

All three of the video amplifiers incorporate a negative feedback from the output plate to the cathode of the video input adder tube. The purpose of this is to prevent phase shift of video information, particularly on the low video frequencies, and to make the over all gain linear.

#### Picture Tube and Clamping Circuits (Fig. 7)

The output of each video amplifier is fed to its respective grid of the picture tube. A clamping tube (6BC7) is used to control the grid operating level. This clamping level is supplied by the horizontal sync pulse on the monochrome signal, clamped at sync amplitude with a voltage decay to black level. The Master Brightness Control (R416) sets the level for all three grids. The Blue Background Control (R439) and the Green Background Control (R460) are set proportional to red to effect a balance of output from each gun to produce a neutral gray on the screen of the picture tube when the grid is operating near cut-off.

The non-linear light output of each of the three guns of the picture tube with respect to

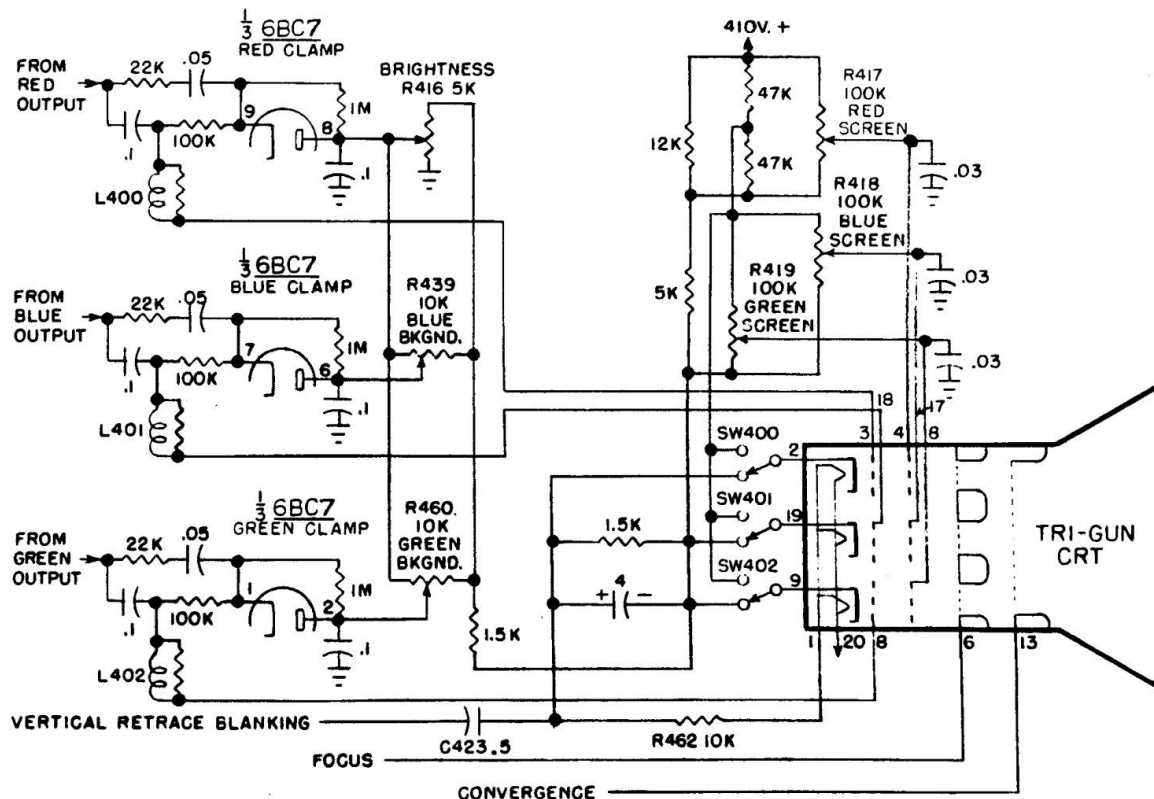


Fig. 7.



the grid voltages requires a method of balancing to have the proper proportions of light output. This is accomplished by having adjustments on each of the respective screens or #2 grids, R417 Red Screen, R418 Blue Screen and R419 Green Screen. These adjustments of light output balance are made during the setup of controls for monochrome balance.

It is necessary to have several adjustments to correct for the light output from low to high signal levels and keep each gun in its proper proportion if a good monochrome display is to be achieved. If all three guns of each and every tube were uniform in output in respect to the control grids, all these adjustments would not be necessary as fixed values could be used.

### Chroma Amplifier (Fig. 8)

The Chrominance Amplifier is a RF bandpass amplifier. The 3.58 MC sub-carrier and its associated sidebands are selected from the point of take-off through a 68 mmf. cap. (C606), L300 a tuned circuit of the grid, and T300 in the plate circuit of the Chroma Amplifier (6BA6). The overall bandpass response curve is humped on the high side at 4.1 MC to make up for the loss of the .5 MC sidebands on the high side of the 3.58 MC sub-carrier that were at-

tenuated in the IF section due to being so close to the sound carrier, thus giving better overall response.

The Chrominance signal is fed to both the R-Y and B-Y demodulator grids (6AS6).

The operation of the Chroma Amplifier is held in a non-operating condition due to a bias developed by the rectification of pulses from the horizontal output transformer. This grid bias will be present on all monochrome reception and the Color Killer Tube ( $\frac{1}{2}$ 6BL7GT) is in a conducting condition until a color sync burst is transmitted, removing the cut-off bias from the grid of the Chroma Amplifier. The Color Control (R304) which controls the gain of the Chroma Amplifier has a switch (SW300) that is open on the off position setting up a high positive cathode voltage making the amplifier inoperative. As the control is advanced the bias is reduced, and the gain is increased. This is the color saturation control for setting the amount of color signal that will be of the proper proportion to the monochrome or luminance signal.

The Chroma Amplifier is cut-off during horizontal retrace by a negative pulse applied to the screen grid. This prevents the Burst signal

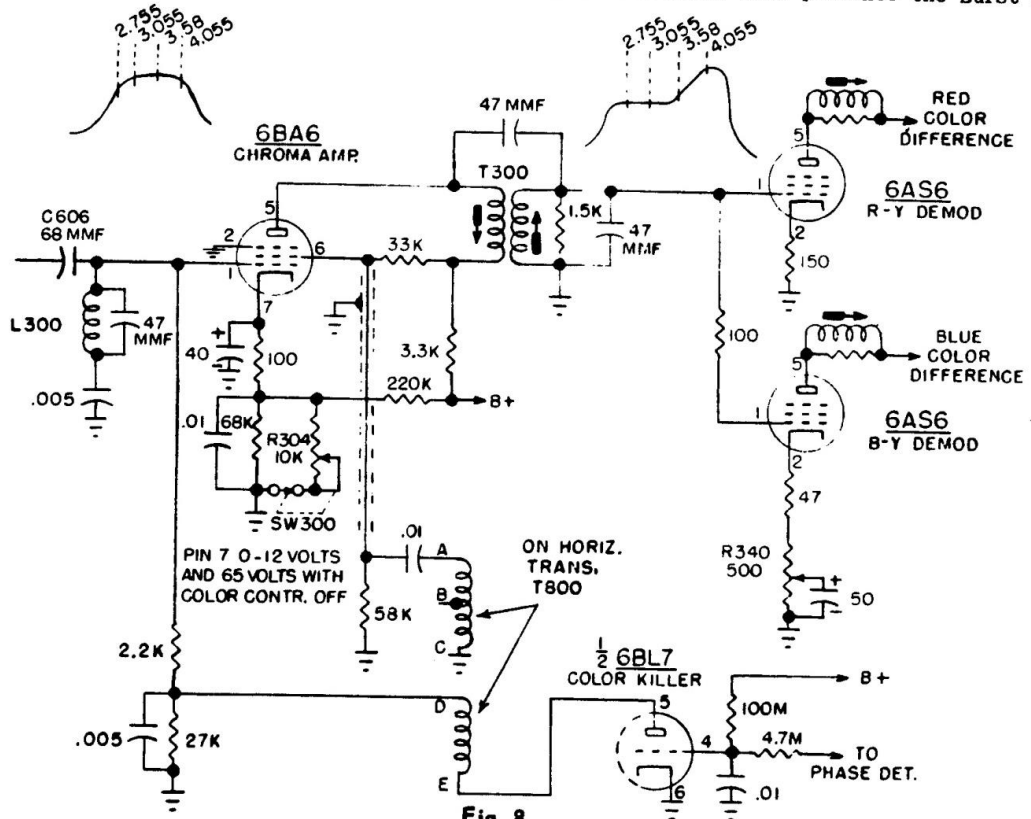


Fig. 8.

from passing through the Chroma Amplifier at this time and supplying a signal to the demodulators during retrace.

### Color Sync Burst and Phase Detector (Fig. 9)

The purpose of the Burst Amplifier (6AH6) is to amplify the color sync burst of 8 to 12 cycles of 3.58 MC on the back porch of the horizontal sync pedestal. This signal is for the purpose of keeping the local oscillator locked in both frequency and phase with the transmitted burst. The Master Phase or Hue Control (T303) varies the phase relation of the local oscillator in respect to the transmitted burst and is used as a correction control for phase changes due to possible phase shifts in transmission and reception. The Burst Amplifier (6AH6) is normally biased off by a high positive cathode voltage and only during horizontal retrace is held in operation by a negative pulse from the horizontal output transformer.

The Phase Detector (6AL5) is used as a phase comparator, that is a small amount of local oscillator output is fed back 90 degrees out of phase with the burst, which is rectified and develops a DC voltage across the Phase Detec-

tor Balance Control (R318). The control having been set for zero, the voltage will change only when the local oscillator is out of phase more or less than 90 degrees in relation to burst.

### Reactance Tube and Electron Coupled Oscillator (Fig. 10)

A positive or negative voltage developed by the Phase Detector will cause a change in the conduction of the Reactance Tube ( $\frac{1}{2}$ 6U8, triode section). This tube is acting as a capacitive reactance and will cause a change in the tuning of the local oscillator ( $\frac{1}{2}$ 6U8, pentode section). This change is in proportion to the voltage developed by the Phase Detector and will correct the oscillator to be in the proper phase relation with the burst, that is 90 degrees out of phase and zero voltage at the Phase Detector balance control (R318).

The Reactance Tube is also controlled by the Color Hold Control (R325). That is, the conduction can be changed and the capacitive reactance will change the local oscillator in both phase and frequency. When the proper setting is achieved the colors will lock in much in the same manner as the horizontal hold control action.

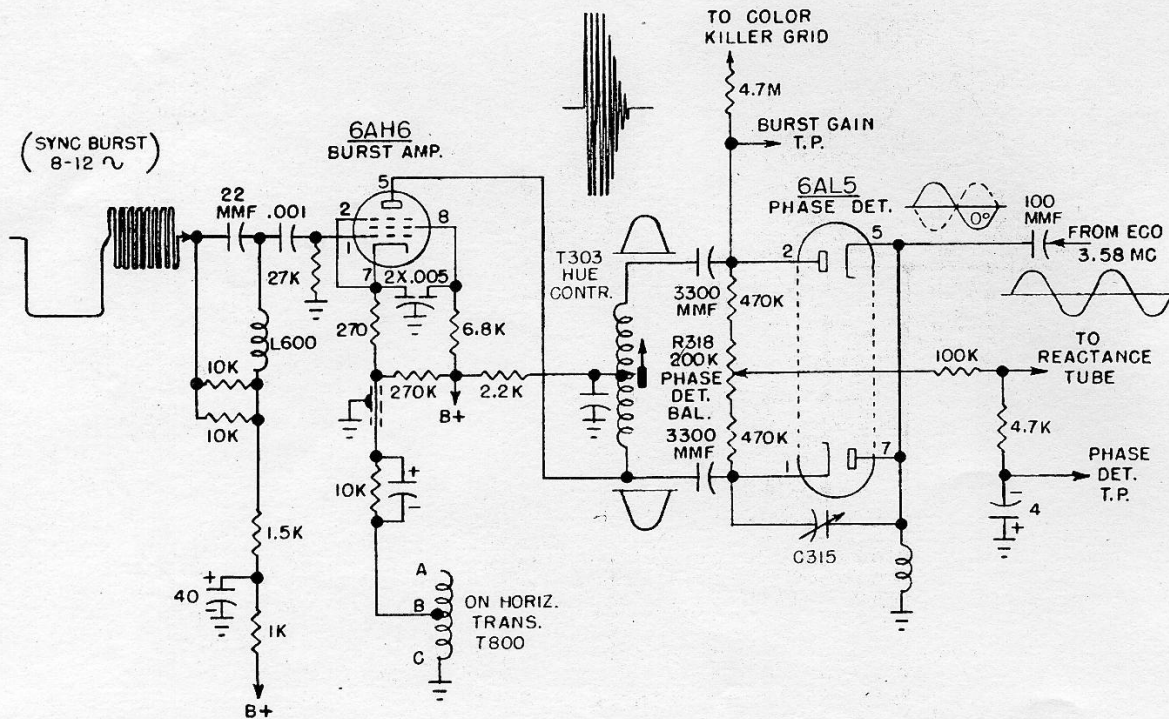


Fig. 9.



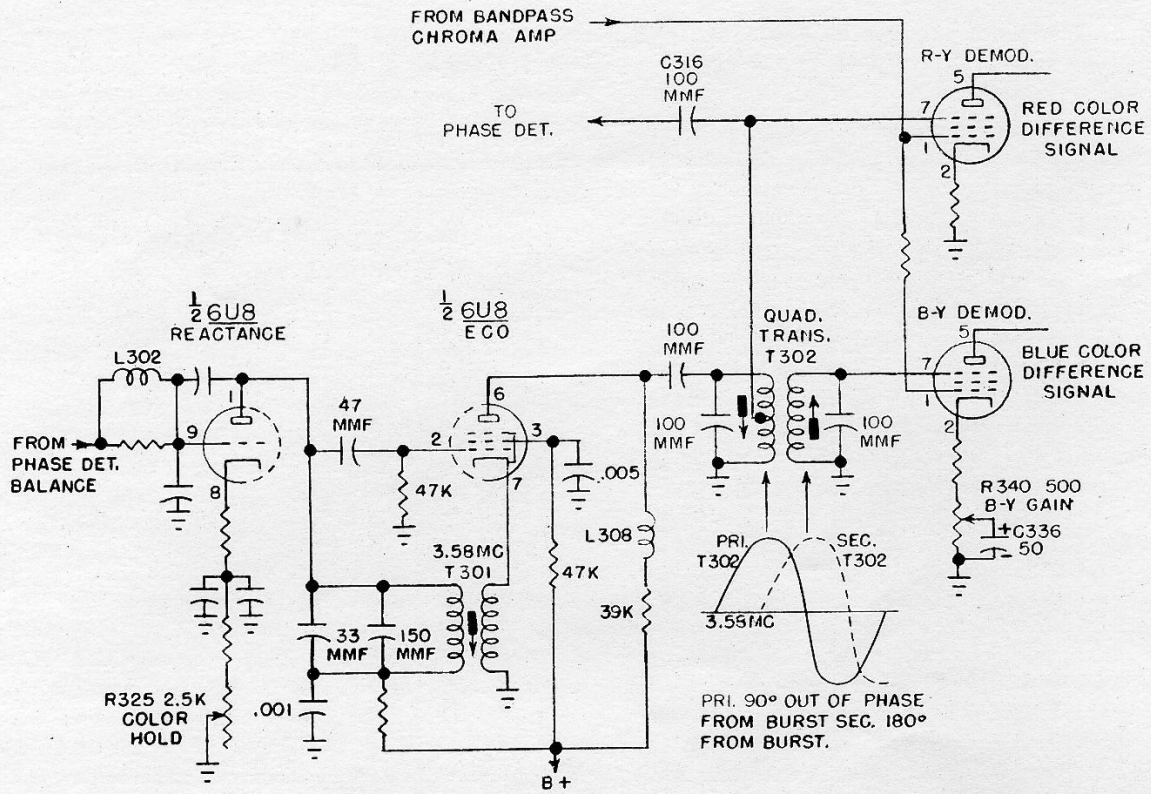


Fig. 10.

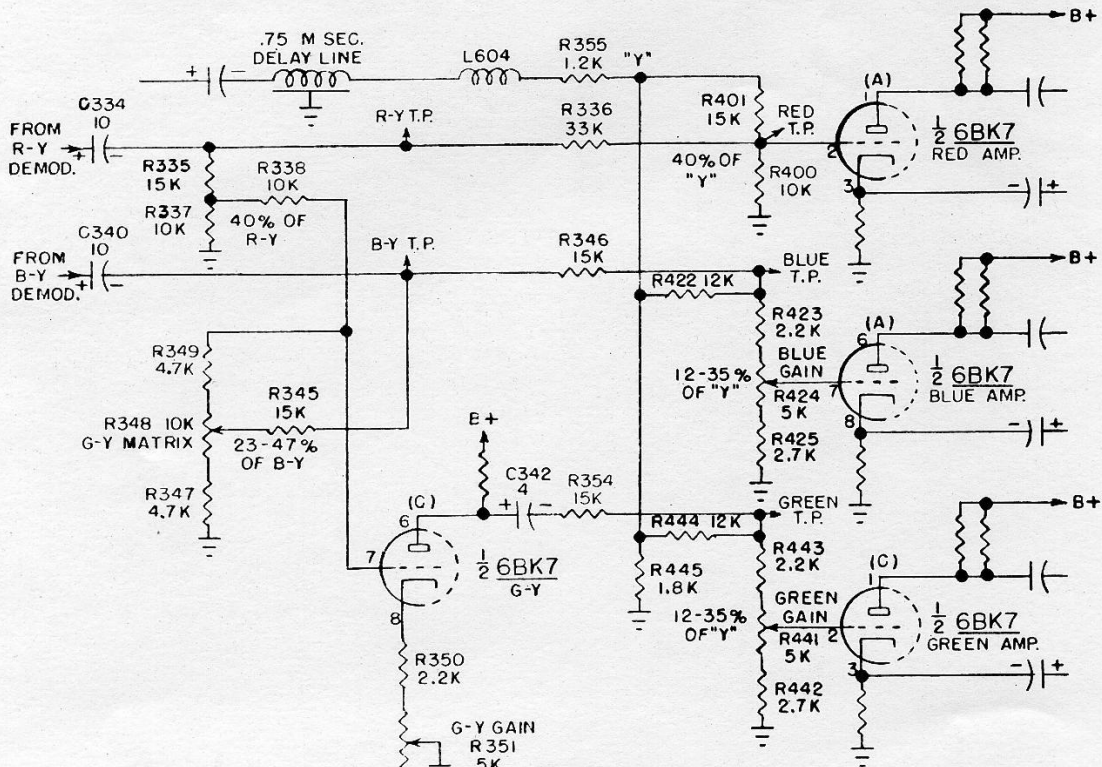


Fig. 11.

The Electron Coupled Oscillator ( $\frac{1}{2}$ 6U8, pentode section), is for the purpose of supplying the local 3.58 MC signal in proper phase with the sub-carrier signal to the synchronous demodulators (6AS6 or 6DB6). The 3.58 MC output of the oscillator (which is 90 degrees out of phase with the burst) is fed to the primary of the Quadrature Transformer (T302). Approximately 30% of the signal developed across the primary is then injected onto the suppressor grid (Pin 7) of the R-Y Demodulator (6AS6 or 6DB6). Also at this point a reference signal is fed through a 100 mmf. capacitor (C316) to the plate (Pin 7) and cathode (Pin 5) of the Phase Detector (6AL5).

The secondary of T302 is said to be in quadrature, as it is 90 degrees out of phase, with the primary and 180 degrees out of phase with the color Sync Burst. The signal developed across the secondary has the same amplitude as the signal at the tap on the primary and is fed to the suppressor grid (Pin 7) of the B-Y Demodulator (6AS6 or 6DB6).

The R-Y and B-Y Demodulators are of the synchronous type. That is, each will detect that portion of the color sub-carrier signal that is in the proper phase with the local oscillator signal applied to the particular demodulator. The demodulator outputs will be the respective color difference signals.

Both demodulators have tuned video pass - band circuits to pass up to .5 MC and also 3.58 MC trap circuits to strip the sub-carrier from the color difference signals.

The positive R-Y and B-Y color difference signals will supply the red and blue signals of both the R-Y and B-Y are added together in the G-Y matrix (Fig. 11) to form the G-Y color difference signal. The G-Y tube ( $\frac{1}{2}$ 6BK7 "C") is used to obtain an 180 degree phase inversion for the purpose of applying the G-Y color difference signal in the proper phase or polarity to the grid of the Green Amplifier ( $\frac{1}{2}$ 6BK7 "C").

Again we find that proportions of signal are selected by resistive divider networks. The R-Y output is fed through a 10 mfd. capacitor (C334) to a 33K ohm resistor (R336) and a 10K ohm resistor (R400) to ground or 23% of the R-Y signal being applied to the red adder. The B-Y

output is fed through a 10 mfd. capacitor (C340) to R346 (15K), the Blue test point, and then through R423 (2.2K), the Blue Gain Control (R424), and R425 (2.7K) to ground, or 12% to 35% of the B-Y signal being applied to the blue adder. The G-Y output is fed through a 4 mfd. capacitor (C342) to R354, R443, R441, and R442. The proportions of G-Y signal applied to the Green adder are the same as the B-Y signals applied to the Blue Adder. The Blue Gain Control (R424), and the Green Gain Control are used for setting up monochrome balance, and the B-Y Gain Control (R340) will be set for a level at the Blue Test Point in respect to that of red. When a color bar is available, either from the transmitter or a shop type generator, a ratio of Blue at approximately 90%, Red at 70%, and Green at 40% of black level. With the B-Y signal removed, the G-Y Gain (R351) will control the level at the Green Test Point that portion of the R-Y signal that is used to form the G-Y signal. After setting R351, the B-Y signal is then applied and the G-Y Matrix Control (R348) will then be used to set the level for the portion of B-Y used to form the G-Y color difference signal.

#### High Voltage, Deflection, and Power (Fig. 12)

The horizontal output transformer (T800) supplies four pulse sources, Chroma Amplifier cut-off, Burst Amplifier key-on, Color Killer to bias off Chroma Amplifier during absence of burst, and conventional AGC.

Focus voltage of 2500V to 3500V is also supplied by the horizontal output transformer (T800). A 1AX2 tube is used to rectify the voltage.

20KV of regulated high voltage is supplied by the high voltage section. Three 3A3's are employed, one as a rectifier, the second as a diode coupler, this is used instead of resistors, as in the conventional doubler circuits, due to the voltage regulator feature which requires a higher value of current. The third 3A3 is the doubler which rectifies the combined voltage of the first rectifier plus the charge of C813. This rectified voltage will double the peak output of the transformer T800. A large capacitor, four times the capacity of the conventional high voltage supply, C814 at 2000 mmf, is used on the output high voltage. The much larger current demand is due to the regulator tube (6BD4) and the three guns of the



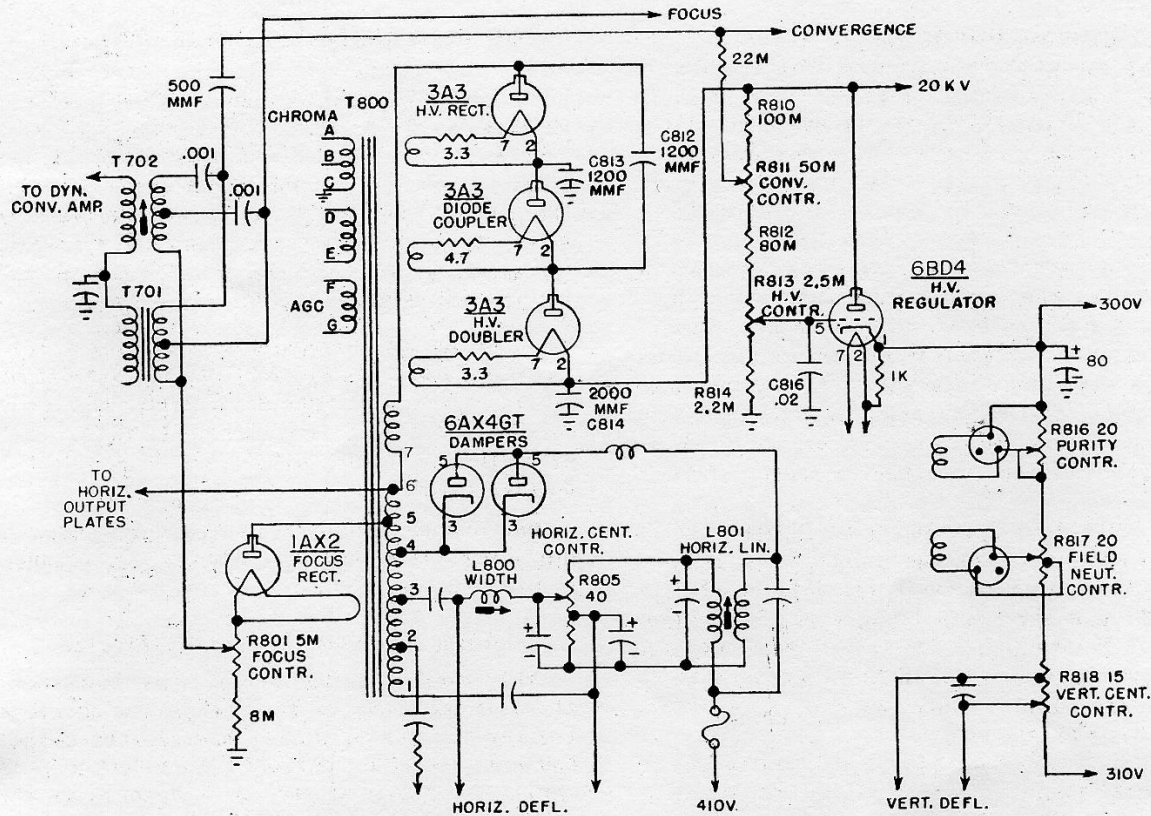


Fig. 12.

CRT. Regulation is required as all three guns of the CRT can be off and on again at full brilliance causing a wide fluctuation of current. Without regulation, there would be a wide fluctuation of high voltage affecting the focus and convergence of the picture tube.

A convergence voltage of 7500V to 12,000V is needed on the convergence electrode of the picture tube. This voltage is taken from a portion of the 20KV Hi-Voltage through a Dropping Resistor (R810) and the Convergence Control (R811).

The plate of the Voltage Regulator (6BD4) is at high voltage potential and the grid is controlled by voltage taken off from control R813, which functions to change the conduction of the 6BD4. As the plate voltage rises the grid also goes more positive and the 6BD4 draws more current, loading down the Hi-Voltage supply. As the plate voltage drops, the grid voltage also drops, and the .02 mfd. capacitor (C815) tends to slow down the change on the grid and prevent overcontrol or a see-sawing effect.

Two damper tubes (6AX4GT) are used, again due to the higher currents handled and dissipated in the horizontal transformer and output.

Electrical centering is used for both vertical and horizontal. This is necessary as the picture tube has three guns and the use of centering magnets would not satisfy all three guns. In varying the Vertical Centering Control (R818) the polarity of the DC voltage applied to the vertical portion of the yoke cannot only be reversed but reduce to zero value as well.

Horizontal centering also uses a control (R805), which is zero DC at center and will reverse the polarity when varied from one end to the other. In order to use this method, the Horizontal Linearity Control (L801) had to be the transformer type of tuned circuit for changing the waveform and affecting the linearity of the horizontal sweep.

The deflection yoke is more elaborate, and

greater care has been taken in its design. The ends of the windings have been placed at a 90 degree angle with the deflection portion to prevent a non-uniform deflection to the three electron beams, as all three beams have to be deflected the same and in direct respect to one another.

The Purity Coil (L802), which is located on the neck of the picture tube at a location to affect the three beams. It acts much in the same manner as the electromagnetic focus coil did, except it squeezes and positions the three beams for a proper centering in their approach to the deflection yoke. The amount of DC is controlled by the Color Purity Control (R816).

The Field Neutralizing Coil located around the front portion of the picture tube acts to set up a uniform magnetic field to counteract outside magnetic effects on various portions around the face of the tube. That is, the electron beams can be caused to change their respective deflections and strike the wrong phosphors by these outside influences. The effect is color contamination in these areas. The Field Neutralizing Control (R817) controls the polarity and the amount of current in the neutralizing coil.

### Power Supply Chassis (Fig. 14)

Several filament voltages are supplied. A 12.75 Volt, 12 Amperes center-tapped winding supplies four filament strings at 6.3 Volts each. A 6.3 Volt, 1.8 ampere winding supplies the picture tube which has three filaments in parallel, one for each gun. Another 6.3 Volt, 1.2 ampere winding supplies the filament voltage for the 6BD4 High Voltage Regulator tube.

There are two B+supplies, one using a 5U4G rectifier supplying 410 Volts to the Red Output Amplifier, Picture Tube Screens, Dynamic Convergence Amplifier, one half of the Vertical Multivibrator, and one half of the Horizontal Multivibrator.

The second B+supply at 310 Volts uses 2 5U4G's in parallel and supplies B+to the balance of the receiver.

### Sweep, AGC, and Convergence (Fig. 13)

This portion of the receiver is just about the same as found in Westinghouse monochrome television receivers with the exception that the horizontal output uses 2-6BG6G Tubes in parallel because of the power demands of the high voltage supply, which is mainly dissipated across the 6BD4 Regulator tube.

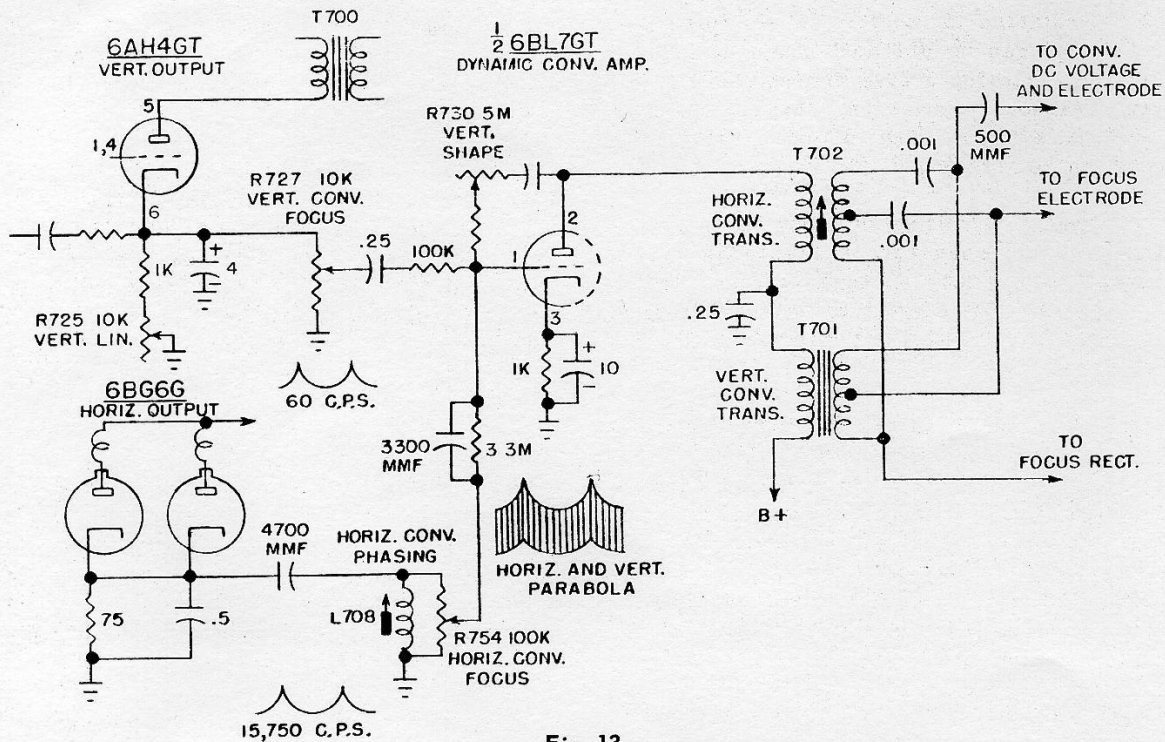


Fig. 13.



The Dynamic Convergence Amplifier ( $\frac{1}{2}$ 6BL7GT) is supplied both horizontal and vertical voltages from the cathodes of each output. These are in the form of parabolas and are used to change the convergence and focus. The parabolas are phased and shaped, then amplified and superimposed upon the DC convergence and DC focus voltages. These voltages are changing proportionately with the deflection from the center of the tube. The vertical is at 60CPS and the horizontal at 15,750 CPS. As two frequencies are used, two output transformers are used in the Dynamic Convergence output circuit, T702,

the horizontal and T701, the vertical. Both are AC coupled through capacitors to the DC convergence voltages. The Vertical Convergence-Focus control (R727) controls the amplitude of the vertical, with the Vertical Shaping Control (R730) proportioning the amount of feedback out of phase to shape the vertical parabola. The horizontal Convergence-Phase Control (L708) is used to select and control the phase of the horizontal parabola, and the Horizontal Convergence-Focus Control (R754) controls the amplitude. These are service controls and normally are not to be touched by the customer.

## TEST EQUIPMENT

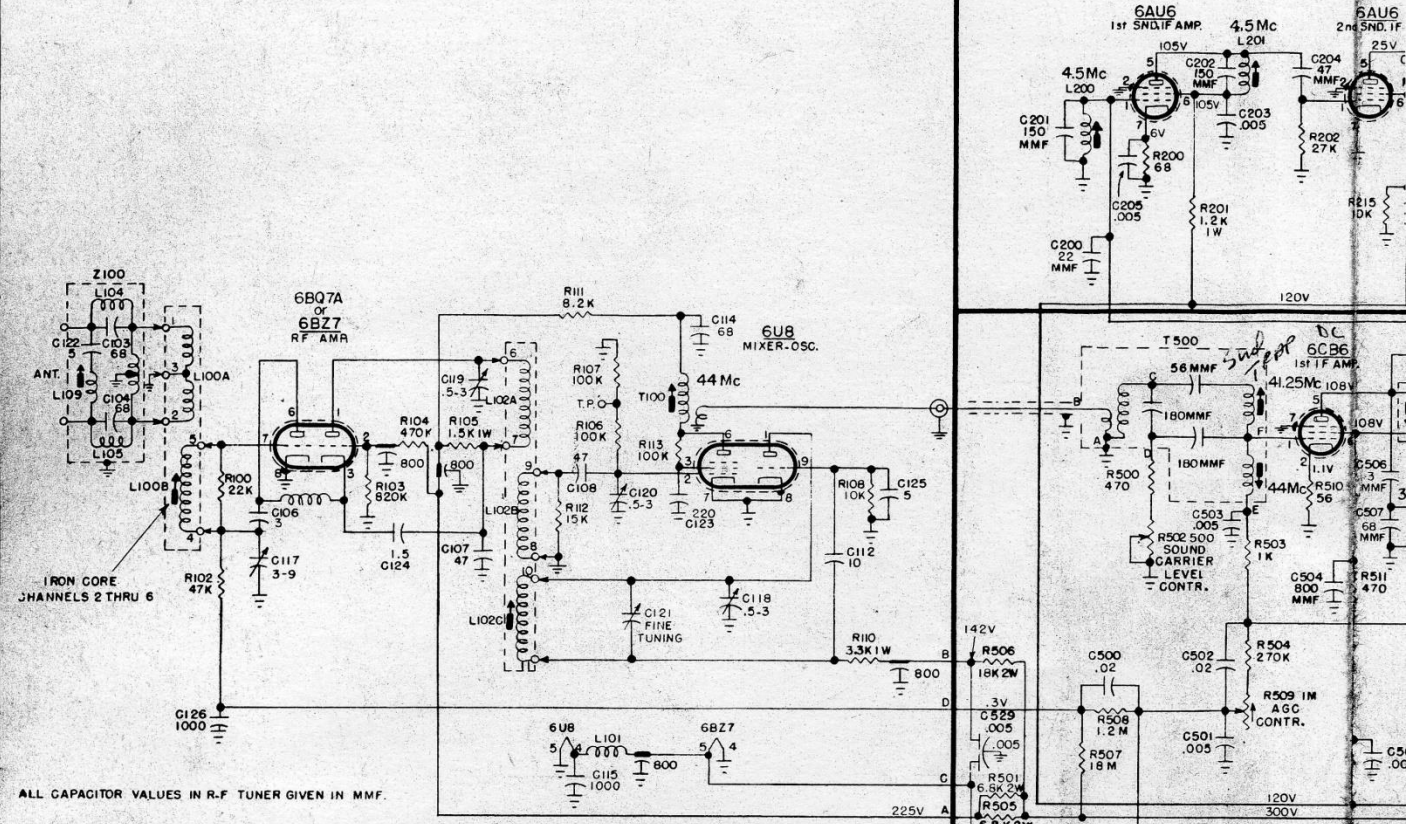
Additional test equipment will be required over the present equipment used for black and white servicing to adequately service color receivers.

Following is the list of additional equipment required.

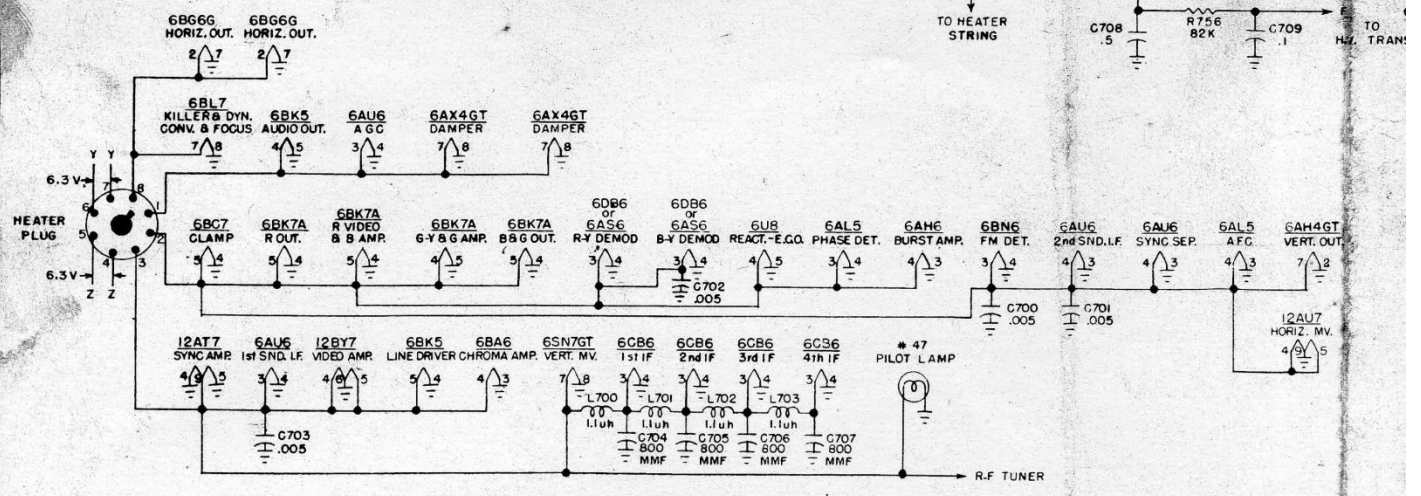
1. A Dot Generator to adjust overall convergence and for checking linearity, both vertical and horizontal. (Small dot type preferred).
2. Oscilloscope with a vertical response from 0 to 4.5 MC or 5 MC for checking burst signal and 3.58 MC oscillator circuits. (Can be advantageously used for B & W servicing).
3. High Impedance Probe for Oscilloscope, enabling check of signal circuits without causing distortion and detuning. (For B & W servicing also).
4. Diode (detector type) Probe for signal rectification. To check signal envelopes of bandpass circuits and for signal tracing. (For B & W servicing also).
5. Video Sweep Generator with sweep of 0-5 MC and suitable precision markers for bandpass alignment and checking of response curves.
6. 3.58 MC Signal Generator - Crystal controlled for adjustment of local oscillator, quadrature transformer, burst coil and phase detector balance.
7. A Crystal Modulator to check overall response from antenna terminals to video detector and to color signal demodulators. Also can be used for checking UHF by modulating video signals onto UHF signal generator.
8. Color Bar Generator for color display on picture tube, a color signal substitution for circuit check, adjustment of Phase, Gains, and Matrixing. This unit has to have NTSC standard of phase, displacement and amplitudes, and should incorporate the correct luminance or monochrome information.



SECTION I R-F



ALL CAPACITOR VALUES IN R-F TUNER GIVEN IN MMF.

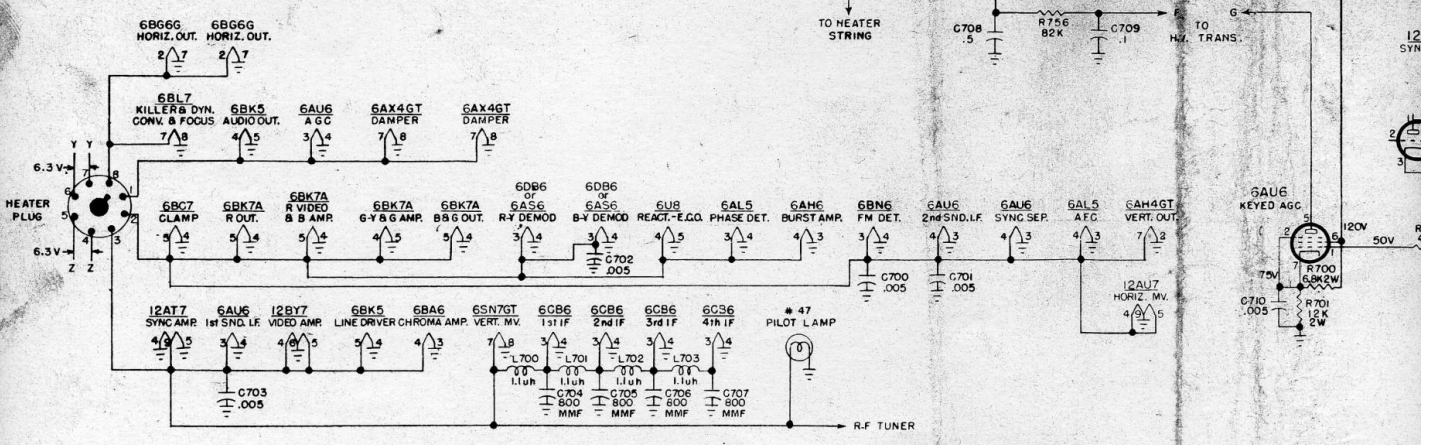
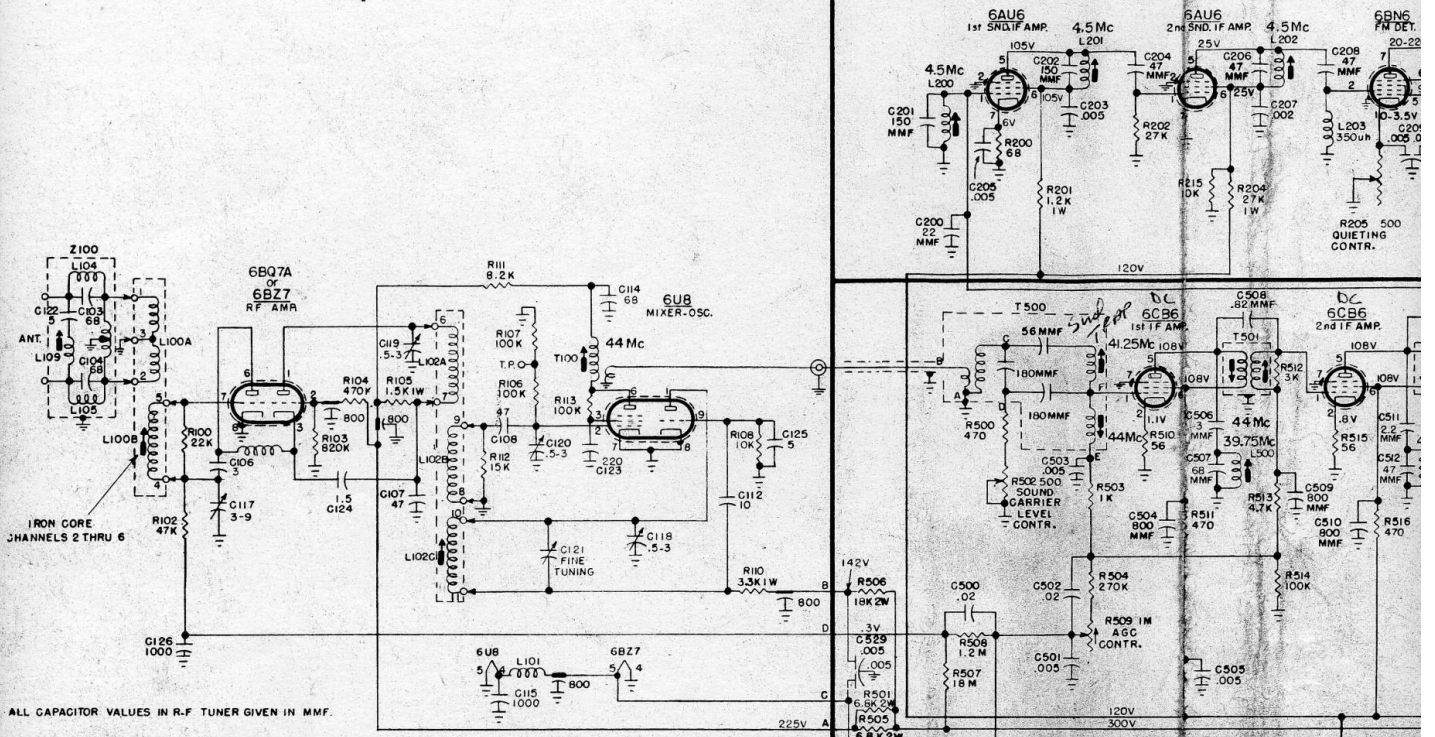


NOTES:

1. PEAK-TO-PEAK WAVEFORMS WERE TAKEN WITH A SIGNAL OF 1.8V.P.P. AT THE VIDEO TEST POINT. ALL OTHER CONTROLS SET FOR NORMAL PICTURE.
2. PARTS TOLERANCE AND RESPONSE OF TEST EQUIPMENT MAY CAUSE SOME VARIATIONS OF THE PEAK-TO-PEAK VOLTAGE READINGS.
3. D-C VOLTAGES MEASURED FROM CHASSIS GROUND USING A 20,000 OHM / VOLT METER AND NO SIGNAL INPUT. READINGS SHOULD BE AS SHOWN ± 20 PER CENT.
4. ALL CAPACITANCE VALUES IN MFD AND ALL RESISTANCE VALUES IN OHMS UNLESS OTHERWISE SPECIFIED.

SECTION 1 R-F

SECTION 2 S

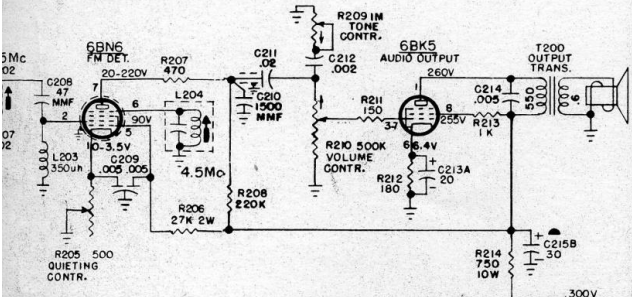


NOTES:

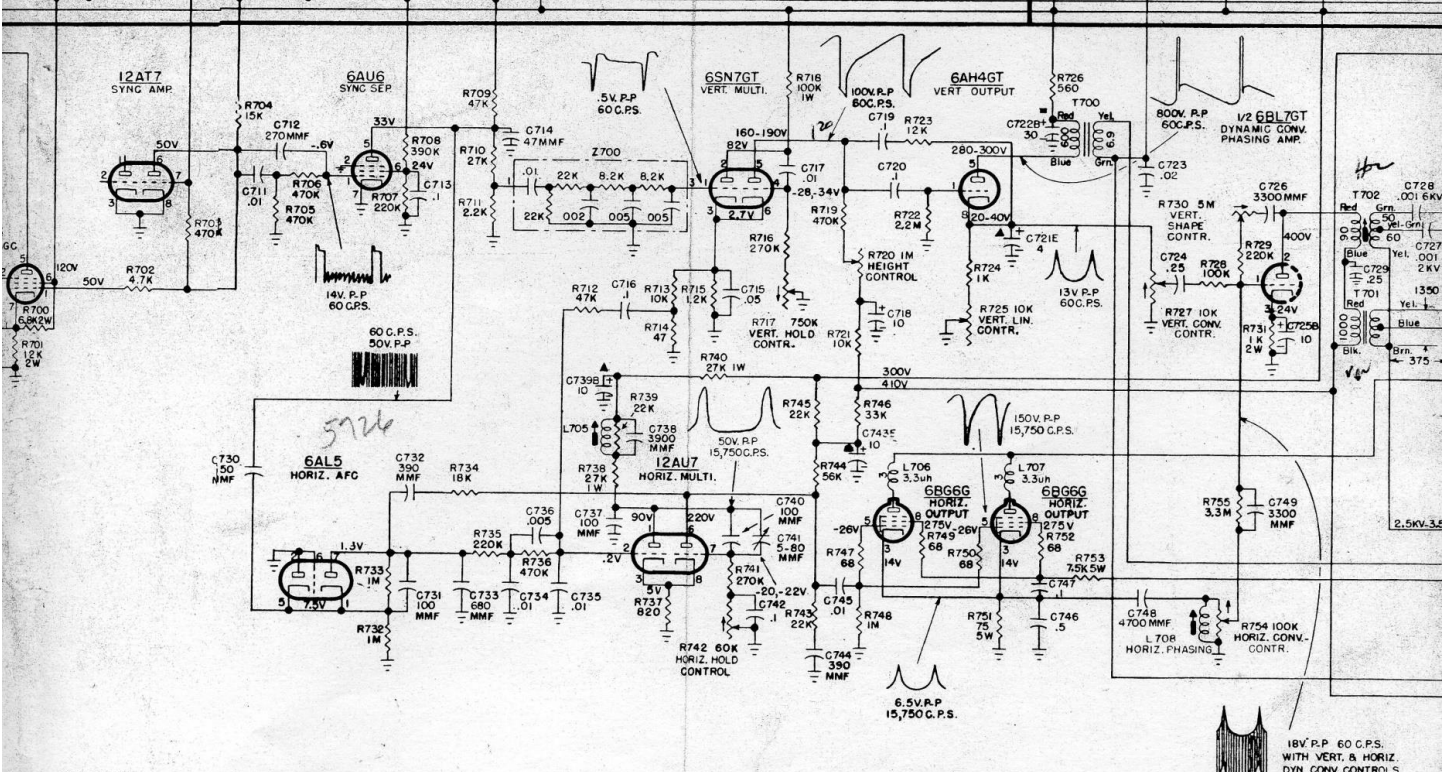
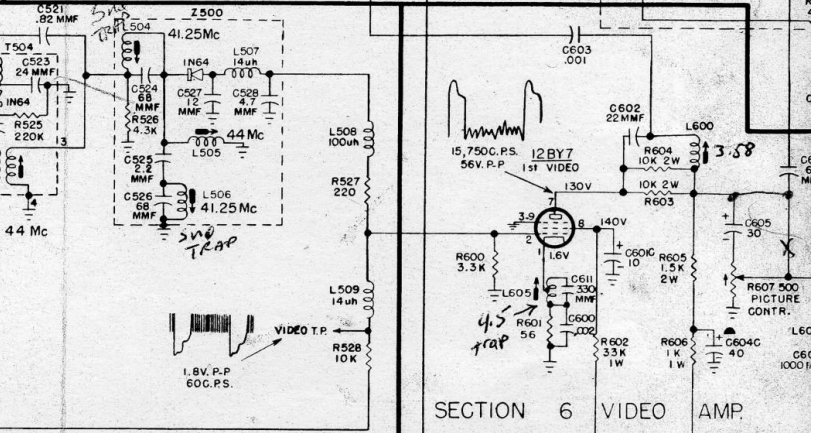
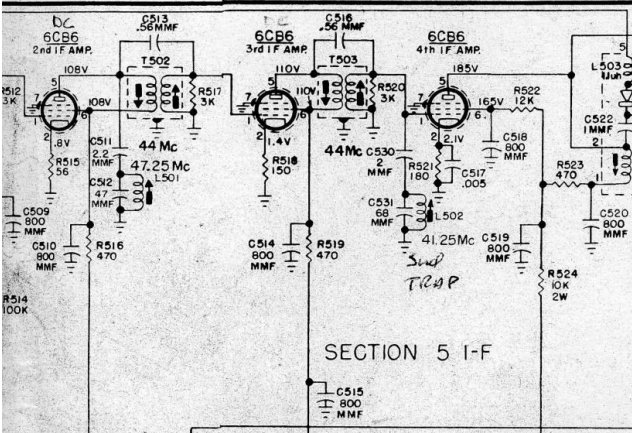
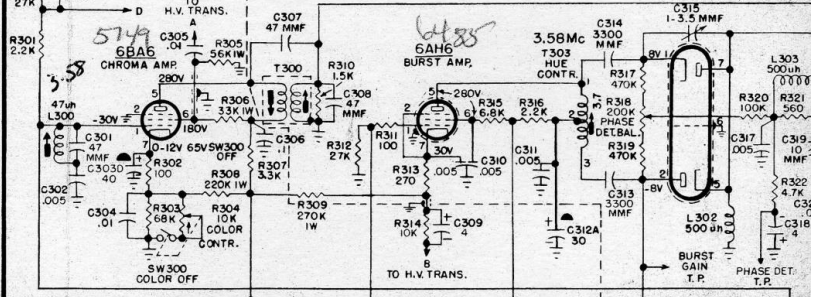
1. PEAK-TO-PEAK WAVEFORMS WERE TAKEN WITH A SIGNAL OF 1.0V P.P. AT THE VIDEO TEST POINT. ALL OTHER CONTROLS SET FOR NORMAL PICTURE.
2. PARTS TOLERANCE AND RESPONSE OF TEST EQUIPMENT MAY CAUSE SOME VARIATIONS OF THE PEAK-TO-PEAK VOLTAGE READINGS.
3. D-C VOLTAGES MEASURED FROM CHASSIS GROUND USING A 20,000 OHM / VOLT METER AND NO SIGNAL INPUT. READINGS SHOULD BE AS SHOWN ± 20 PER CENT.
4. ALL CAPACITANCE VALUES IN MFD AND ALL RESISTANCE VALUES IN OHMS UNLESS OTHERWISE SPECIFIED.



SECTION 2 SOUND



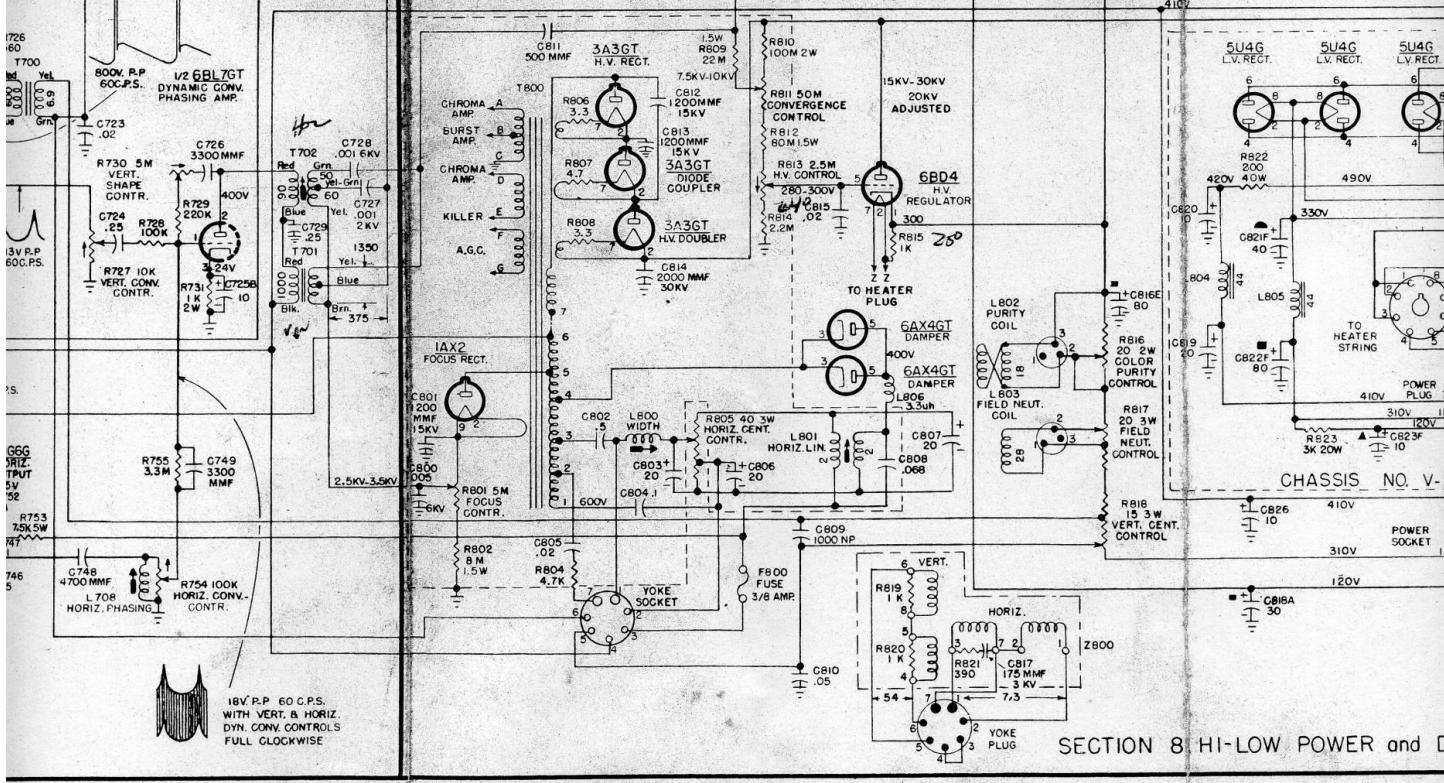
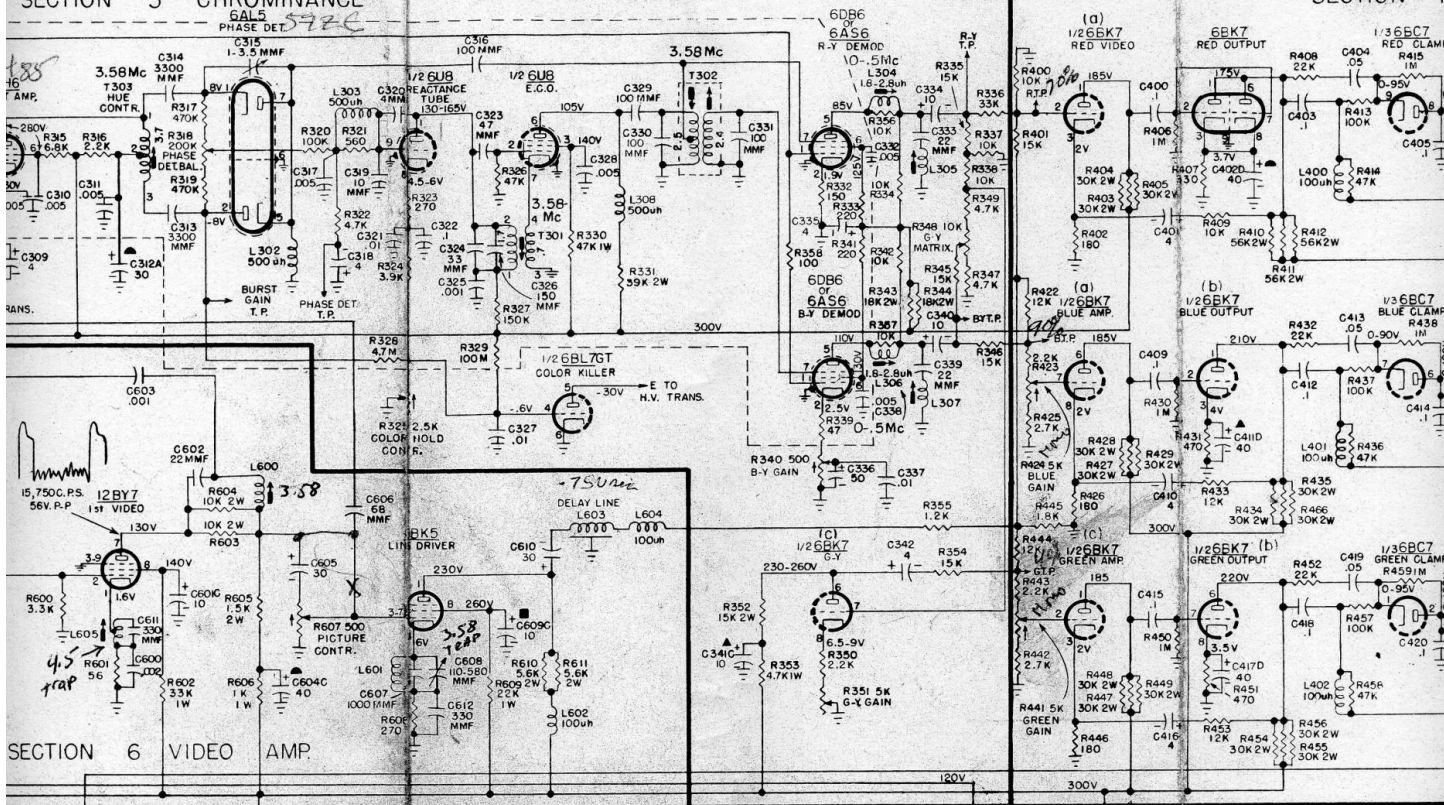
SECTION 3 CHROMINANCE



7 SWEEP and HEATERS

SECTION 3 CHROMINANCE

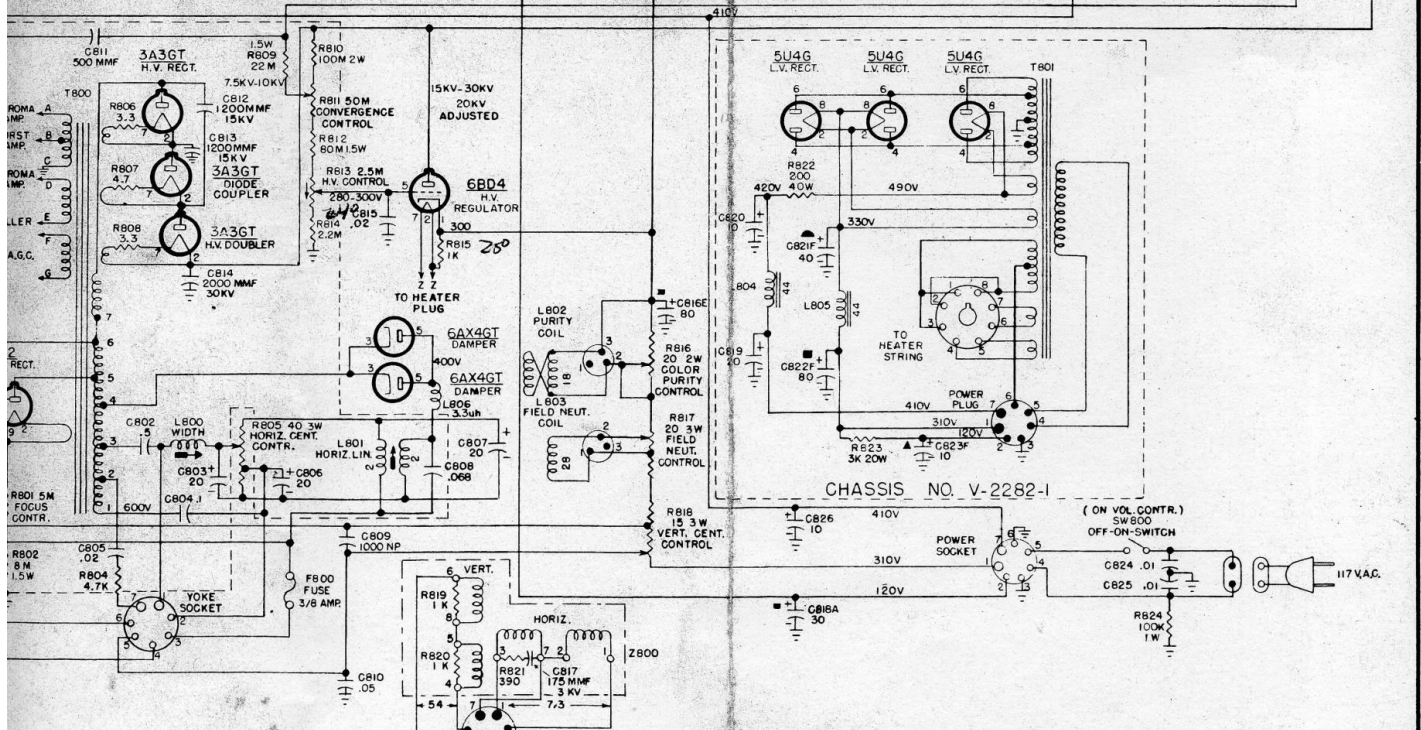
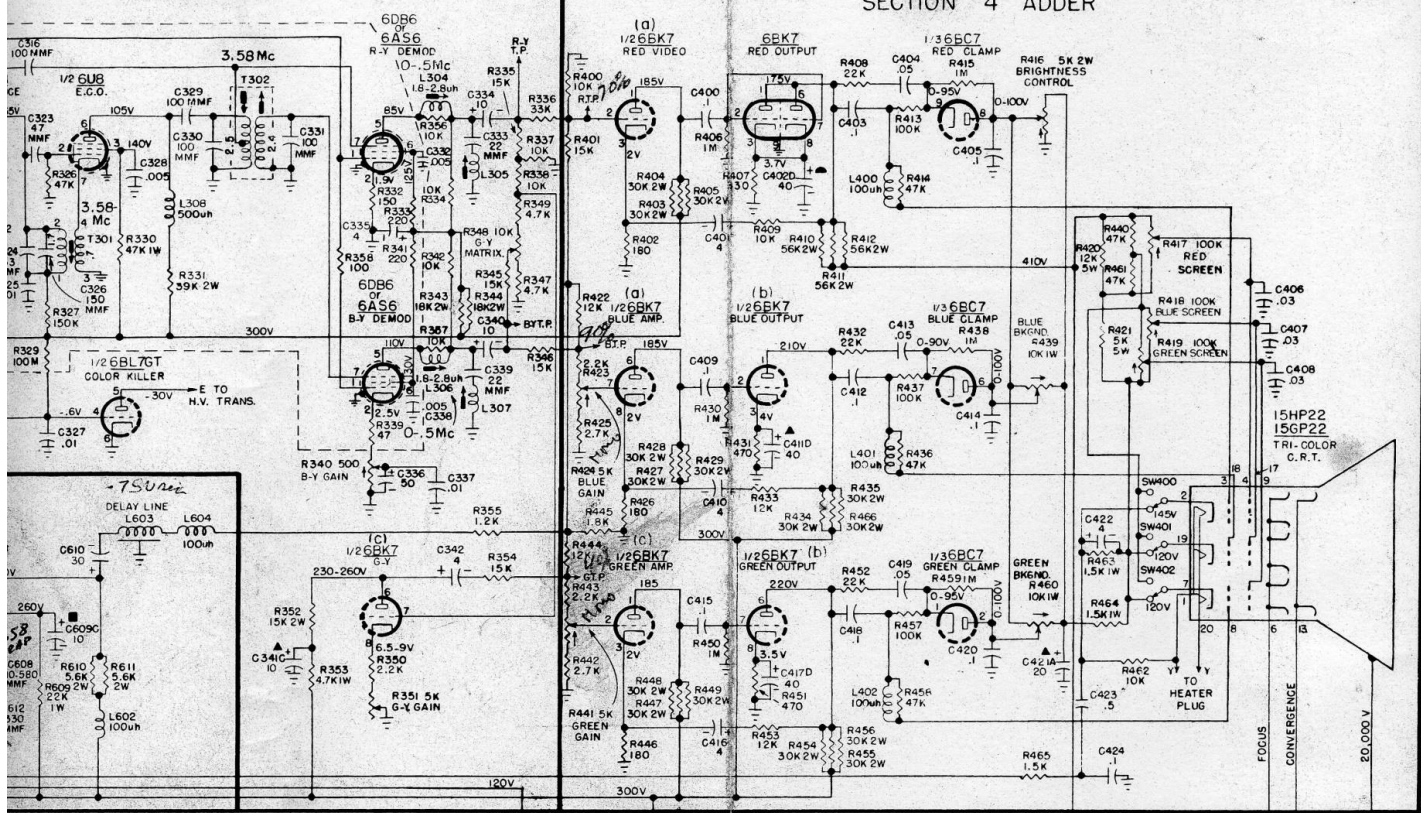
SECTION 4



18V P.P. 60C.P.S. WITH VERT. & HORIZ. DYN. CONV. CONTR. FULL CLOCKWISE



SECTION 4 ADDER



SECTION 8 HI-LOW POWER and DEFLECTION

1954  
Model #

840CK15

Serial -- 05380

STEREO-VISION

