

RCA VICTOR

TELEVISION SERVICE CLINIC

PRINCIPLES OF COLOR TELEVISION  
and  
TECHNICAL FEATURES OF THE RCA VICTOR  
MODEL CT-100  
COLOR TELEVISION RECEIVER

PREPARED BY THE COMMERCIAL SERVICE SECTION  
RCA SERVICE COMPANY, INC., CAMDEN, N. J.

*A Service of Radio Corporation of America*

## FOREWORD

*The purpose of this booklet is to acquaint the television service technician with the principles of color, the methods used to apply these principles to color television, and developments in receiver circuitry to enable reproduction of color television pictures.*

*The text discusses the operation of the circuits used in the RCA Victor Model CT-100 color television receiver, explains the reasons for these circuits, and includes practical service information for the technician. It is written in the interest of bringing this information to RCA Victor Distributors, Dealers and Independent Service Organizations.*

THE TEXT OF THIS BOOKLET IS DESIGNED FOR PRESENTATION IN LECTURE FORM AT CLINIC MEETINGS SPONSORED BY THE HOME INSTRUMENT DEPARTMENT OF THE RCA VICTOR DIVISION AND THEIR RCA VICTOR DISTRIBUTORS. THE SERVICING ORGANIZATIONS, HOWEVER, ARE NOT DESIGNATED AS AUTHORIZED TO RENDER TELEVISION SERVICE TO RCA VICTOR TELEVISION RECEIVERS BY MERE ATTENDANCE AT THE CLINIC MEETINGS.

## INTRODUCTION

The RCA Victor Television Service Clinic is a means by which all servicemen can keep abreast of the ever increasing field of television servicing.

The success of our Clinic Program is attributed to the meeting of a demand for comprehensive coverage of television service and installation practices. This demand has been met through the presentation of a series of Service Clinic Lectures, beginning with basic television principles and progressing through UHF television.

Included in the lecture series is service and technical information on RCA Victor television chassis, and up-to-date descriptions of the latest developments in VHF, UHF and color television.

Following is a list of the lectures in the Television Service Clinic Series:

The lectures numbered 1 through 9 have been compiled to form Television Clinic Lectures—Volume I.

- No. 1: *Basic Circuit Description of an RCA Victor Television Receiver.*
- No. 2: *Servicing the RCA Victor Television Receiver—The R-F Unit, Picture I-F and Sound Channel.*
- No. 3: *Servicing the RCA Victor Television Receiver—The Video and Sync Circuits.*
- No. 4: *Servicing the RCA Victor Television Receiver—Deflection Circuits and Power Supplies.*
- No. 5: *Servicing the RCA Victor Television Receiver—Troubles Other Than Component Failures.*
- No. 6: *Practical Antenna and Transmission Line Considerations and RCA Victor Television Receiver Installation Techniques.*
- No. 7: *Technical Features of the New RCA Victor "Million Proof" Television Chassis.*
- No. 8: *Technical Features of the RCA Victor KCS66-68 Inter-carrier-Sound Television Chassis.*
- No. 9: *Introduction to UHF Television.*

The lectures listed below are printed in individual booklet form.

No. 10: *Technical Features and Simplified Alignment of the RCA Victor KCS72-72A Television Chassis.*

No. 11: *Technical Aspects of RCA Victor UHF Receiving Equipment.*

The Volume and current Clinic Lectures are available, at a nominal charge, from the RCA Service Company, Inc., Commercial Service Section, Camden, N. J.

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First Edition—Third Printing  
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# PRINCIPLES OF COLOR TELEVISION

## INTRODUCTION

Many methods of adding color to television have been proposed and some of these have been put into operation. Until the advent of the RCA Color Television System, however, no system had successfully met the criteria deemed necessary to protect the public's investment in black-and-white television receivers while simultaneously providing a color television service.

Outstanding among the criteria is compatibility. Compatibility means that color television programs can be seen in black-and-white on all existing television receivers without any changes or added devices. It means that color television receivers can show black-and-white pictures, also without any changes or additions. When a color television program is being telecast the color television receiver automatically shows a color picture and the black-and-white receiver shows the color picture in black-and-white.

In order to meet the compatibility requirement, horizontal and vertical synchronizing frequencies, the 6 megacycle channel bandwidth, negative modulation and vestigial sideband transmission must remain essentially the same as used for black-and-white picture transmission.

Some other requirements which must also be considered are: that the receiving system must produce a color picture having high quality color fidelity, adequate definition, good picture texture, and sufficient brightness to enable viewing under normal television viewing conditions.

Further considerations are, that the receiving system should have freedom from unduly prominent picture structure; freedom from mis-registration of colors; and freedom from abnormal susceptibility to interferences.

The RCA Victor Model CT-100 Color Television Receiver described in this lecture fully meets these requirements.

The expansion of color television broadcasting creates the need for service technicians qualified to service properly the receivers being produced. Color television receivers, though similar in many respects to the familiar black-and-white receivers, require additional circuits to process the information needed to reproduce pictures in color.

Before attempting to become familiar with the additional circuits, the basic principles used in color television should first be considered. A study of color television principles will necessarily include principles which are also used in black-and-white television. A brief review of the operation of a television system follows.

## Operating Principles of a Television System

In a television system, the scene to be transmitted is separated into many thousands of tiny elements in the television camera by electronically scanning a image of the scene. See figure 1. Each picture element is converted into a voltage representing the shading value of that element. For a dark area of the image the element voltage is high and for a light area the element voltage is low.

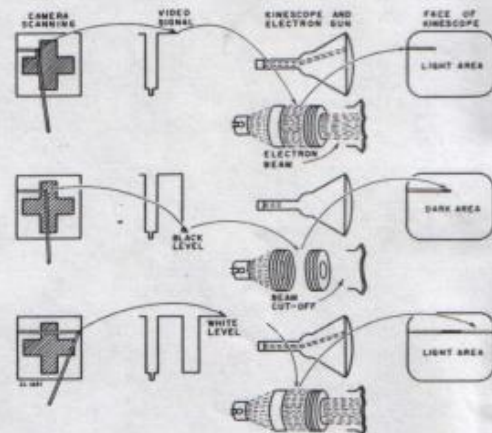


Fig. 1—Operating Principles of a Television System

The picture information, in the form of a varying voltage, appears at the grid (or cathode) of the kinescope. When the voltage at the grid (assuming the video signal is applied to the grid) of the kinescope varies toward the positive direction (low "minus" voltage) a high beam current results, and a white element appears on the kinescope screen.

When the video voltage at the kinescope grid goes in the negative direction (high "minus" voltage) the beam current is decreased. When the voltage at the kinescope grid goes negative beyond a predetermined level (tube "cut-off"), the beam current is cut off entirely and nothing, or a black element, appears on the screen. The shading, movement and detail appearing on the face of the kinescope is the reconstructed picture, with the picture elements varying between maximum brightness and no brightness, in synchronization with the image being scanned in the television camera.

The black-and-white television receiver then, reproduces a picture in terms of only *brightness* value for any portion of the picture.

white, result. The white is a result of the eye's lack of selectivity, that is, the inability to discern individually the three primary hues when they are present in combination. The yellow hue results from the mixture of red and green, because the eye tends to average the stimulation from both the red and green wavelengths and the brain perceives a sensation of a hue called "yellow."

When green and blue are mixed, a blue-green hue, called "cyan" results. Emitted light of the red, green, and blue hues, are called "additive primary colors," since when added together they produce white light.

The magenta, yellow and cyan resultants of the additive system are complementary hues commonly called red, yellow and blue.

When filters having these hues are placed over a light source they remove, or subtract, all but their component hues. For instance, a piece of yellow glass placed over a white light source will pass only yellow light, which is a mixture of the red and green components of the white light. If the visible spectrum were observed through the yellow glass, only the red and green hues would be observed and the blue portion of the spectrum would appear as a black, or colorless band.

Another instance occurs in the color printing process, where colored inks applied to white paper permit only their own hues to reflect from the paper. Magenta, yellow and cyan (sometimes called red, yellow and blue) are known as the subtractive, or "printer's" primaries. These hues are of concern only when desiring to filter or reflect light and will not be considered further in this discussion. Since present methods of reproducing a colored television picture depend upon colored light sources to produce the sensation of various hues, only the additive primaries red, green and blue will be considered.

#### Color Matching and Visual Acuity

The poor selectivity of the eye in determining hue can be used advantageously in color television by an experimentally determined fact that, as the size of an object decreases, the properties of color needed to match the color of the object are less demanding. This means that as the size of the object decreases, fewer colors are needed to match the color of the object observed.

As shown in figure 8 at the top, for relatively large color areas, three hues produce the sensations of red, green and blue. These three hues can be mixed to provide a match for almost any hue as has already been stated.

In the center of the illustration, although the same three hues are present, only a blue-green and an orange-red hue can be perceived. The color areas, although having the same hues as the top figure, are smaller.

From this, then, it can be observed that as an object decreases in size only *two* hues, orange-red and blue-

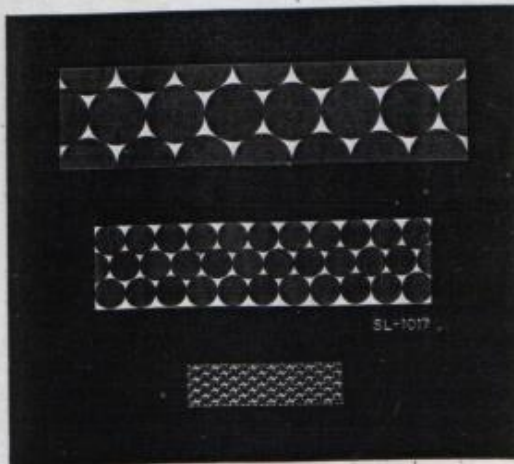


Fig. 8—Color Matching and Visual Acuity

green, are needed to create the necessary color sensation for the eye. In the lower illustration the same hues are again present but (by squinting your eyes) all color sensation disappears and only greyish-white remains. Greyish-white, (remembering the scale in figure 3) is a sensation of brightness only. Thus, for very small objects, no hue at all is required. *Brightness only*, is perceptible for objects which have very fine detail.

#### REPRODUCING PICTURES IN COLOR

Presentation of the attributes of color, (combinations of brightness, hue and saturation) on the face of a picture tube then, will enable the reproduction of a picture in full color. Since *any* normal kinescope is capable of reproducing variations in *brightness only*, some of the facts mentioned previously must be brought to mind. As shown in figure 9(a) when lights of red, green and blue hues are presented simultaneously, and in the proper proportions (30% R, 59% G, 11% B), a sensation of brightness (or white) can be created. This, of course, is for very small areas of color. If one of the three hues is removed, a sensation of the mixture of the remaining two will result (i. e. remove the blue light; red and green will remain and produce a sensation of yellow). See figure 9(b). By varying the brightness of one of the remaining lights when blue light is removed, the sensation produced will be either reddish, or greenish, depending upon which of the remaining lights is varied. By varying the brightness of one, or all, of the three lights in combination then, hue (color) can be changed. It has been stated previously that the measure of saturation of a hue is its freedom from dilution with white. If the brightness of the red, green and blue lights were adjusted to produce the sensation of white, and in addition, the brightness of one, or two, of the hues is varied, in effect (since white is already present due to the three hues being in combination) the *saturation*

## CHARACTERISTICS OF COLOR

### The Visible Spectrum

All colors result from the perception of reflected or emitted light. One accepted explanation of light is that it occurs in the form of electromagnetic waves, similar to radio waves but very much shorter in wavelength. The wavelength of a very high frequency radio signal, for example, might be as short as 3 meters between wave crests. The wavelength of red light (the longest wavelength of light) is about 7 ten-millionths of one meter. The wavelength of the shortest light wave (deep purple) is about 4 ten-millionths of a meter. The term commonly used to measure these very short wavelengths is the millimicron. A millimicron is equal to one-billionth of one meter.

Figure 2 illustrates the location of the visible spectrum within the entire known electromagnetic radiation spectrum.

Because the human eye is peculiarly sensitive to radiation occurring at wavelengths between 400 and 700 millimicrons, that portion of the entire radiation spectrum becomes visible.

Light is visible because, when subjected to radiation occurring within this portion of the spectrum, the receptor sections of the eye are stimulated and produce conscious sensations in the brain. The sensations produced result in psychological reactions which can be defined as "vision."

### Attributes of Color

Figure 3 illustrates three properties that are attributes of color. These are "brightness," "hue" and "saturation." It can be seen that color appears to be three dimensional. "Brightness," also called "luminance," is a measure of the intensity of reflected or emitted light as compared with the brightness of a neutral, or gray scale ranging from black (absence of brightness) to white (maximum brightness). "Hue" is the property most commonly used to describe color.

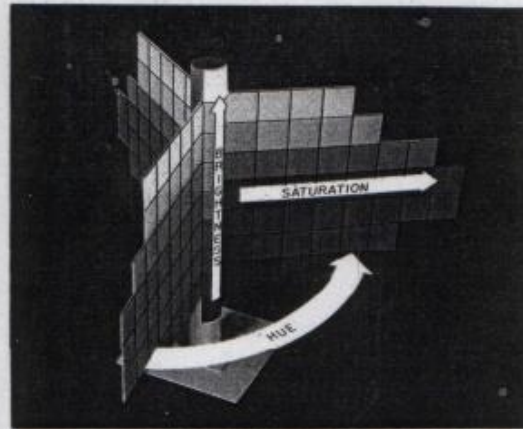


Fig. 3—Attributes of Color

It represents the distinction between red, green, blue, yellow, etc. The third property of color, "Saturation," is the distinguishing factor between strong and pale variations of the same hue. Saturation can be thought of as the "purity" of a hue, or its freedom from dilution with white. As a given hue becomes more and more diluted with white, it loses its vividness and becomes pale. For instance, pink could be considered as a red hue highly diluted with white. The term "Chroma" is often used to mean saturation. It has been stated that the eye is sensitive to radiation occurring between the wavelengths of 400 and 700 millimicrons. Although extremely sensitive for detection of light, the eye suffers from lack of selectivity, that is, it has no tuning mechanism.

When simultaneous radiation from all of the wavelengths between 400 to 700 millimicrons is presented to the eye in nearly equal quantities, the eye sees white. White results because the eye is unable to select individual hues from the light source. When one hue (or narrow band of wavelengths) dominates, or has greater amplitude than any of the other hues, the eye sees that color.

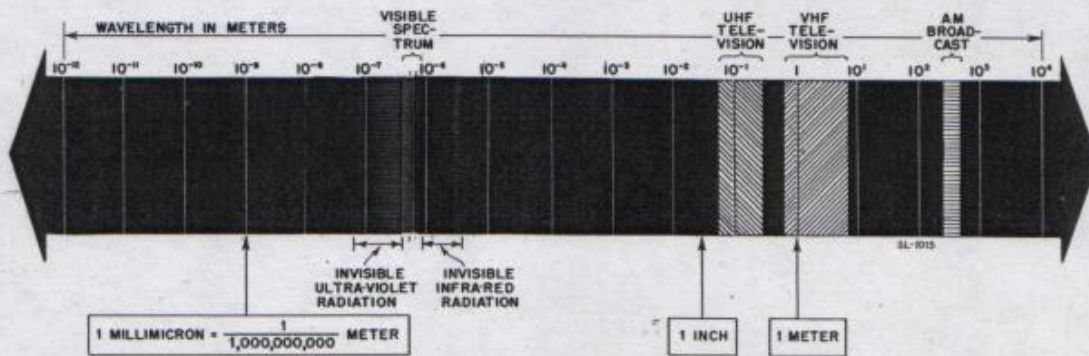


Fig. 2—The Electromagnetic Radiation Spectrum

### Primary Colors

Figure 4 shows that white light, when passed through a glass prism, can be separated into its component hues. This occurs because the speed of light through glass is much slower than through air, or space. As the white light, containing *all* hues, passes through the prism, the shorter wavelengths are slowed down, or bent, more than the longer wavelengths and thus leave the opposite face of the prism at a point displaced from the point of entry by the relation of deceleration caused by the thickness and transmission index of the glass.

If a card is placed opposite an exit face of the prism, a rainbow effect called a "spectrum" appears on the card. It can be seen that the short wavelengths (blue) appear at one end, and the long wavelengths (red) appear at the other end of the spectrum.

The component hues in the white light are now visible because each color area on the card is illuminated by light of only one hue and the eye sees from that area, reflected light of only the illuminating hue.

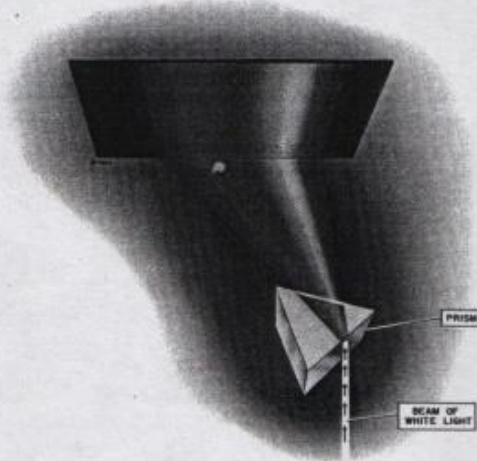


Fig. 4—Separating White Light into Component Hues

### Color Mixing

Further experiment has shown that white light can be produced by mixing colored lights of the red, green and blue hues (see figure 5) when the red, green and blue hues are of specified wavelengths. The white light (100% brightness) will consist of 59% green light, 30% red light, and 11% blue light.

Light from the three specified hues, red, green and blue, when individually varied in brightness can be mixed to produce a sensation of almost any hue and saturation of that hue. As an example, if the red light were mixed with the blue light, an in-between sensation would result. This would be a new hue called "magenta". See figure 6. When the three lights are added together in an overlapping fashion, as in figure 7, six hues, plus

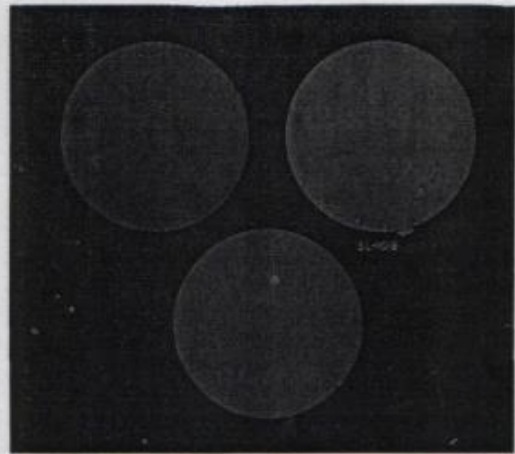


Fig. 5—The Primary Hues, Red, Green and Blue

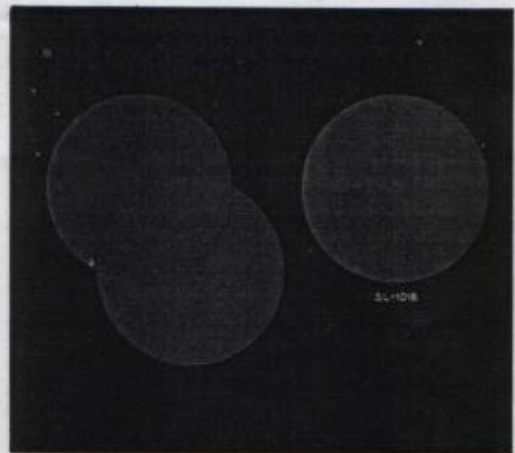


Fig. 6—Magenta Resultant of Mixing Red and Blue Lights of Specified Wave Lengths.

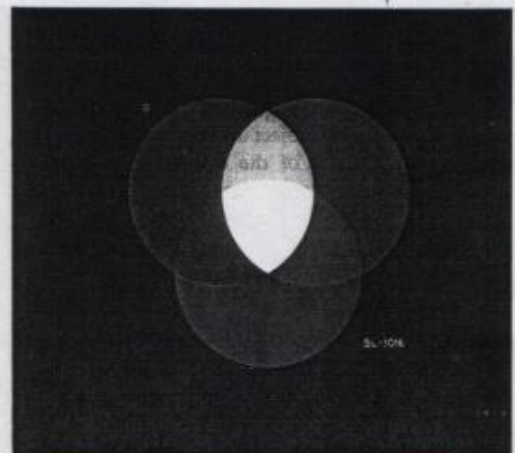


Fig. 7—Resultant Mixtures of Red, Green and Blue Lights



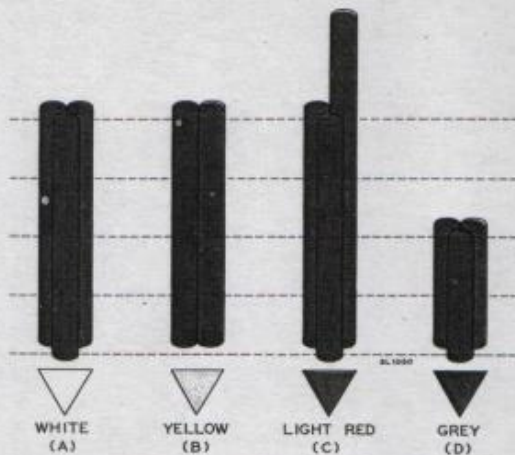


Fig. 9—Changes in Brightness, Hue and Saturation

of the hue being varied will change. This is shown in figure 9(c). Also, if the three colored lights are adjusted to produce white, and their brightnesses are varied *simultaneously, in the same direction*, an increase (or decrease) in the overall brightness will result. See figure 9(d). The above statements reveal then, that by varying *only the brightness* of three simultaneously presented colored lights, varying degrees of brightness, hue and saturation can be produced.

The black-and-white picture tube reproduces a picture in terms of brightness only, regardless of the color of light emitted by the phosphor. For instance, a kinescope could be made to reproduce a picture in black-and-red, or black-and-green. The light from the phosphor indicates only the brightness for any portion of the picture.

Since it has been shown that brightness variations in the three specified hues can, in effect, reproduce brightness, hue and saturation changes (when the three hues are varied simultaneously in brightness only) and since the black and white type kinescope reproduces brightness changes in *one hue* only, a device for reproducing brightness changes in three hues simultaneously is required. The RCA tricolor kinescope is such a device.

### THE TRICOLOR KINESCOPE

The type 15GP22 tricolor kinescope is a directly-viewed picture tube which can reproduce a picture either in color, or in black-and-white. See figure 10.

Enclosed within the glass tube envelope, at the viewing end of the tube, is an assembly consisting of an aperture mask, a viewing screen, and a decorative mask. The viewing screen has, deposited on its rear surface, an orderly arrangement of very small, closely spaced phosphor "dots." These dots are arranged in groups of three, or "trios," which consist of a green



Fig. 10—RCA 15GP22 Tricolor Kinescope

light-emitting dot, a red light-emitting dot and a blue light-emitting dot. Three electron guns are mounted within the base-end of the tube, spaced  $120^\circ$  apart with respect to each other and having their axial centers parallel with the central axis of the tube.

The tube is designed so that, when operating properly, each color phosphor will emit light only when excited by the beam from its respective electron gun. Thus, if signals representing each of the three hues (red, green and blue) are presented simultaneously at the grids of their respective electron guns, the brightness variations from each set of phosphor dots can result in representations of changes in brightness, hue and saturation in the reproduced picture. A cross-section of the tricolor kinescope is shown in figure 11.

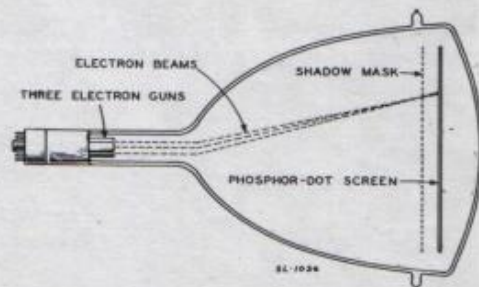


Fig. 11—Cut-away Drawing—Tricolor Kinescope

The phosphor dot plate (the viewing screen) has approximately 195,000 dot trios, or 585,000 separate dots. Having so great a number of dots over the viewing area of approximately 90 square inches means that each dot is extremely small and therefore impossible to resolve from a normal viewing distance due to the limited acuity of the eye. The inability of the eye to resolve the separate color dots results in the perception

of the additive mixture of the colors of the individual dots. As explained previously, if a single green dot emitted green light and an adjacent red dot emitted red light of proportional intensity, a sensation of yellow would be perceived. If all three dots in a trio were excited in the proper proportions, a sensation of white, or brightness only, would be perceived.

Positioned directly behind the phosphor dot viewing screen is the aperture, or shadow mask. This consists of a metal plate having small holes equal in number to and centered with respect to the phosphor dot trios. The mask provides separation of colors by shadowing two of the three dots in the trios from two of the electron beams while permitting the third dot to be excited.

With this type kinescope three separate electron guns are used to cause three different phosphors to emit light of three different colors. By varying the brightness output of each phosphor, as has been shown, a full-color picture can be reproduced.

### COLOR IN THE TELEVISION SYSTEM

It is an established fact that color television signal standards are compatible with black-and-white signal standards. Therefore black-and-white transmissions, with video and all the necessary blanking and synchronizing components, will be reproduced with comparable quality in black-and-white, on both the black-and-white and color television receivers.

In color transmission, color information is added to the transmitted signal within the standard 6 mc. bandwidth. This information permits color television receivers to reproduce a scene in color and, at the same time, the black-and-white television receivers will respond to the same signal, without objectionable effect on the picture quality. The sound transmission remains the same in both system so it will not be discussed in detail at this time.

The following discussion is based on a comparison between the two systems, therefore it is desirable to discuss briefly the black-and-white system in an elementary form before progressing into the color television system.

The camera, represented in figure 12, is pointed in the direction of an object (which can be in black-and-white, or color) so that the light reflected from the object is focussed on the sensitized plate of the camera tube, forming an image which is scanned and con-

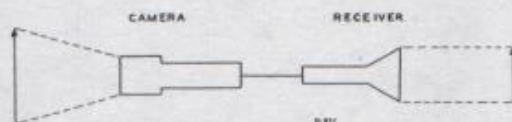


Fig. 12—An Elementary Television System

verted into electrical impulses. This video information together with blanking and synchronizing pulses is transmitted, over wires, to a kinescope where the electrical impulses are reconverted into an image that is displayed in black-and-white on the face of the kinescope.

It has been stated previously that the three primary colors, red, green and blue, mixed together in various proportions produce virtually all the variations of color, so for this and more involved technical reasons these three primary colors have been established for the color television system.

Before attempting to explain what constitutes the color signal let us briefly review some basic factors involved in producing the color signal.

Since certain shades of various colors reflect the same quantity of light as certain degrees of whiteness (greys), it is obvious that a *single* camera tube which depends upon variations of reflected light for its operation, will not be able to distinguish between various colors. Therefore, the single camera tube used separately without some color separating device is suitable only as a pick-up device for a black-and-white television system.

### The Color Television Camera

Figure 13 shows three camera tubes, together with filters that render them individually sensitive to only one of the three primary colors. They are connected

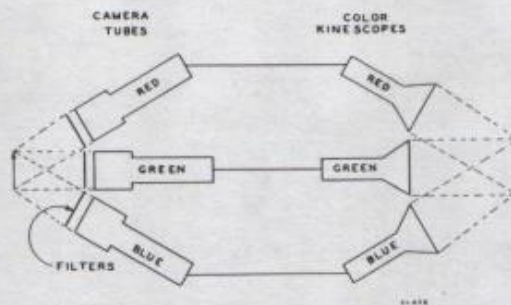


Fig. 13—An Elementary Color Television System

to three kinescopes, each of which reproduces an image in its corresponding color. If a colored object is placed before this camera unit, each camera tube will be affected by only that portion of the picture which corresponds to its color sensitivity. Likewise, the kinescope connected to it will reproduce only that portion of the picture. If, however, the portions of the object reproduced on each of the three kinescopes are superimposed upon each other, as shown in figure 14, the three colors will fit together in a replica of the original object. This basic tri-color system, with various additions and refinements, can transmit and reproduce with very great detail, a scene in color.

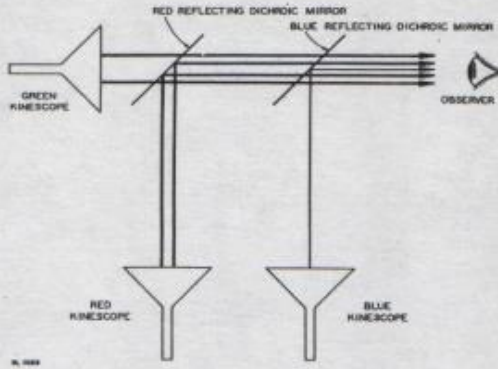


Fig. 14—Early Method of Reproducing Color Television Pictures

The superimposing of color elements from three separate color sources can be accomplished by utilizing the properties of "dichroic" mirrors. Dichroic mirrors permit passage of certain colors, and reflection of others. This system was outmoded for receivers with the advent of the tri-color kinescope. At the present time the camera unit presents problems of a different nature and still uses the three separate camera tubes and dichroic mirrors as shown in figure 15.

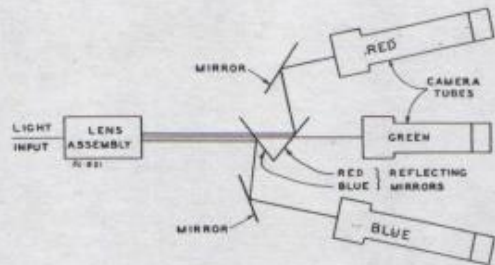


Fig. 15—Simplified Color Television Camera

Figure 16 shows a simplified block diagram of a color television transmitting system which will be discussed briefly.

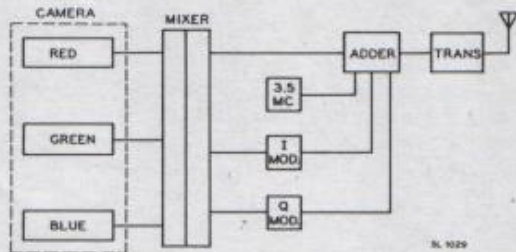


Fig. 16—Simplified Block Diagram—Color Television Transmitting System

You will observe that we have a camera with three individual pickup tubes. Each tube, by the use of color filters, responds to one of the three primary colors previously selected. These three tubes convert light energy into electrical impulses which are mixed and fed to three separate channels. One signal is fed through the adder and then to the transmitter. The other two signals are applied to individual modulators and with a 3.58 mc. sub-carrier signal, are sent through the adder to the transmitter.

The transmitted color signal is picked up by the receiver (figure 17), amplified, converted to an I-F frequency and detected. A portion of the detected signal is fed to each of the three guns of the tri-color kinescope. The other portion of the detected signal is separated into two other signals, which are fed through their respective channels, to each of the three guns of the tri-color kinescope.

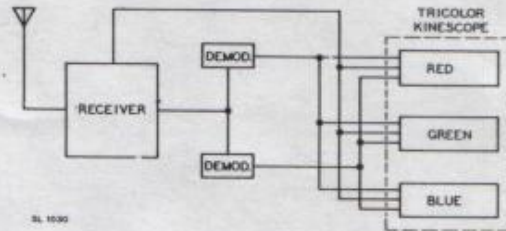


Fig. 17—Simplified Block Diagram of a Color Television Receiver

#### Comparison—Black-and-White, and Color Receivers

Figure 18 (on the following page) illustrates a block diagram of a modern up-to-date black-and-white television receiver. Since it has been shown that additional information is necessary to reproduce a picture in color, it is obvious that additional circuits are required to process this information. Figure 19 shows the black-and-white receiver with the circuits added to process this additional information to reproduce pictures in full color (with the tri-color kinescope substituted for the black-and-white kinescope).

Either of these two receivers will reproduce a picture in black-and-white but because of the tri-color kinescope, the method used to create the black-and-white picture in the color receiver will be somewhat different. It has previously been stated that if the three primary colors are mixed in the correct proportions, the result will appear to be white. Therefore, it seems reasonable to believe that if the three electron beams in the tri-color kinescope are focussed and adjusted correctly, a perception of a white screen will result. A black-and-white signal then can be impressed simultaneously on all three grids of the tri-color kinescope and variations in brightness of the three-dot trios, as the three beams sweep across the screen, will result in a black-and-white picture.

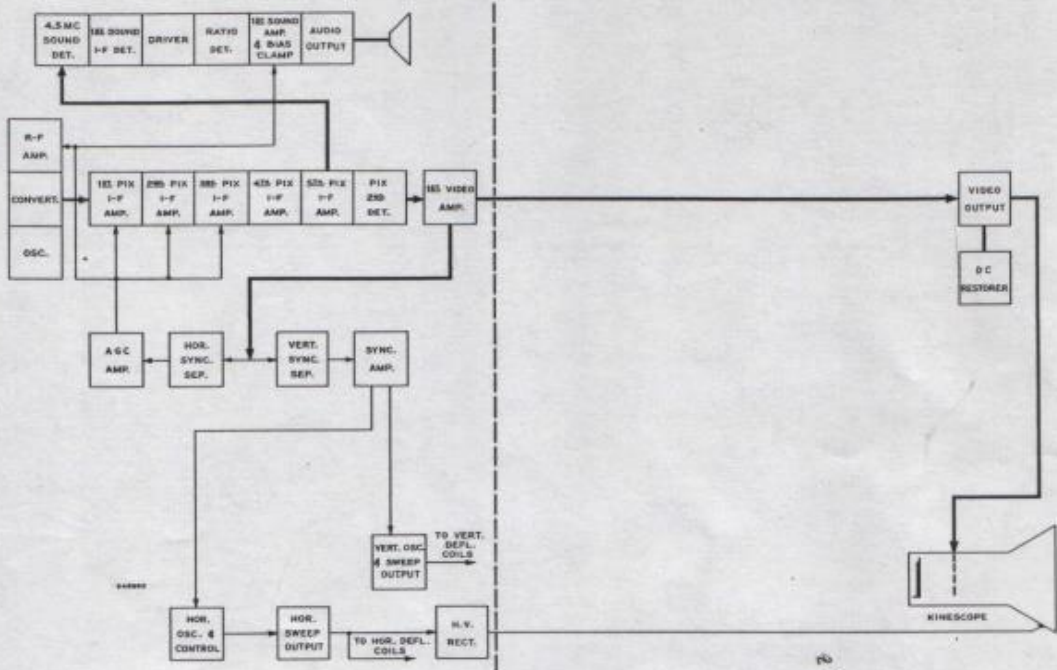


Fig. 18—Block Diagram—Black and White Television Receiver

0-3-5M2

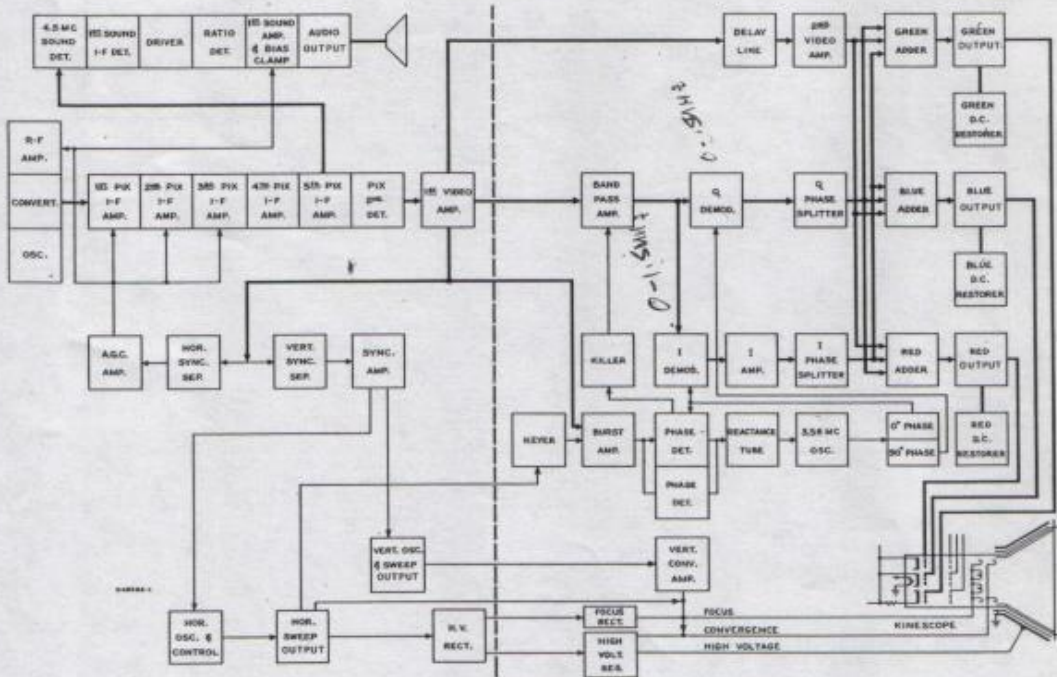


Fig. 19—Block Diagram—Color Television Receiver

## THE COLOR TELEVISION SIGNAL

When a color television camera is creating one of the three signals in the color system, the outputs of the red, green, and blue camera tubes are mixed in the correct proportions to produce a white signal.

This white signal hereafter called the "Y" signal is a mixture of the red, green and blue camera outputs in a percentage ratio of 30% red, plus 59% green, plus 11% blue, which has been established as the brightness response of the human eye to white, or brightness having no dominant hue or color.

The Y signal permits the black-and-white receiver to function (in black-and-white) from color signals and also establishes a "brightness" signal for the color system.

We have shown that the compatibility requirement has been partially fulfilled in that a black-and-white telecast signal will produce a black-and-white picture on both the color and black-and-white receivers, and also, a color telecast will produce a black-and-white picture on a black-and-white receiver. However, we have not accounted for a color telecast reproducing a color picture on a color television receiver.

In order to reproduce a picture in full color, the three attributes of color (hue, brightness and saturation) are required.

The Y signal, as established above, consists of the brightness portion of the three color signals. By establishing two other signals, hereafter designated as "I" and "Q," the requirements for hue and saturation for color transmission can be fulfilled. Color synchronization is also required.

A synchronizing signal consisting of a burst of 8 cycles (minimum) of the subcarrier frequency (3.58 mc.) is inserted immediately following the horizontal sync pulse as illustrated in figure 20. The color sync signal is called "burst." Its application will be discussed later.

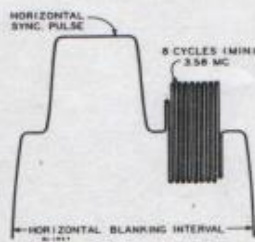


Fig. 20—The Color Synchronizing Signal

The I signal is composed of color signal ratios of 28% green, plus 60% red, minus 32% blue. The Q signal is composed of minus 52% green, plus 21% red, plus 31% blue. These percentages were established through extensive research.

We have now reached a point where we not only have to transmit the "Y" (brightness) signal but we have to establish a means of transmitting additional information, namely I and Q signals, and color sync signals. All of this information must be transmitted within the same bandwidth as the black-and-white system, and be received on black-and-white receivers with a minimum of interference visible in the picture. By viewing a sketch of the black-and-white standards, figure 21, it appears that the usable portion of the allotted 6 mc. bandwidth has been completely filled.

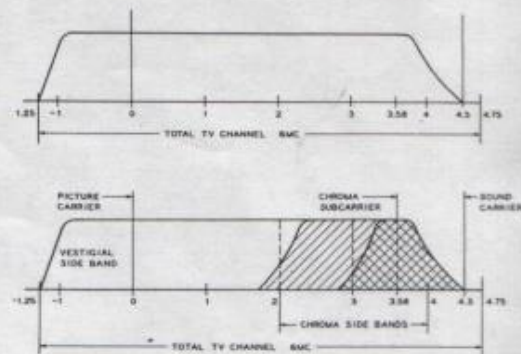


Fig. 21—Channel Spectrum—Black-and-White and Color Television Signals

It has been found, however, that an additional carrier, separated from the main carrier by some odd multiple of one-half the line frequency, may be transmitted within the same spectrum space occupied by the luminance signal without causing objectionable interference. Just what effect this additional signal will have on a picture on a black-and-white receiver can be understood by visualizing what happens during interlace scanning.

Figure 22(a) represents a black-and-white signal at the grid of the black-and-white receiver kinescope for a small portion of a scanned line. In the color system it would represent the luminance component "Y." The relative position of the line representing the black level in respect to the wave then, indicates that the voltage envelope, on the left, is an excursion toward the white level. The voltage envelope on the right indicates an excursion into the grey region (toward black).

Figure 22(b) represents the first scan of a color system signal including both the luminance (a) and the chrominance (color) elements. It can be seen that the envelope representing white in wave (b) indicates little or no output from the color system. This is quite obvious since all three primary colors added together produce white and a white section reproduced on a black-and-white kinescope requires minimum grid voltage. Increasing grid voltage in the negative direction drives a black-and-white kinescope toward "cut-off," or black.

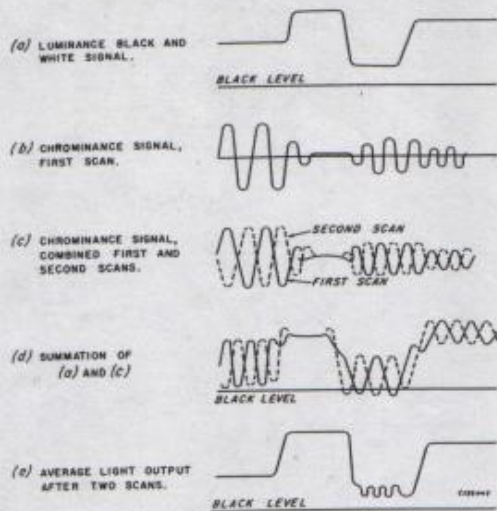


Fig. 22—Frequency Interlace

Because of frequency interlace the chrominance information reproduced on the same line during the next scan (1/30 of a second later) is 180° out of phase with the original chrominance signal and will appear as indicated by the dotted line in figure 22(c).

By super-imposing the resultant waveform derived from adding the first and second scanned lines of chrominance signals indicated in (c) on that of the luminance signal shown in (a), the waveform will appear as shown in figure 22 (d). When adding the two voltages the resultant waveform will be approximately as shown in (e). It should be noted that the small ripple in the right envelope of the wave indicates that there is not 100% cancellation. In this cancellation effect we have again taken advantage of the persistence of vision which tends to average out the undesirable effect after two scans. As a result, at the average viewing distance, the eye effectively sees a scene in black-and-white with a minimum of interference.

An undesirable factor involved in selecting the chrominance carrier frequency was a beat note resulting from the chrominance and sound carriers. After considerable field testing, 3.58 mc. was established as the sub-carrier frequency for transmitting the I and Q chrominance signals. In order to satisfy the requirements of the transmission standards, the I and Q signals may be used to amplitude-modulate two 3.58 mc. subcarriers, one of which is 90° phase displaced from the other. The in-phase component of the subcarrier is called the I signal, and the 90° phase displaced component is called the Q signal. Alternatively, two different signals, each composed of different proportions of signals representative of red, green and blue may be used to amplitude modulate two 3.58 mc. subcarriers related by other than 90°. The resultant

is a single 3.58 mc. subcarrier which is amplitude and phase modulated. However, it must be understood that the subcarrier is suppressed and only the sidebands are transmitted.

The various hues result from vector addition of the chrominance signals. Each hue has a different phase angle with reference to the I and Q axis. It can be seen in figure 23 that hue varies with the phase, and saturation varies with the amplitude of the chrominance sub-carrier sidebands.

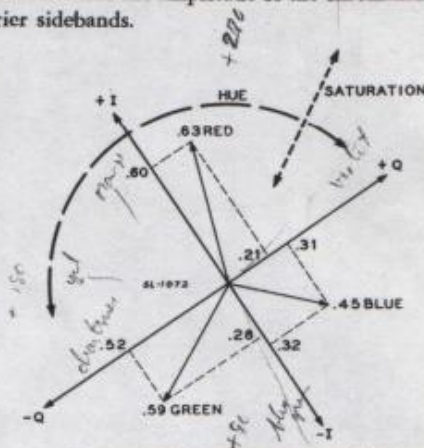


Fig. 23—Vector Relationship of Hue and Saturation

By extensive research relating to the perception of color by the human eye, it was established that the I and Q chrominance signal could be limited in bandwidth to a frequency of 0.5 mc. and, when reproducing large color areas, satisfy the requirements of the eye.

It was also found that by extending the bandwidth of only one of the chrominance signals to 1.5 mc., small color areas could be reproduced satisfactorily. This limited bandwidth is possible, since, as mentioned previously, the eye loses the sense of color as the size of the area decreases until only a brightness sensation is presented to the eye. Therefore, color in the smallest areas is represented by changes in brightness only.

As a result the I chrominance signal is extended to 1.5 mc. and the Q chrominance signal is limited to 0.5 mc. (with reference to the color subcarrier). The spectrum of the transmitted color signal is shown in figure 21. To familiarize ourselves more thoroughly with the color signal, and in what manner hue, saturation and brightness can be evaluated by Y, I and Q signals, figure 24 shows a series of blocks which represent a series of colors which constitute a portion of a scanned scene. Figure 24 (b), (c), (d) is based upon 100% output from each of the three camera tubes when scanning the fully saturated hues shown in figure 24 (a). The combination of the three camera tube outputs to produce white, is shown in the first vertical row of blocks. The red block (second block in (a)) represents a fully saturated hue, therefore 100% output of only the red camera, as shown in (b), is necessary and the other cameras have no output.

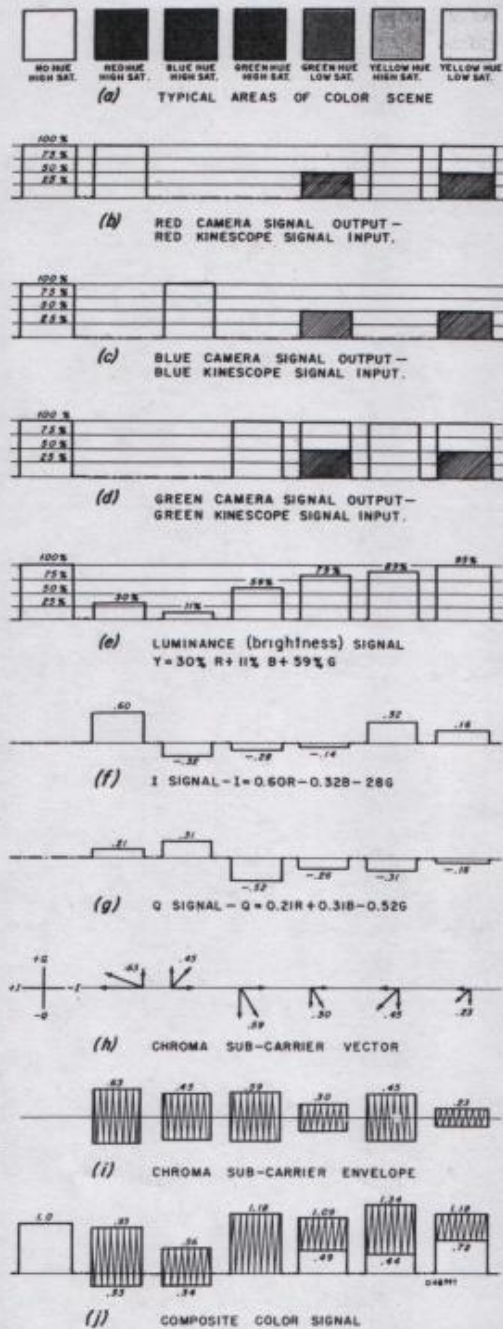


Fig. 24—Development of the Color Television Signal

The blue block represents a fully saturated hue, therefore, 100% output from only the blue camera is necessary. Likewise, the green block represents a fully saturated green hue, and the output of only the green camera is necessary.

If complete saturation of a hue is the absence of white, then the light green block in (a) showing a low

degree of saturation must have some quantity of white mixed with it. We can then, for reasons of simplicity, assume light green to consist of 50% of white and 50% of green. In this description we have assumed that white is produced from equal outputs from all three camera tubes. The shaded areas indicated, represent the output required from each camera tube to produce the 50% white. Since we have assumed 50% saturation for the light green, we then require *half* the output from each of the three camera tubes mixed with the *full* output of the green camera tube to produce the 50% saturated green signal. The fully saturated yellow block requires equal output from both the red and green camera tubes, since red and green produce yellow.

The light yellow block representing low saturation of yellow (again assuming 50% saturation) brings about a slightly different problem since yellow is not one of the three primary colors. First, to produce fully saturated yellow, we mix the full output of both the red and the green camera tubes, then, to acquire the white necessary to produce the 50% saturation we again take half the output of each of the three camera tube outputs. This is shown in the shaded sections directly in line and below the light yellow block.

We have now accounted for both hue and saturation. Let us see how the brightness signal is produced. Let us recall the standard luminance signal which is represented by 30% R, plus 11% B, plus 59% G.

The first block, being white, will constitute the full output from each of the three camera tubes. According to the Y signal standards the luminance signal for the fully saturated red, blue and green blocks will be 30% output from the red camera tube, 11% of the output from the blue camera tube and 59% of the output from the green camera tube.

For the light green block (referring to the above values for the luminance signal, because this is the brightness signal needed to produce the low saturated green) we have 30% of the 50% red signal (shaded area in (b)), 11% of the 50% blue signal (shaded area in (c)), and 59% of the 100% green signal (100% output as shown in (d)).

The sum total is 30% of 50% or .15, 11% of 50% equals .055, 59% of 100% equals .59, therefore, .15 plus .055 plus .59 equals .795 or 79.5%, which is the luminance value of the light green signal.

The luminance value of the yellow signal is 30% of the 100% red signal in (b), 11% of the 100% blue signal in (c), and 59% of the 100% green signal in (d).

The sum total is 30% of 100% or .30, 11% of 0 or 0 and 59% of the 100% or .59, therefore .30 plus 0 plus .59 equals 89%. Likewise the luminance value of the low saturation yellow signal is 30% of the 100% red signal in (b), 11% of the 50% blue signal in (c) and 59% of the 100% green signal in (d). The sum total

is 30% of 100% or .30, 11% of 50% or .055 and 59% of 100% or .59. Therefore .30 plus .055 plus .59 equals .945 or 94.5%.

To determine the I signal value for the above color blocks a similar operation is performed using the I signal ratios (established on page 13) 60% red, -32% blue, -28% green. Then, 60% of 100% red equals .60, -32% of 100% blue equals -.32, and -28% of 100% green equals -.28. The three values .60, -.32 and -.28 constitute the I signal values for white.

For the *low saturation* green, 60% of 50% red in (b), -32% of 50% blue in (c) and -28% of 100% green (d). The sum total, 60% of 50% equals .30, -32% of 50% equals -.16 and -28% of 100% equals -.28, therefore adding .30, -.16 and -.28 equals -.14, the signal value for low saturation green. For *high saturation* yellow 60% of 100% red in (b), -32% of 0 blue in (c) and -28% of 100% green in (d). The sum total, 60% of 100% equals .60, -32% of 0% equals 0 and, -28% of 100% equals -.28. Therefore .60 -.28 equals .32.

For *low saturation* yellow, 60% of 100% red in (b) plus 32% of 50% blue (c), -28% of 100% green (d). The sum total 60% of 100% equals .60, -32% of 50% equals -.16, -28% of 100% equals -.28. Therefore .60 -.16 -.28 equals -.16.

Using the Q signal ratios established on page 13, the Q signal for each of the color areas is evaluated as shown in figure 24 (g).

As stated previously, the I and Q signals are added vectorially.

In figure 24 (i) it can be seen what the I and Q signals will look like after they have been vectorially added. By adding (i) (figure 24), which is the vector resultant of I and Q chrominance signals and (e), the luminance signal, the resultant composite color signal will resemble the wave shown in (j).

## SUMMARY

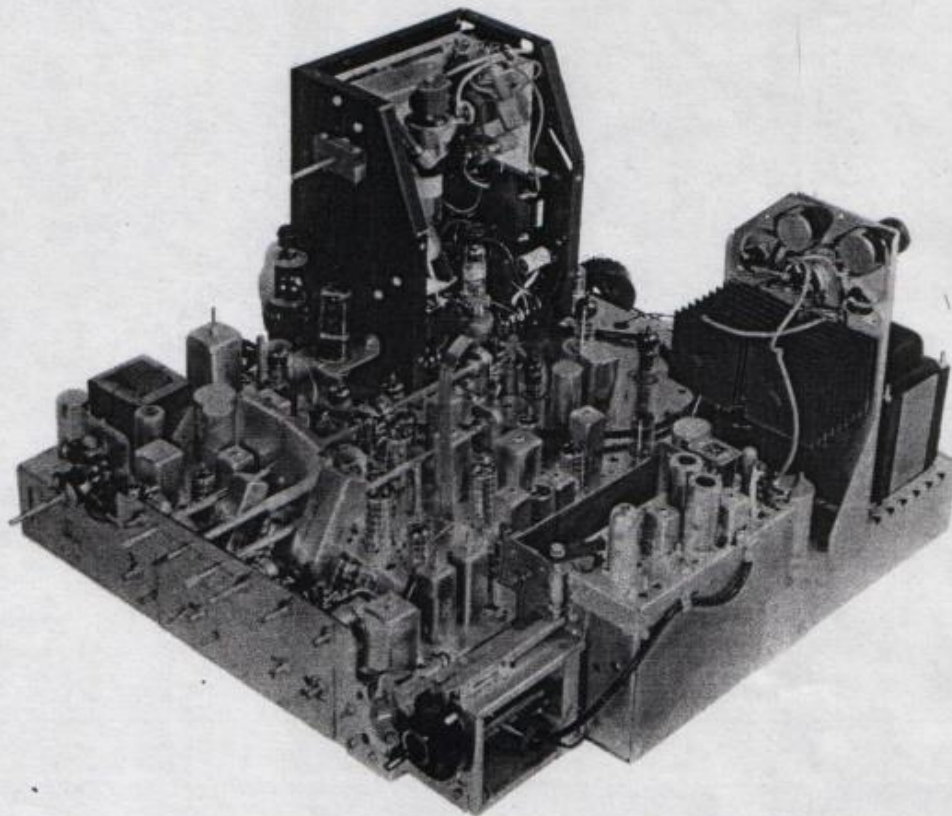
The preceding pages have reviewed the operation of the black-and-white television system and introduced some of the underlying principles of color and their application to the present television system.

A comparison has been drawn between the black-and-white system and the color television system. It has been shown that, although the color television system must process more information than the black-and-white system in the same channel allocations, the means are at hand for so doing.

The color television receiver described in the following pages fully meets the requirements for providing high-quality picture reproduction, both in color, and in black-and-white.

The principles introduced here, together with those which have been reviewed, are aids for acquiring an understanding of the operation of this receiver.





*RCA Victor Model CT-100 Color Television Receiver Chassis*

## PICTURE I-F CHANNEL

The picture I-F amplifier (the first stage of which is shown in figure 28) is designed for a 45.75 mc. picture carrier, a 42.17 mc. color sub-carrier frequency, and a 41.25 mc. sound carrier. Seven stages of I-F amplification are used in order to secure uniform gain over the full 4.5 mc. bandwidth required for satisfactory color reception. The seven stages (including two in the tuner unit) consist of one 6U8, three 6DC6's, a pentode section of a 6AN8, and one 6CL6.

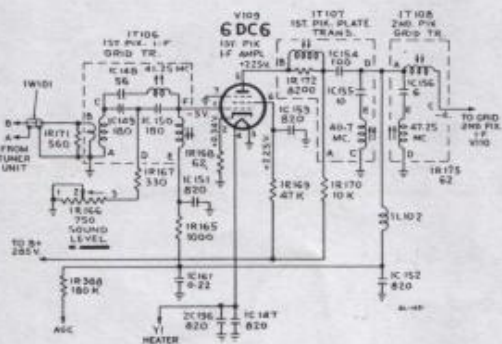


Fig. 28—1st Picture I-F Schematic Diagram

To reduce cross-modulation, the sound carrier is attenuated as soon as possible in the I-F amplifier. This attenuation is accomplished by a filter network (tuned to 41.25 mc.) which is included in transformer T106 and is connected in the input circuit to V109, the first I-F amplifier. The attenuation is controlled by an adjustable sound level control (1R166).

The output of V109 is fed to the 2nd I-F amplifier, a 6DC6 (V110), through band-pass network and rejection trap assemblies 1T107 and 1T108. The former is tuned to 40.7 mc. and the latter to 47.25 mc., to attenuate the adjacent picture and sound signals respectively.

The second, third and fourth picture I-F amplifier stages, shown in figure 29, (V110, V111 and V112A) constitute a stagger-tuned I-F system with the second (1T109) and fourth (1T111) stages tuned, respec-

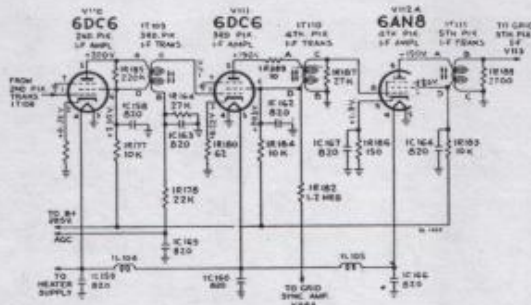


Fig. 29—2nd, 3rd and 4th Picture I-F Amplifier Schematic

tively, to the high and low frequency sides of the band-pass. The third stage (1T110) is tuned to approximately the center of the band. The fifth picture I-F amplifier (V113) figure 30, incorporates two very important rejection circuits in its plate circuit. First, a mutually-coupled absorption trap (part of 1T112) tuned to 47.25 mc. for adjacent channel sound rejection. Second, a filter network which includes a rejection trap (part of 1T113) tuned to 41.25 mc. This trap is for minimizing the effect of the 920 kc. beat between the accompanying sound carrier and the chrominance sub-carrier. The sound rejection control (1R276) provides for adjustment of this rejection.

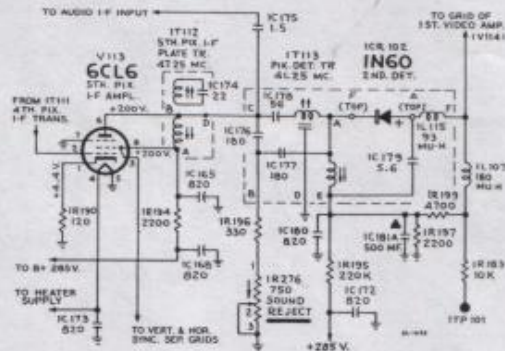


Fig. 30—Schematic, 5th Picture I-F and 2nd Detector

## SOUND I-F AND AUDIO CHANNEL

The take-off point for the inter-carrier sound information is in the plate circuit of the fifth picture I-F stage (see figure 30) and is so chosen to take advantage of the added gain of the picture I-F system. Figure 31 shows the chassis location of major component parts of the sound I-F and audio channel. The inter-

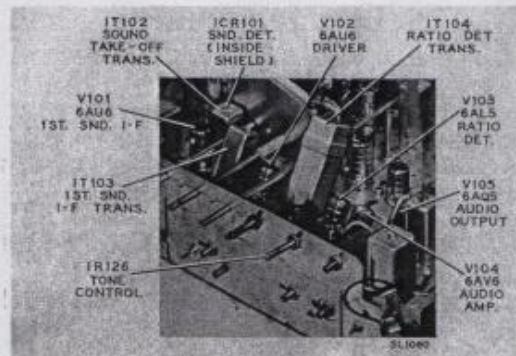


Fig. 31—Sound I-F and Audio Component Locations

carrier sound information which consists of two signals (one of 45.75 mc. and the other 41.25 mc.), is fed to a 1N60 crystal diode-detector (1CR101) which pro-

duces a 4.5 mc. sound I-F signal (see figure 32). The 4.5 mc. sound signal is fed through the I-F amplifier channel consisting of an amplifier stage 6AU6 (V101),

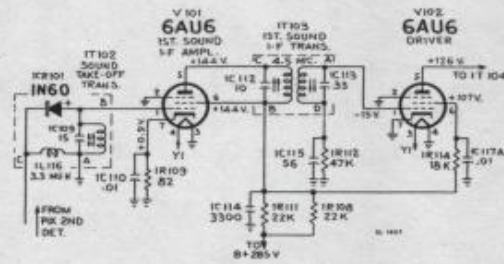


Fig. 32—Schematic Diagram, Sound Take-off, 1st Sound I-F and Driver

driver 6AU6 (V102), and a ratio detector 6AL5 (V103). These circuits are of conventional design. See figure 33. The audio signal from the ratio detector is fed to a two-stage amplifier consisting of a 6AV6

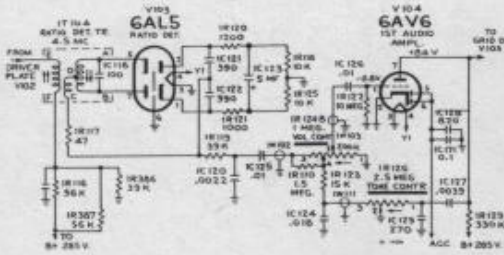


Fig. 33—Schematic Diagram, Ratio Detector and 1st Audio Amplifier

voltage amplifier (V104), and a 6AQ5 power output stage (V105) capable of supplying approximately 3 watts output to the loud speaker. See figure 34.

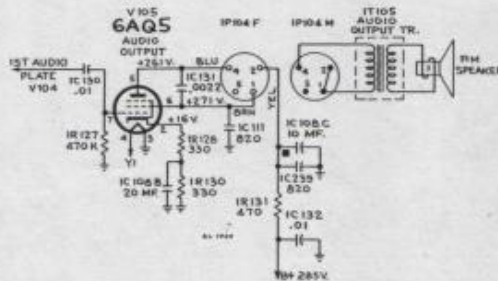


Fig. 34—Audio Output Schematic Diagram

## DEFLECTION SYNCHRONIZATION

Part of the video signal is fed from the plate circuit of the first video amplifier to a dividing network where a portion of the signal is fed to the grid of the vertical sync separator 12AT7 (V118B) and another portion of the signal is fed (by DC coupling) to the grid of the horizontal sync separator, the triode section of a 6AN8 (V117B).

Noise immunity is improved, in the vertical sync separator (figure 35), by feeding a signal voltage from the screen of the fifth picture I-F amplifier tube (V113) to the grid of the sync separator. Noise pulses arriving by way of the sync line are effectively cancelled by the same noise pulses (of opposite polarity)

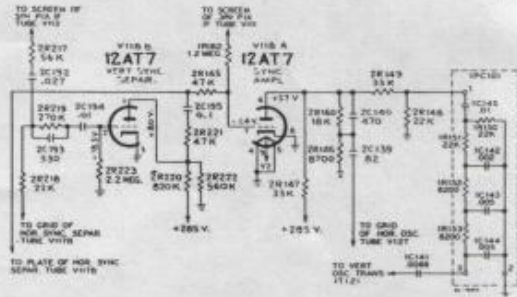


Fig. 35—Vertical Sync Separator and Sync Amplifier Schematic

arriving from the fifth picture I-F stage. Further stabilization of sync is obtained from the variable clipping action in the sync amplifier as a result of a connection between the screen grid of the 6DC6 (3rd picture I-F tube) and the grid of the sync amplifier through a 1.2 megohm resistor (1R182). As the plate and screen-grid voltage varies slightly with changes in signal resulting from AGC action, the varying voltage applied to the grid of the sync amplifier tube causes the operation of the tube to vary in accordance with the signal amplitude. By this action, sync tips are maintained at cut-off, and noise pulses greater than sync are beyond cut-off and are therefore effectively removed.

After both the horizontal and vertical sync pulses are amplified by the sync amplifier, one-half of a 12AT7 (V118A), the horizontal pulses are fed from the plate circuit through an 82 mmf. capacitor (2C139) to the horizontal oscillator control tube. The vertical sync signal is fed through a "printed circuit" integrating network (1PC101) for proper shaping before application to the vertical oscillator tube.

## AGC

A signal consisting of horizontal sync pulses, is fed from the cathode of the horizontal sync separator tube, the triode section of a 6AN8 (V117B) figure 36, through the AGC control (1R139B) to the grid of the AGC amplifier tube, the pentode section of a 6AN8 (V117A). The AGC amplifier tube is driven into conduction by a positive pulse applied to its plate (through a capacitor (3C134)) from the horizontal

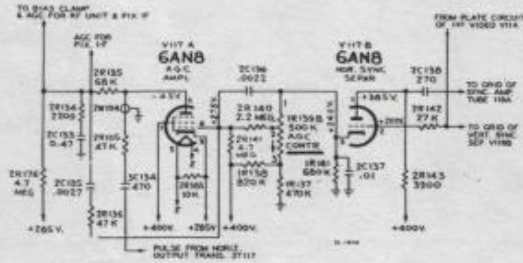


Fig. 36—Schematic Diagram—AGC Amplifier and Horizontal Sync Separator

deflection output transformer (term. 5, 3T117). Therefore the AGC tube conducts only during blanking, or retrace time, which assures that the AGC bias is controlled by the synchronizing pulses. A bias clamp (diodes of 6AV6, V104), provides improved signal-to-noise ratio.

## HORIZONTAL DEFLECTION AND HIGH VOLTAGE

Horizontal synchronizing pulses are fed from the sync amplifier tube, one-half of a 12AT7 (V118A), see figure 37, through an 82 mmf. capacitor (2C139) to the input of the horizontal sweep oscillator and control tube (V127). This tube and its associated components

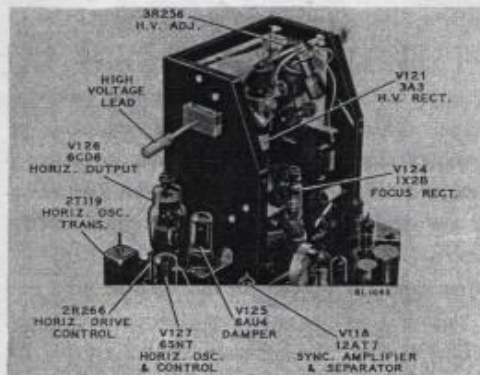


Fig. 37—Horizontal Deflection Components

constitutes a "synchroguide" circuit, (see figure 38) the output of which is used to drive the horizontal output tube, a 6CD6 (V126). Fixed bias is maintained on the horizontal deflection output tube in the event of horizontal drive voltage failure.

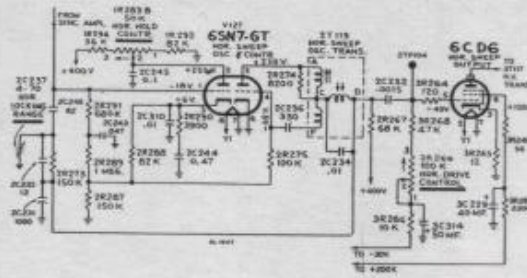


Fig. 38—Horizontal Deflection—Oscillator, Control and Output Schematic

High voltage (ultor voltage), is derived from the high-voltage rectifier, a 3A3 (V121) figure 39, which rectifies the inductive kickback pulses from the horizontal deflection output circuit. Regulation of the high voltage is effected by the triode regulator tube, a 6BD4 (V120) shunted across the high voltage sup-

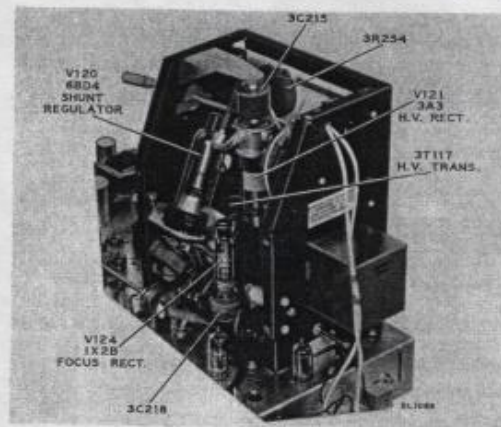


Fig. 39—High Voltage Power Supply

ply. This is shown in figure 40. Regulation of high voltage is necessary because of the inter-dependency of beam current and convergence. The potentiometer (3R256) connected in series with the high voltage bleeder provides the bias for the regulator tube and is used to establish the high voltage level.

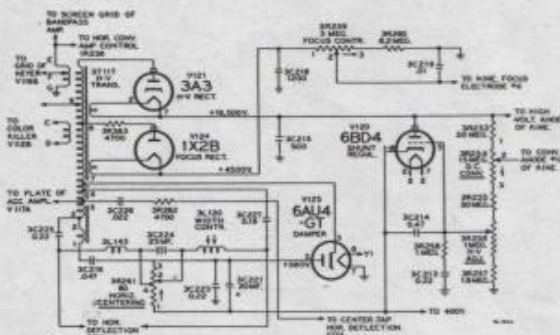


Fig. 40—High Voltage Power Supply Schematic

In order to maintain a fixed ultor/convergence voltage ratio, the DC convergence control (3R254) is connected in series with the high voltage bleeder system.

The focus voltage is supplied from a separate rectifier, a type 1X2B (V123), which also derives its voltage from the horizontal deflection output transformer (term. 3, 3T117). Two separate windings, of a few turns each, are wound on the horizontal deflection output transformer, and provide pulse voltages for the "Color Killer" bias rectification, (term. "C" and "D", 3T117), bandpass amplifier keying, (term. "E", 3T117), and horizontal dynamic convergence excitation (term. "E", 3T117). Taps on the horizontal deflection output transformer provide the necessary deflection voltage to the horizontal deflection coils (term. 3 and 6, 3T117).

The horizontal centering control (3R261) figure 41, provides a means of centering the raster either to the right, or left, by controlling the direction of the DC current flowing through the deflection coils. To prevent the DC from passing through the horizontal output transformer winding, two inductances (3L145 and 3L120), and blocking capacitors (3C225 and 3C227) are introduced into the circuit as shown in figure 41.

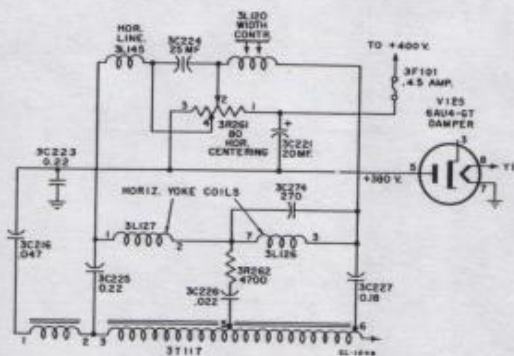


Fig. 41—Simplified Schematic—Horizontal Centering Circuit

One of the chokes (3L120) is adjustable and is used as the width control. In order to have control over the direction of current flow through the yoke, approximately 10 volts DC is applied to the potentiometer (3R261) which has both a fixed center tap and a movable contact arm.

By connecting one end of coils 3L145 and 3L120 together through the blocking capacitor (3C224) and then connecting the same ends of the coils, one to the fixed tap and the other to the movable taps, it is possible to have one lead either more, or less, positive than the other (depending upon the setting of the movable contactor) and thereby change direction of current flow. The capacitor (3C224) being quite large has a very low impedance at the horizontal deflection voltage frequency and therefore, as far as AC is concerned, the two coils are effectively connected together.

When the movable tap (#2) is to the right, higher voltage end (#1) of the control, the current will take the direction of flow through coil 3L120, 3L127 and 3L145 to center tap #4 back to the low voltage side #3 and the raster will move in one direction. On the other hand if the movable tap #2 is to the left, or lower voltage side (#3), the current will take the direction of flow from the fixed tap #1 through 3L145, 3L127, 3L126 and 3L120 to the movable arm #2 and the low voltage end #3 of the potentiometer, and the raster will move in the opposite direction. Therefore the direction of current flow (centering direction) is determined by the position of the movable contact to the right or left of the fixed contact and the amount of current is determined (centering limits) by the amount of displacement of the two contacts.

### VERTICAL DEFLECTION

The vertical oscillator and output tube, a 12BH7 (V128) figure 42, is incorporated in a conventional blocking oscillator and output circuit which supplies vertical deflection voltage through a transformer (1T120) to the vertical deflection coils.

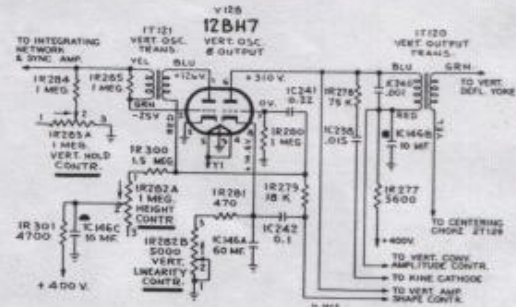


Fig. 42—Schematic Diagram—Vertical Oscillator and Output

The simplified diagram, figure 43, shows the vertical centering control (2R104) shunted by a fixed center tap resistor (2R191) together with the choke (2L101) connected in series with the negative return of the "B" supply. This control governs the amount and direction of DC current flowing through the vertical deflection coils and determines whether the raster is shifted up, or down, on the screen.

It can be seen that there is one position where the movable arm contact of the potentiometer will have the same voltage as the center tap of the fixed resistor. Therefore, there will be no difference in potential between the two ends of the DC current loop through the deflection coils.

When the arm is moved from the center position, a difference in potential will exist between the DC loop ends, and current will flow through one choke winding and then through the two deflection coils through the other choke winding to the lower voltage tap. The direction of current flow (centering direction) is determined by the position of the movable contact arm



## VIDEO CHANNEL

The video section of the receiver as shown in the block diagram, figure 47, performs three separate functions. These functions are luminance signal processing, chrominance signal processing and matrixing. A brief description of the overall video section will be given here for the purpose of better understanding its function. A detailed description of each block is included in the following sections.

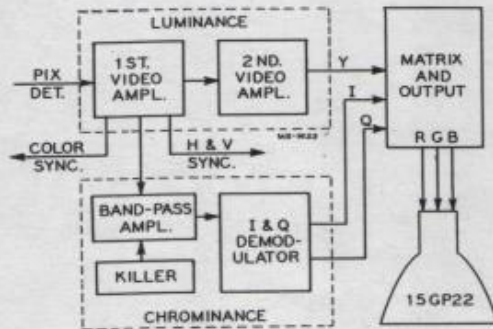


Fig. 47—Block Diagram—Luminance, Chrominance, Matrix and Output Sections

The luminance channel receives from the picture second-detector, a composite video signal, which is composed of the transmitted picture information plus the synchronizing information for the color and deflection circuits. The main function of the luminance channel is to provide a brightness signal ("Y" signal) at the output of the video amplifier. In a black-and-white television receiver, the "Y" signal is fed directly to the kinescope. In the color television receiver, the "Y" signal is fed through a matrix and output section before it is applied to the kinescope. Other functions of the luminance channel are to provide horizontal and vertical sync pulses to the deflection circuits, and chrominance information and color sync for the chrominance channel.

Throughout the entire video section in the color receiver the luminance and chrominance signals are within the range of frequencies referred to as video frequencies. The luminance channel has a frequency range (bandwidth) of approximately 0-4 mc. and compares with the video amplifier section in black-and-white receivers.

The "I" and "Q" signals are restricted in bandwidth as previously mentioned. The "I" channel passes information in a bandwidth limited to 1.5 mc. and the "Q" channel passes information in a bandwidth limited to .5 mc. "I" and "Q" channel bandwidths are referenced to the color sub-carrier frequency.

## LUMINANCE CHANNEL

The luminance channel consists of a 6CL6 first video amplifier (V114) and the pentode section of a 6AN8 second video amplifier (V115A). As indicated in figure 48, the first video amplifier provides information for many sections of the receiver. Video from the split plate-load resistors (2R207 and 2R208) is supplied to the second video amplifier (V115A). Video from the plate circuit also supplies horizontal

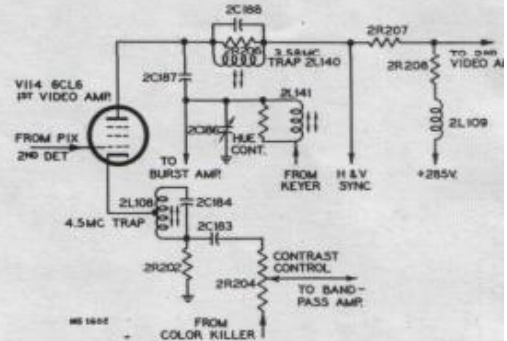


Fig. 48—1st Video Amplifier Schematic

vertical sync information to the deflection circuit. Chrominance information is prevented from combining with luminance information before matrixing by a 3.58 mc. trap (2L140). Color sync information (or "burst"), is removed at the burst take-off capacitor (2L141), and applied to the grid of the Burst Amplifier, the pentode section of a 6AN8 (V129A). A gate pulse from the Keyer tube, the triode section of a 6AN8 (V116B) is also applied to the Burst Amplifier through the inductance (2L141). In the cathode circuit of the first video amplifier a 4.5 mc. trap (2L108 and 2C184) attenuates sound information that might be present in the video signal. One section of a dual contrast control (2R204) in the cathode of the first video amplifier serves the purpose of controlling video signal voltage supplied to the Band-Pass Amplifier, the pentode section of a 6AN8 (V116A).

The second video amplifier, figure 49, amplifies the output of the first video stage to produce a luminance or "brightness" signal of sufficient amplitude to mat-

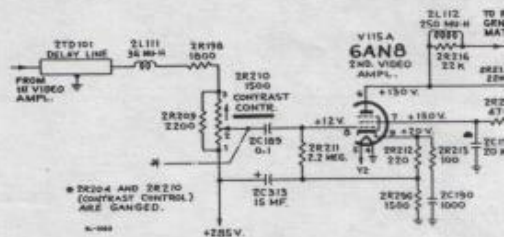


Fig. 49—2nd Video Amplifier Schematic

with the I and Q signals. Since this luminance information is of wider bandwidth than the chrominance information, it is necessary to delay the "Y" signal so that the two signals will coincide at the matrix to enable proper registration on the kinescope. The delay amounts to approximately one microsecond, which is equivalent to about 5/32 of an inch on the kinescope in the CT-100. This delay is accomplished by inserting a section of delay line (2TD101) between the first and second video amplifiers. The other section of the dual contrast control (2R210) is ganged to the control (2R204) in the cathode of the first video amplifier. This arrangement makes possible the correct ratio of luminance to chrominance information for any degree of contrast.

### CHROMINANCE CHANNEL

The chrominance channel, as the name implies, deals with that portion of the composite video signal which supplies color information only. This consists of the color video or "chroma" information and the color synchronizing pulses. The main function of the chrominance channel is to recover the two independent signals, "I" and "Q", that are represented in the modulated color sub-carrier as received. The "I" and "Q" signals are video signals which contain color information but, by themselves, cannot produce a true color television picture. However, when I, Y, and Q signals are added together in the matrix, the resulting red, green and blue video signals can produce (after amplification) a high definition color picture on the tricolor kinescope.

In order to recover the "I" and "Q" signals from the composite video signal it is necessary to extract the sidebands of the color sub-carrier (3.58 mc.). This is done by the Band-Pass Amplifier, see figure 50, the pentode section of a 6AN8 (V116A). Video from

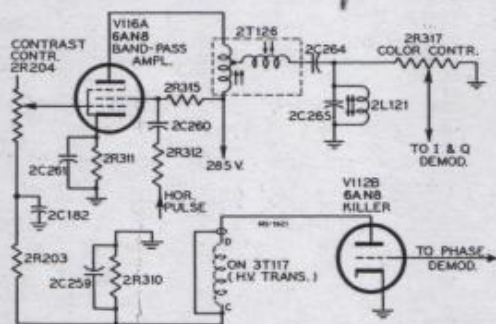


Fig. 50—Band-pass Amplifier Schematic

the contrast control (2R204) is fed to the grid of V116A, which amplifies a band of frequencies from approximately 2.4 mc. to 4.0 mc. The band-pass transformer (2T126), and the band-pass secondary coil (2L121), determine the band-pass of the circuit. The

circuit is terminated in a Color Control (2R317), that determines the amplitude of voltage supplied to the I and Q demodulators. The Color Control enables the operator of the receiver to control the intensity of the colors in the picture on the kinescope. The band-pass amplifier is not allowed to operate during blanking time since the DC restorers might clamp the background level on burst information rather than on tips of sync. A large negative pulse from the horizontal output transformer (term. "E" 3T117) applied to the screen grid of V116A prevents operation of the band-pass amplifier during blanking time.

During the reception of black-and-white transmissions it is desirable that the band-pass amplifier be inoperative so that video signals cannot enter the matrix section through the chrominance channel. A "color killer" circuit, the triode section of a 6AN8 (V112B), applies a negative bias voltage to the grid of the band-pass amplifier whenever the killer tube conducts. Conduction will depend on the absence of a bias voltage on the killer grid. This voltage is present whenever burst (from color transmissions) creates the bias at the Phase Detector, V130B. Since there is no burst present in black-and-white transmissions the killer tube will conduct and "kill" the band-pass amplifier so that the black-and-white signal will be present only in the luminance channel.

It is interesting to note the manner in which the killer circuit develops a negative DC voltage. A winding of the horizontal output transformer (terminals "C" and "D", 3T117) is placed in the plate lead of the killer tube so that the plate voltage for this tube is derived from a horizontal pulse. When conduction takes place the pulsating voltage charges the capacitor 2C259 and it discharges through the resistor 2R310 creating a negative, pulsating DC voltage. Resistor 2R203 and capacitor 2C182 aid in smoothing out the pulsating DC voltage.

The chroma signal from the band-pass amplifier contains the sidebands of the 3.58 mc. color sub-carrier. In order to recover the separate "I" and "Q" color signals from the chroma signal, a synchronous detector is used. This is referred to as the "I" and "Q" demodulator.

### I AND Q DEMODULATORS

The main function of the demodulator portion of the chrominance section is to recover the I and Q signals from the combined I and Q sidebands of the 3.58 mc. color sub-carrier. This is accomplished by two multiplier circuits using 6BY6 pentode tubes, V132 and V133.

In order to detect a suppressed-carrier signal, the carrier that was suppressed in the transmitter must be re-inserted in the receiver. In this application, two carriers that are of the same frequency but differing in phase by 90 degrees, are re-inserted.



"I" CW and "Q" CW created in the color sync section are the carriers in this receiver and are re-inserted by applying them to the number three grids of the respective I and Q demodulator tubes. Chrominance information from the band-pass amplifier is applied to the control grid of each demodulator tube. In the I demodulator, the chrominance sidebands combine with "I" CW signal to reproduce the original I signal. When the chrominance signal is combined with "Q" CW in the Q demodulator tube, the original Q signal appears in the output. In demodulation or detection processes in general, both the sum and difference frequencies are produced in the output. In the I and Q demodulator the difference frequencies are used and the sum frequencies are filtered out.

The filter in the Q demodulator consists of 2L122, 2C266 and 2R321 which limits the frequency pass-band to 500 kc. See figure 51. The cathode resistor

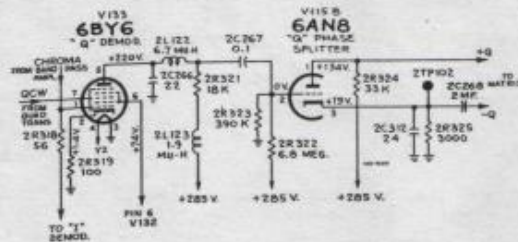


Fig. 51—"Q" Demodulator and Phase Splitter Schematic

2R319 of the Q demodulator is un-bypassed to prevent the loss of low frequencies. A triode section of a 6AN8 (V153B) provides Q of positive polarity at the plate and of negative polarity at the cathode.

A test point, 2TP102, is available at the cathode of the Q phase splitter so that an oscilloscope may be used to observe the Q component of a color bar test pattern. As shown in figure 52, the filter 2T123 of the I demodulator not only limits the frequency pass band to 1.5 mc. but also delays the signal since the I channel is wider than the Q channel.

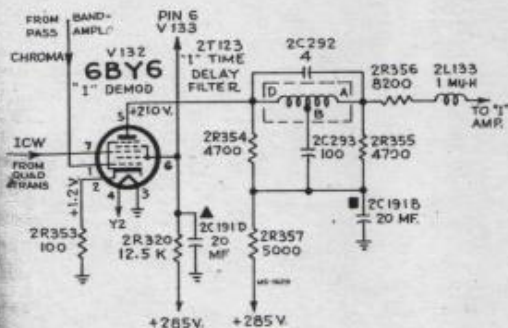


Fig. 52—"I" Demodulator Schematic

As shown in figure 53 a 6AN8 (V134A and B) provides added gain for the I channel as well as providing a means of obtaining I of both positive and negative polarity. The gain of the I channel may be adjusted to be equal to that of the Q channel by means of the I gain control, 2R361. A test point 2TP103, is provided for observing the I component of a test signal.

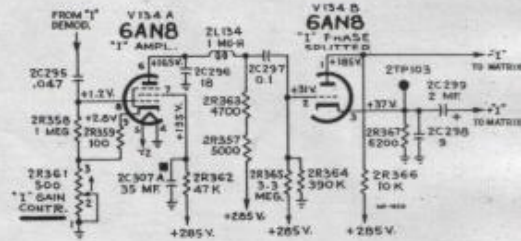


Fig. 53—"I" Amplifier and Phase Splitter Schematic

## MATRIX AND OUTPUT

The main function of the matrix and output section is to cross-mix "Y", "I" and "Q" signals in the proper proportions and polarities to produce three video signals which correspond to the red, green and blue signals at the output of the color camera. The output section amplifies each signal separately and feeds it to its respective control grid in the triode color kinescope. In the transmitter the "Y", "I" and "Q" signals were created by combining a portion of the outputs of the color camera in accordance with the following equations:

$$Y = .30R + .59G + .11B$$

$$I = .60R - .28G - .32B$$

$$Q = .21R - .52G + .31B$$

It seems only logical then, to use the same formulas for separating the signals in the matrix of the receiver. By using simple arithmetic and these formulas, the functioning of the matrix can be explained. The matrix section receives equal amplitudes of the "Y" signal of positive polarity. The "I" and "Q" signals however, are mixed with "Y" in proportions and polarities as shown in the following table:

Red Matrix	Green Matrix	Blue Matrix
100% of + Y	100% of + Y	100% of +
94.5% of + I	27.1% of - I	111% of -
62.1% of + Q	64.7% of - Q	170% of +

In order to illustrate the mathematics of matrixing three hypothetical examples are presented. They show the mixing of the chrominance and luminance signals resulting from three different color scenes.

In a scene composed of only a fully saturated red hue, only the red camera tube will have output and likewise only the red gun in the kinescope should conduct, thus:

**Example 1:**

Red Scene	Red Matrix	Green Matrix	Blue Matrix
Y = .30 R	+ .30	+ .30	+ .30
I = .60 R	+ .57	- .16	- .66
Q = .21 R	+ .13	- .14	+ .36
	100%	.0	.0

The equations for "Y", "I" and "Q" previously shown, apply for all scenes, but as there is no green or blue in this scene, only the values for red apply. It can be seen that the luminance ("Y") signal is present in the maximum amount (+.30) in each matrix, but is cancelled in the green and blue matrix, with negative quantities of "I" and "Q". These values were obtained by taking a percentage of 60 for "I" and a percentage of 21 for "Q", with the polarity indicated in the matrix percentage tables.

A similar treatment can be given to a scene involving two primary colors, red and green, which when mixed in equal amounts, produce yellow.

**Example 2:**

Yellow Scene	Red Matrix	Green Matrix	Blue Matrix
Y = .30R + .59G = .89	+ .89	+ .89	+ .89
I = .60R - .28G = .32	+ .30	- .09	- .36
Q = .21R - .52G = .31	- .19	+ .20	- .53
	100%	100%	0

With maximum output from the red and green output stages, the red and green guns of the kinescope have maximum conduction and the light output from the red and green phosphors gives the illusion of yellow.

**Example 3:**

White Scene	Red Matrix	Green Matrix	Blue Matrix
Y = .30R + .59G + .11B = 100	100	100	100
I = .60R - .28G - .32B = .00	.00	.00	.00
Q = .21R - .52G + .21B = .00	.00	.00	.00
	100%	100%	100%

A white scene will require maximum signal on all three grids of the kinescope. Note that the signal is entirely a *brightness* signal ("Y") and that no information is contained in the "I" or "Q" channels.

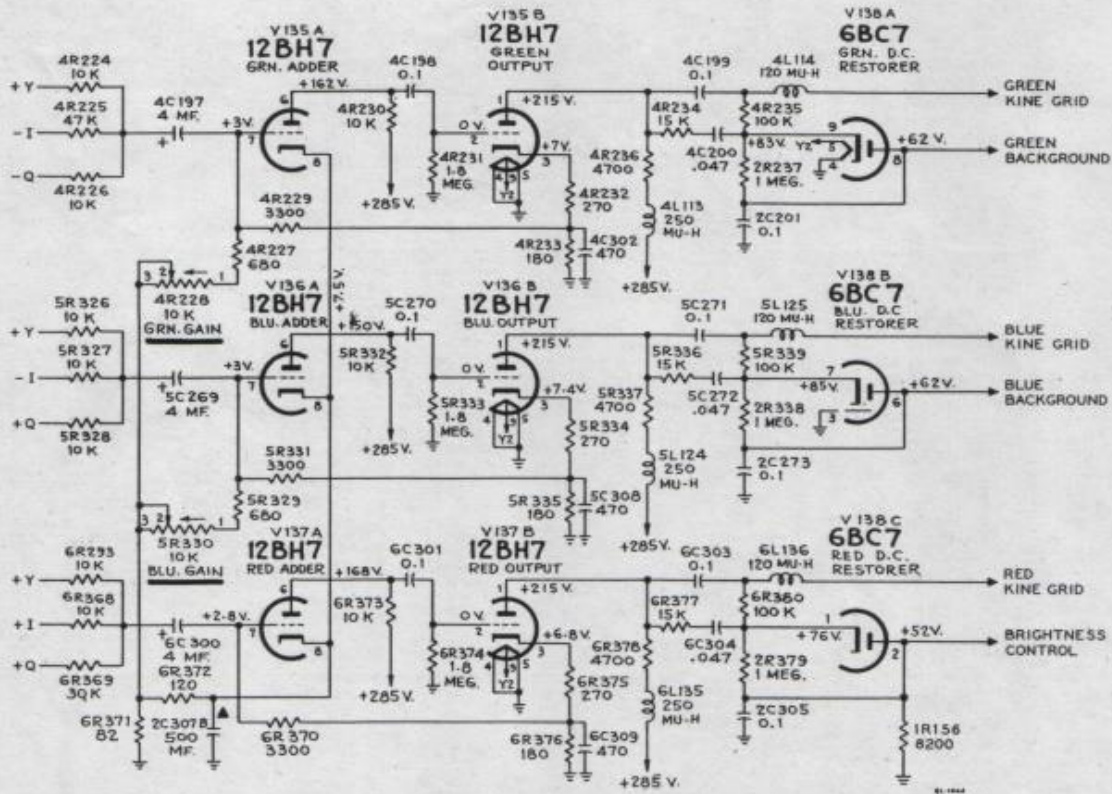


Fig. 54—Matrix and Output Schematic

Three 12BH7 dual triode tubes shown in the diagram, figure 54, are used to amplify the video signals representing red, green, and blue information. Excitation of the red phosphor of the kinescope requires a greater signal than the green or blue phosphors to produce the same amount of light output. Therefore, the red adder has fixed output, and the input to the green and blue adders is variable in order that their outputs may be adjusted to be equal. The three amplifiers (adders and output stages) are otherwise identical. Shunt and series video peaking is used as high frequency compensation for optimum video response. A specially designed triple diode tube (6BC7), is used for DC restoration for the three output stages. Three "background", or brightness, controls (1R162A, 1R162B, 1R124A) are used because the phosphor light output versus kinescope grid bias is not the same for each gun. Figure 55 shows a simplified diagram of the kinescope controls. Assume that the blue and green background controls are positioned so that the bias applied to each kinescope grid will be the same.

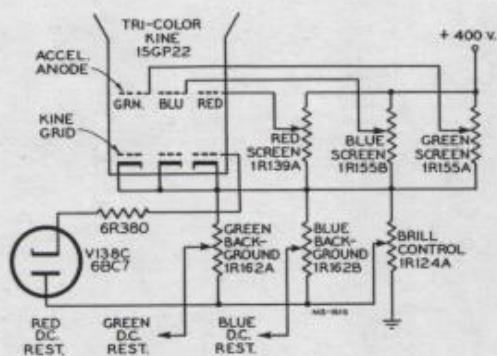


Fig. 55—Simplified Diagram—Kinescope Controls

If the brightness control (1R124A) is set for high brightness and the screen controls (1R155A, 1R155B, 1R139A) are adjusted for a white raster, the raster will not remain white when the brightness control is adjusted to give a low level of brightness. (NOTE: The screen controls vary the voltage on the accelerating anode and are generally adjusted for a low level white. Before checking the brightness control action a black-and-white signal should be received, and the video gain controls adjusted for a black-and-white picture). With the brightness control at a low level, the blue and green background (brill) controls will require slight adjustment in order to produce a grey picture having no trace of color. This adjustment is sometimes referred to as "tracking".

## TRICOLOR KINESCOPE

### Purity and Convergence

Because an assembly of three electron-guns (see figure 56) having inter-dependent variables is used in the tricolor kinescope, special compensating devices not used with black-and-white kinescopes are required.

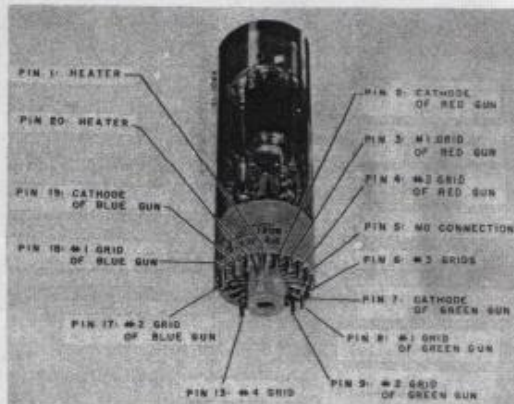


Fig. 56—Tricolor Kinescope Electron Guns

The cut-away drawing, figure 57, shows that, unlike the black-and-white kinescope, it is necessary for each of the three beams to be projected through a hole in the shadow mask to excite its respective phosphor dot. The beams must be projected at such an angle that each beam will strike only its particular color phosphor dot. As the beam sweeps from one trio to the next the mask "shadows" the adjacent dots in the trio and prevents excitation of the other two dots by the electron gun intended to excite the third. It is essential that the three beams excite only their respective phosphor dots in the same trio. Excitation of all of the phosphor dots is required to produce white.

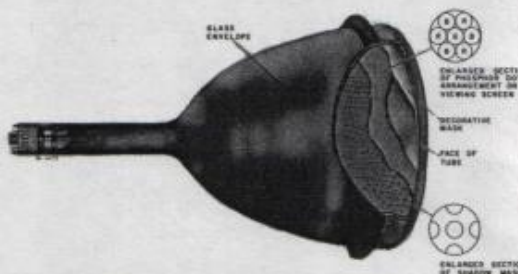


Fig. 57—15GP22 Tricolor Kinescope—Cut-away Drawing—Faceplate end

Figure 58(a) shows the beam from the green gun passing through a hole in the shadow mask and striking the correct phosphor dot. Figure 58(b) shows the same beam striking portions of both the green and blue dots. This would result in color contamination since each time the green gun was required to operate to produce green, it would produce instead, green and blue.

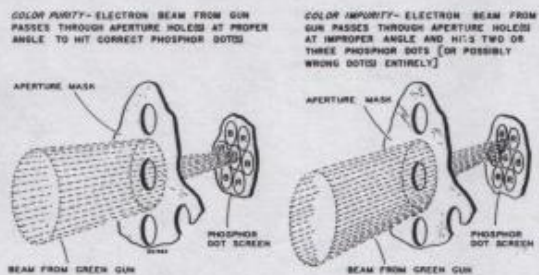


Fig. 58—Color Purity

In order to achieve the condition called "color purity" (or "purity") shown in figure 58 (a) the purity coil (2L143, 2L144), shown in figure 59 is rotated around the neck of the kinescope and the DC current through the coil is varied with the Cross Purity control, until the beam being adjusted strikes only its respective phosphor dots. This is indicated by a solid color field on the viewing screen. This operation is performed for each of the three beams until optimum color fields result. Usually the red adjustment is made first.

To prevent stray external magnetic fields from affecting color purity by deflection of any of the electron beams, a mumetal shield, as shown in figure 59 is placed around the major portion of the kinescope. A small magnetic field from the field neutralizing coil (2L137), installed around the faceplate, neutralizes any stray magnetic fields that might affect color purity near the edges of the picture.

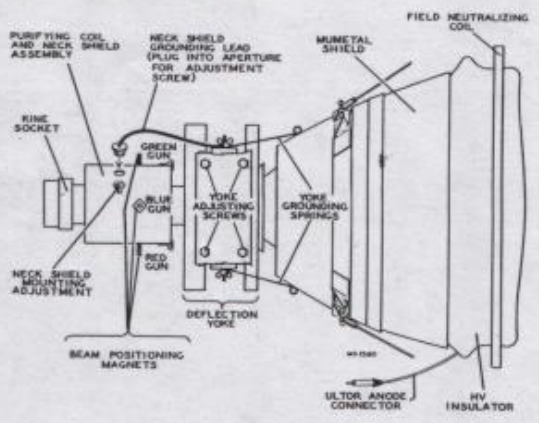


Fig. 59—Purity Coil, Yoke and Beam Magnet Adjustments

The field neutralizing control, 2R107, regulates the DC current in the coil and effectively controls the amount of neutralizing magnetic flux about the coil and the edges of the picture.

Although it would seem that these adjustments would eliminate the possibility of color contamination, it is possible that a beam would excite its respective phosphor dot through the wrong hole in the shadow

mask. This is illustrated in figure 60, where the purity adjustment is correct (i. e. the beams are exciting the proper phosphors) but the blue beam is exciting a blue phosphor dot in the wrong dot trio. This again would result in color contamination.

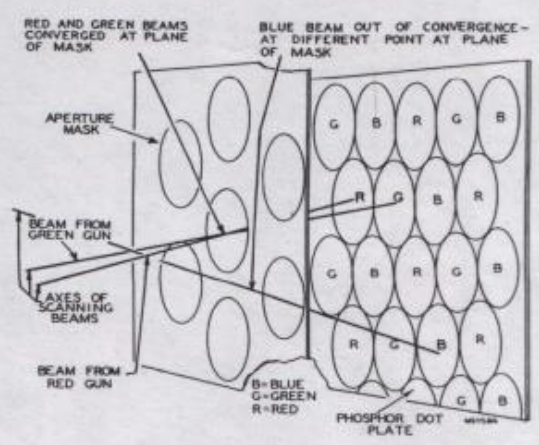


Fig. 60—Beams out of Convergence

It becomes necessary then, to make additional adjustments in order to have the beams converge and pass through the same hole in the shadow mask so that the three beams strike only their respective phosphor dots in a particular trio. In order to adjust convergence properly, a piece of test equipment, called a "dot generator", is used. The dot generator provides a considerable number of small rectangular areas, called "dots", on the screen of the kinescope. These indicate output from each of the electron guns. When proper convergence is achieved, a series of white dots, indicating that the red, green and blue beams are properly registered, appears on the viewing screen.

The output of the dot generator may be fed into the video section (or the antenna input, depending upon the design of the dot generator) of the color receiver and a series of dots, as shown in figure 61 will appear on the viewing screen. The DC Convergence Control governs the voltage applied to the convergence anode of the kinescope.

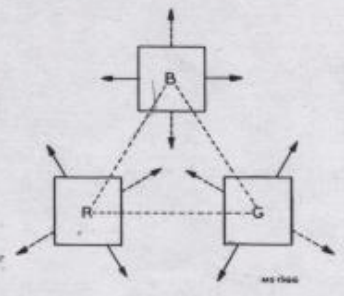


Fig. 61—Dot Convergence Pattern

It may not be possible to achieve convergence in the center of the screen with the DC convergence control alone, therefore an assembly containing three small permanent magnets (one for each gun) is positioned about the neck of the kinescope with each magnet perpendicular to its respective electron-gun. The magnets can be adjusted to compensate for slight deviations in the dot patterns by controlling the electron beams, as shown in figure 61, and are adjusted by screwing toward, or away from, the electron guns.

When adjusting convergence it is desirable to compensate as much as possible with the DC convergence control rather than the magnets, since each magnet has some effect on all of the electron beams.

Both the magnets and the DC convergence adjustments would be sufficient if the shadow mask could follow the curvature of the arc produced during deflection of the three beams. It can be seen in figure 62 that when the convergence is correct in the center of the screen it will be incorrect at the outer edges, and when correct at the outer edges will be incorrect in the center.

By adjusting the DC convergence correctly for the center of the screen and then modulating the DC convergence voltage with an AC voltage having a parabolic wave-shape, and in-time with the beams as they sweep across the face of the tube, uniform convergence over the entire screen can be obtained.

This correction is called "dynamic convergence" and is corrected in both the vertical and horizontal planes. Figure 63 shows that the horizontal conver-

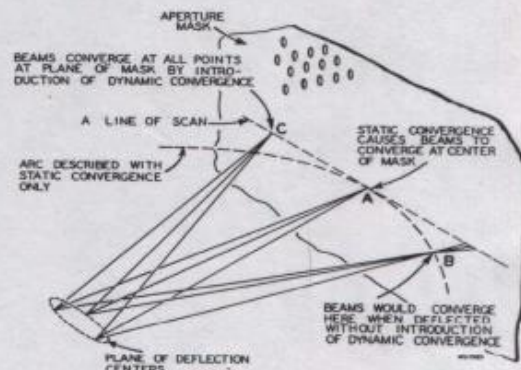


Fig. 62—The Effect of Dynamic Convergence

gence voltage is derived from the horizontal output transformer through an amplitude control (1R238), and a shaping circuit consisting of 1L138, 3C202 and 3L139. 1R238 provides control over amplitude and 1L138 over the shape of the dynamic convergence modulating voltage.

Vertical convergence voltage is derived from the vertical output tube, V128, applied to the Vertical Convergence Amplifier V119, a type 12AU7. The Vertical Shape Control 1R248B controls the shape of the waveform applied. 1R248A controls the amplitude of the voltage supplied from the vertical output circuit. The composite horizontal and vertical output voltage from the Vertical Convergence Amplifier is then applied to the convergence and focus elements of the kinescope.

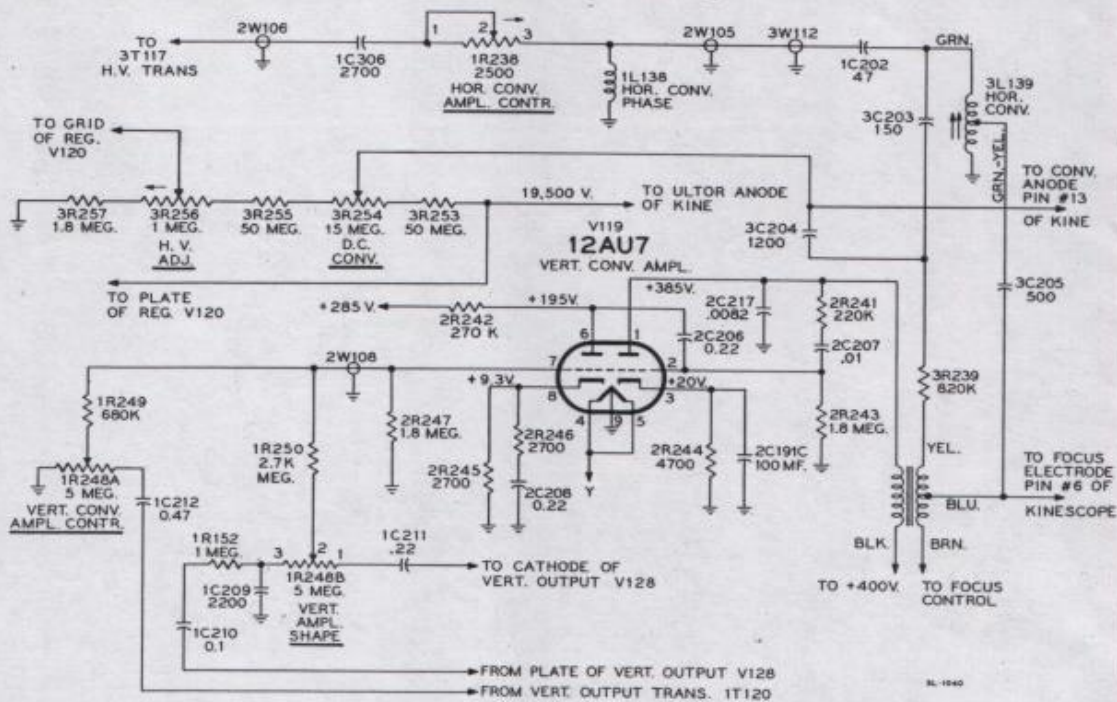


Fig. 63—Vertical Convergence Amplifier Schematic

It can be seen in figure 62 that the length of the beams varies as they sweep across the flat surface of the screen, therefore, in order to maintain focus across the entire face of the tube the focus voltage will have to change accordingly. By modulating the focus voltage similar to that for dynamic convergence, optimum focus can be obtained over the entire screen. Optimum focus and convergence are illustrated in figure 64.

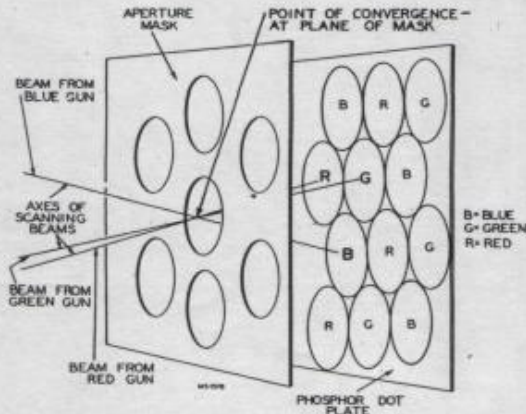


Fig. 64—Optimum Convergence

### COLOR SYNCHRONIZATION

In the discussion of the detection of the color signals in the chrominance channel the need for two 3.58 mc. carrier signals was shown. A block diagram of the color synchronization stages is shown in figure 65.

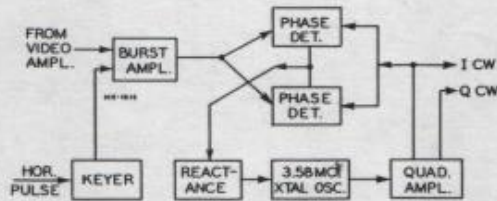


Fig. 65—Block Diagram—Color Synchronization Stages

The color synchronization section of the receiver creates these signals ("I" CW and "Q" CW) with a 3.58 mc. crystal oscillator (V131B) and a quadrature amplifier (V130A). "I" CW is maintained in phase with the transmitter by means of a phase detector (V129B and V130B) and a reactance tube control circuit (V131A). Burst reference is extracted from blanking by the action of a keyer tube (V116B) on the burst amplifier (V129A).

#### Keyer and Burst Amplifier

A simplified schematic diagram of the Keyer and Burst Amplifier stages is shown in figure 66. A negative pulse from the horizontal output transformer is applied to the grid of the keyer tube, the triode section of a 6AN8.

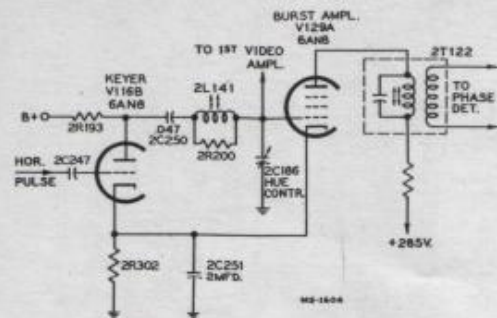


Fig. 66—Simplified Schematic—Keyer and Burst Amplifier

This pulse does not develop any appreciable voltage at the cathode because of the large 2 mfd. capacitor (2C251), but a large positive pulse is present in the plate circuit. This positive "spike" is coupled to the grid of the burst amplifier tube, the pentode section of a 6AN8, through a .047 mfd. capacitor. The tube is driven into conduction by this spike and allows the 3.58 mc. burst signal, from the video amplifier, to be amplified. A coil (2L141) in the video amplifier, is effectively in the grid circuit of the burst amplifier and is tuned to 3.58 mc. The variable capacitor (2C186), labeled "Hue Control", is a front panel control for adjustment of burst phase. After the color sync section has been properly adjusted, any change in the setting of the "Hue Control" changes the phase of the "I" CW and "Q" CW signals, and causes a change in the colors reproduced on the kinescope.

The plate circuit of the burst amplifier is also tuned to 3.58 mc. and the amplified signal is transferred to the phase detector by means of the burst amplifier transformer (2T122).

#### Phase Detector

The function of the phase detector is to detect any variation between the phase of the locally generated "I" CW signal and the phase of the burst reference signal from the transmitter. Figure 67 shows the triode sections of two 6AN8 tubes (V129B, V130B) used as diodes in a balanced detector circuit.

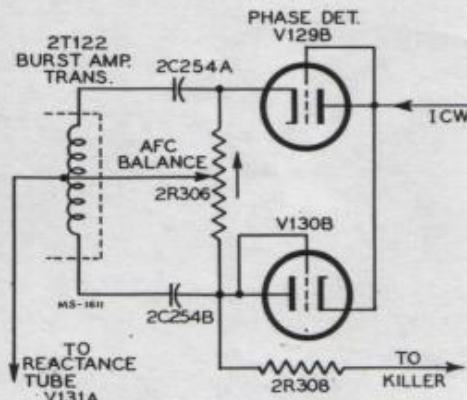


Fig. 67—Simplified Schematic—Phase Detector

A signal ("I" CW) from the quadrature amplifier circuit is applied to the plate and grid of V129B which is connected to the cathode of V130B. The burst signal from the burst amplifier transformer (2T122) is applied to the cathode of V129B and the grid and plate of V130B. Whenever the CW signals are not correctly phased with burst, as a result of oscillator drift, a correction voltage is developed in the phase detector and is fed to the reactance tube which corrects the frequency and/or phase of the 3.58 mc. oscillator.

### 3.58 mc. Oscillator, Reactance Tube, and Quadrature Amplifier

This portion of the color synchronization section creates two 3.58 mc. CW signals, displaced 90° in phase. Refer to simplified schematic diagram, figure

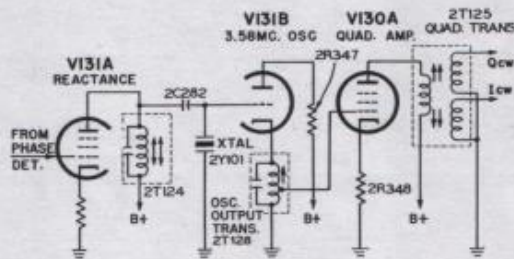


Fig. 68—Simplified Schematic—3.58 mc. Oscillator, Reactance Tube, Quadrature Amplifier

68. The crystal oscillator, a triode section of a 6AN8 (V131B), has an output transformer (2T128) in its cathode circuit. The adjustment of 2T128 determines the amplitude of the signal which is applied to the grid of the quadrature amplifier, the pentode section of a 6AN8 (V130A). The transformer (2T125), in the plate circuit of the quadrature amplifier, provides a means of dividing the signal in two, with one of the resulting signals ("Q" CW) 90 degrees out of phase with the other ("I" CW). The "I" CW, or in-phase, signal is maintained in-phase by the phase detector

previously described. The "Q" CW or quadrature phase, signal is maintained 90 degrees displaced from "I" CW by proper adjustment of the transformer (2T125).

Although the quartz-crystal controlled oscillator is very stable, a reactance tube circuit is required to compensate for the slightest frequency or phase drift. A pentode section of a 6AN8 (V131A), is used as the reactance tube. When the circuit is properly adjusted, a capacitive reactance is added to the crystal grid circuit that resonates the oscillator tuned-circuits to the correct frequency. Whenever the "I" CW signal is not locked-in with the burst reference, a correction voltage (which may be of either positive or negative polarity, depending upon whether the frequency is higher or lower) is applied to the grid of the reactance tube. The change in conduction of the reactance tube presents greater, or less, capacitive reactance that tunes the 3.58 mc. crystal oscillator. When the frequency changes sufficiently for "I" CW to lock-in with burst, the correction voltage on the grid of the reactance tube is zero, and the circuit is said to be in "color-lock".

### SUMMARY

The RCA Victor Model CT-100 color television receiver embodies late developments in receiver circuitry necessary for high quality color, and black-and-white, picture reproduction.

A glance at the circuit schematic diagram will reveal much new circuitry. Each circuit has been discussed in detail to help the technician understand its operation and relationship to other circuits in the receiver.

Apart from the purely technical considerations, the receiver has been designed for ease in maintenance. Normal service controls are located at the front of the receiver chassis and can be adjusted while observing the kinescope. Kinescope and chassis adjustments are accessible when the top of the cabinet is removed.

## INSTALLING AND SERVICING THE RCA VICTOR MODEL CT-100 COLOR TELEVISION RECEIVER

### ANTENNA REQUIREMENTS

An antenna suitable for reception of color television signals has, in general, the same requirements as for black-and-white television reception. It should provide, at the receiver antenna terminals, a signal free from noise, interference and reflections.

Properly installed dipole and fan type broad-band antennas normally have adequate bandwidth to receive the full 6 mc. signal required for color television reception.

Figure 69 shows a dipole-and-reflector type antenna suitable for reception of both color and black-and-white television signals.

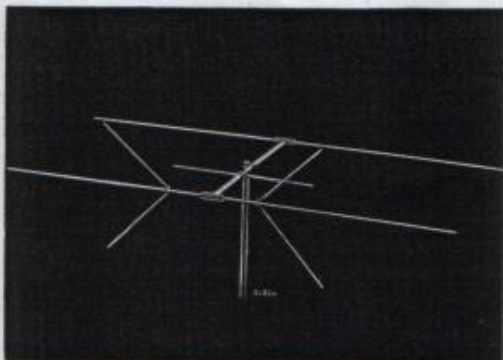


Fig. 69—Dipole-and-Reflector Type Antenna Suitable for Color Signal Reception

Some types of antennas, designed specifically for high gain, at a sacrifice in bandwidth, may not be suitable for color television reception although producing an acceptable black-and-white picture.

Gain is important, as in black-and-white reception, only to produce a signal free from noise or reflections.

Reflections, which in black-and-white reception may be unobjectionable, may cause partial, or even complete cancellation of the color sub-carrier "burst" if the signal path length difference is a half-wave multiple of the burst frequency (3.58 mc.).

Partial cancellation of burst results in considerably de-saturated color. Complete cancellation of burst results in no color at all. (With burst lacking, the color killer prevents color signal information from entering the chrominance channels of the receiver).

Interference, which appears as in black-and-white television (but in various colors) may sometimes be reduced by orientation of the antenna.

### Transmission Lines

The transmission line impedance should match the input impedance of the receiver, or the preamplifier if one is used.

Improperly installed transmission lines can result in a mis-match in the line impedance.

With unshielded transmission lines, running the line too close to metal objects or the use of a poorly designed lightning arrestor can cause a mis-match.

The commonly used 300 ohm unshielded line should be installed at least three inches away from any parallel surfaces including brick, stone and concrete. For short distances, inside, the line may be tacked to wood surfaces. Tacking should be avoided, if possible, when making long inside runs. Instead, a better method is to allow the line to contact wood only at intervals or to use stand-off insulators.

### Boosters

In some installations, where it is necessary to increase gain due to an extremely long line run, or lack of sufficient signal at the receiver antenna terminals, a booster is used.

The suitability of any booster, of course, is dependent upon its design. If the booster amplifies only a portion of the 6 mc. channel it probably will not provide adequate signal at or near the color sub-carrier frequency (3.58 mc. above picture carrier frequency). The installation of a booster having insufficient bandwidth into an adequate antenna system may result in loss of color information.

### Signal Distribution Systems

Multiple outlet distribution systems, with or without amplifiers, also require broad-band units (i. e. amplifiers, transformers, tap-offs, etc.) to provide an adequate color signal. Mis-matched impedances between units could result in lack of color signal information at the receiver antenna terminals.

Overloading of amplifiers in an attempt to obtain higher output may cause cross-modulation between the sound and color sub-carrier causing a 920 kc. beat to appear on the screen of the receiver. In installations where this occurs, reduction of the input signal will be required. Additional amplifiers may then be necessary to supply the required number of outlets.



Poor sync, distorted sound, reflections, smear, high-peaking (white outlines), weak picture and loss of color information in the vicinity of the 3.58 mc. sub-carrier frequency can be caused by improper isolation of receivers in a multiple outlet system. Each receiver should have *at least* 6 db. of resistive isolation from the transmission line.

Many color television receivers will be installed in place of, or in addition to, present black-and-white receivers and may be attached to the existing antenna system. Figure 70 shows a method of isolating two receivers when connected to a common 300 ohm transmission line. In installations where 72 ohm transmission line is used, 39 ohm resistors should be substituted for the 150 ohm resistors shown.

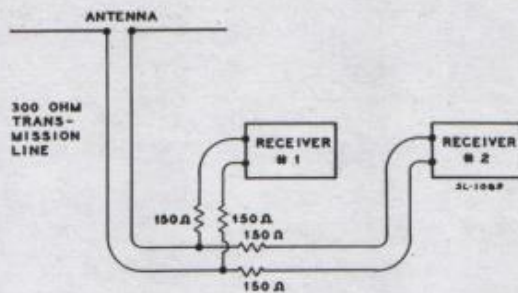


Fig. 70—A Method of Isolating Two Receivers on One Transmission Line

### Summary

The antenna requirements for color television reception are no more strict than for *good* black-and-white reception. Color will make the defects in a system more noticeable to the customer. If good installation and maintenance practices are followed, the customer will be assured of excellent pictures on both black-and-white and color receivers.

### INSTALLATION AND SET-UP ADJUSTMENTS

The following procedure outlines the method of installing the tricolor kinescope and associated components and performing the set-up adjustments in the receiver.

**NOTE:** A number of receivers have been shipped from the factory with the kinescope, yoke and purity coil assembly installed. Others have had the tricolor kinescope and associated components installed and properly adjusted in the factory, then disassembled and shipped with the receiver as a matched set.

The instructions apply to initial installation and set up as well as for replacement of the kinescope when necessary.

**CAUTION: DO NOT HANDLE THE KINESCOPE IN ANY MANNER UNLESS SHATTERPROOF GOGGLES ARE WORN.**

1. Remove cabinet back panel shown in figure 71. Remove cabinet top by removing wood screw and turning four latches under cabinet top.

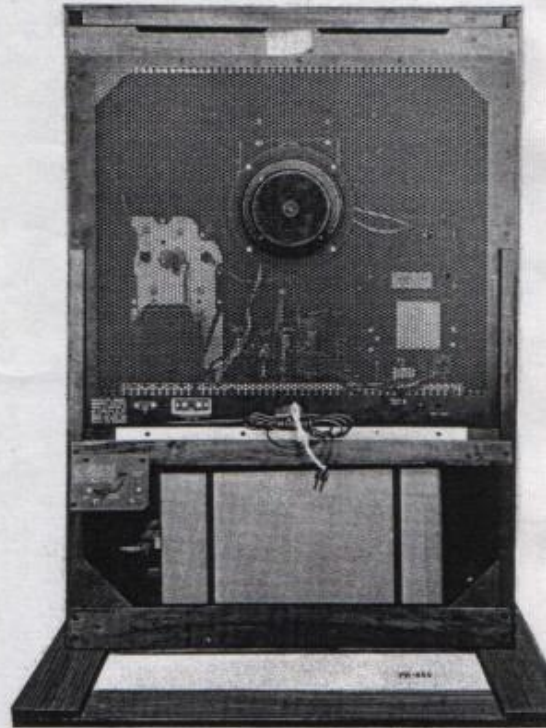


Fig. 71—Rear View—CT-100

2. Check contents of shipping carton. See figure 72.
3. Remove the cross-bar used to support the yoke assembly.



Fig. 72—Contents of Shipping Carton

4. Place kinescope face down on a protective surface and assemble, as shown in figures 73 and 74, the following items:

- High voltage anode lead
- High voltage insulator
- Mumetal shield
- Retaining ring

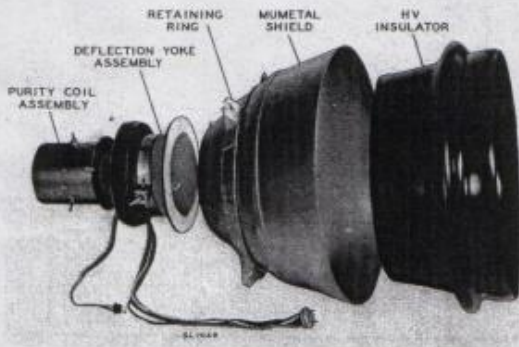


Fig. 73—Kinescope Accessories

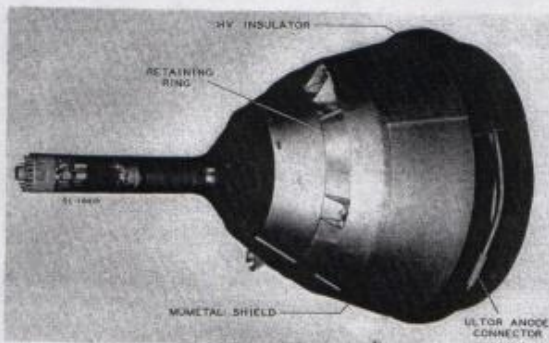


Fig. 74—Partial Installation of Kinescope Accessories

5. Place cabinet face down using a pad to protect cabinet front. Make sure pad is thick enough to prevent control shafts from being damaged.

6. Pick up the kinescope and, with the blue gun (near pin 17) toward you, place kinescope in the cabinet as shown in figure 75.

7. Install the four retaining rods by hooking them into the metal loops provided at the cabinet front. Slide the rods into the slots in the retaining ring brackets and tighten the knurled nuts just finger tight. See figure 76.

8. Return receiver to an upright position.

9. If necessary, loosen the knurled nuts slightly and rotate the kinescope to align the kinescope mask with



Fig. 75—Placing Kinescope in Cabinet

cabinet mask. Tighten the nuts *finger-tight* and tighten the plastic retaining blocks.



Fig. 76—Kinescope Mounted in Cabinet

### Installation of Deflection Components

1. Mount the yoke assembly on the cross-bar as shown in figure 77.

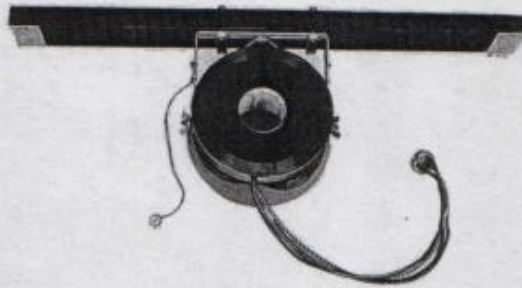


Fig. 77—Yoke Mounted on Cross-bar

2. Install cross-bar and yoke assembly. The front edge of the yoke should be positioned approximately one inch from the bell of the kinescope. See figure 78.

3. Slide the purity coil and neck shield assembly forward on the neck of the kinescope until the rear edge of the neck shield bracket is approximately  $\frac{1}{4}$  inch beyond the front edge of the kinescope socket.

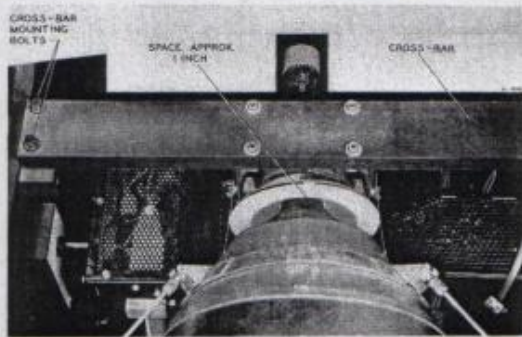


Fig. 78—Positioning the Yoke

4. Position the assembly to make the reference marks on the assembly bracket and on the kinescope neck coincide. Tighten assembly sufficiently to prevent it from changing position. Plug ground lead into the hole on the neck shield. See figure 79.

5. Rotate the purity coil flange to make reference marks on flange and on neck shield coincide.

6. Connect kinescope socket, H. V. lead, purity coil plug, deflection yoke plug, and the antenna transmission line.

Proper operation of the receiver for both color and black-and-white reception should now be possible.

### Set-up Adjustments

In the event that a tricolor kinescope requires replacement it may be necessary to make complete set-up adjustments. The following test equipment should be available:

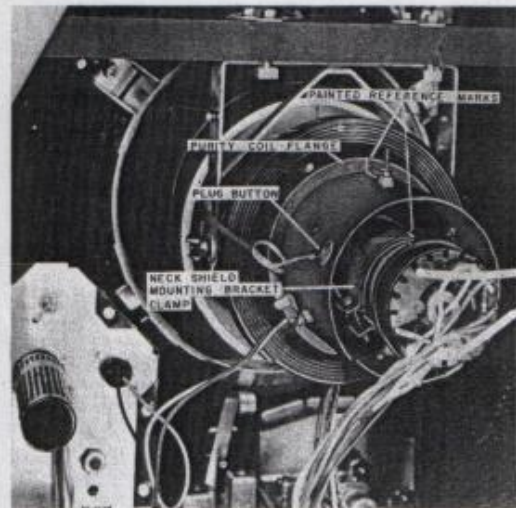


Fig. 79—Neck Shield Assembly

Vacuum Tube Voltmeter (RCA "VoltOhmyst" WV-97A or equivalent)

Dot Pattern Generator (RCA WR-36A or equivalent)

High Voltage Probe for measuring voltages up to 50,000 volts (RCA WG-289 High Voltage Probe or equivalent)

The following sequence of adjustments should be used. Tune in a black-and-white picture and check the horizontal and vertical size and centering.

### Width and Horizontal Drive Adjustments

1. Adjust the Horizontal Drive Control (figure 80) to the point where the vertical white fold-over line at the side of the screen just disappears.

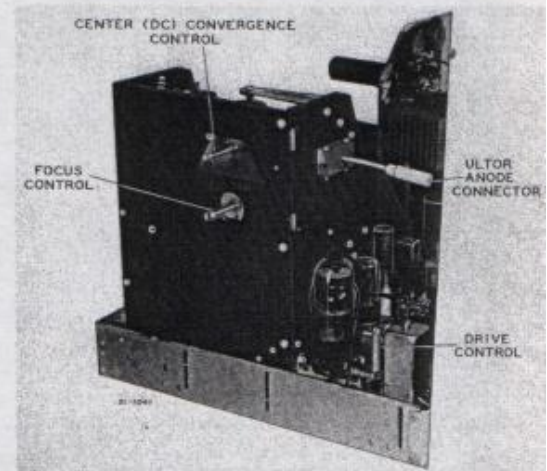


Fig. 80—Horizontal Drive, Focus and Convergence Controls

2. Adjust the Width Control to overscan the picture area *no more than* approximately one-quarter inch at each side. See figure 81.

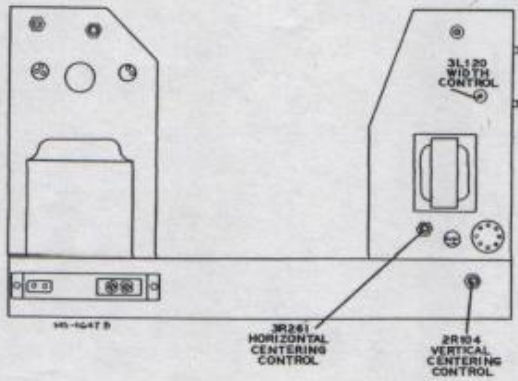


Fig. 81—Centering Adjustments

### Centering Adjustments

Adjust horizontal and vertical centering by means of the electrical centering controls on the rear of the chassis as shown in figure 81.

### Height and Vertical Linearity Adjustments

Adjust the Height Control and Vertical linearity Controls (see figure 82) until the picture is symmetrical from top to bottom.

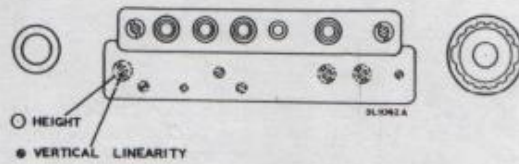


Fig. 82—Height and Vertical Linearity Adjustments

### High Voltage Adjustment

1. Set Contrast and Brightness Controls at minimum.
2. Place the High Voltage probe of the "Volt-Ohmyst" on the corona cup of the High Voltage rectifier tube as shown in figure 83.
3. Turn High Voltage Adjustment until 19,500 volts is indicated on the "Volt-Ohmyst."

### Color Purity Adjustments

1. Set Contrast Control to minimum.
2. Set Brightness Control for maximum brightness.

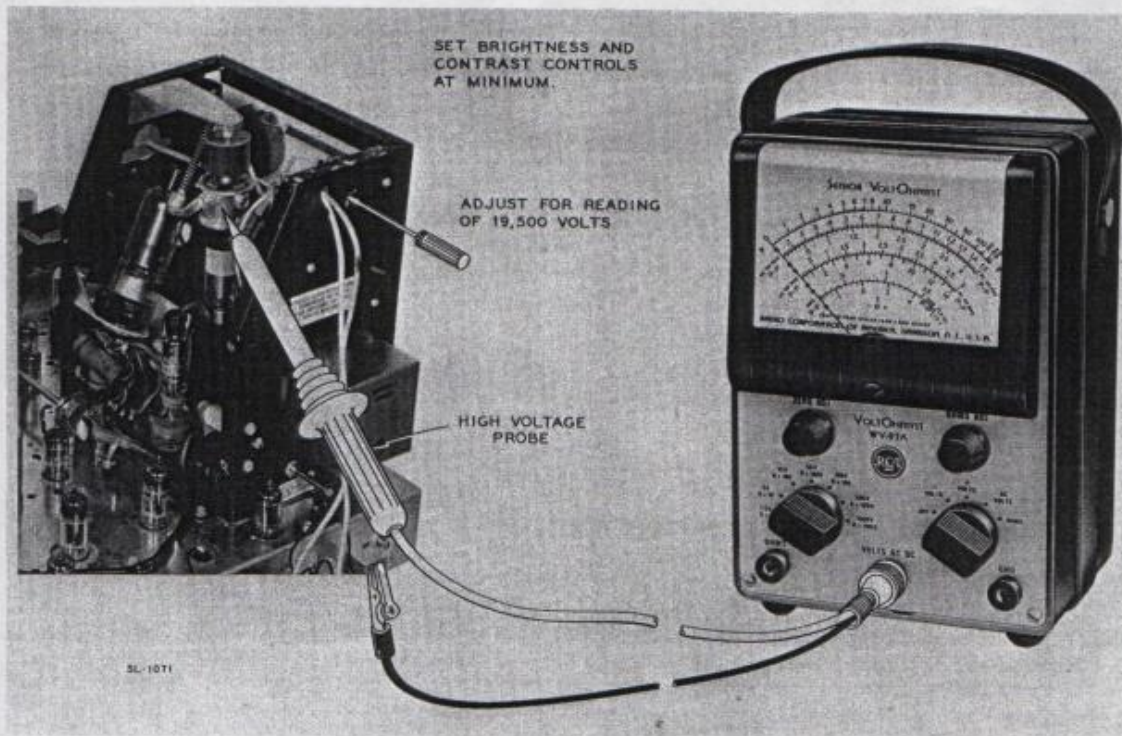


Fig. 83—High Voltage Adjustment

3. Set Green Screen and Blue Screen Controls at minimum.

4. Set Red Screen Control at maximum. See figure 84.

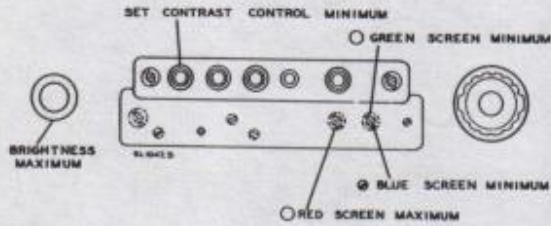


Fig. 84—Kinescope Screen Controls

5. Remove field-neutralizing coil plug shown in figure 85.

6. Loosen yoke cradle bolts and slide yoke to the rear as far as possible.

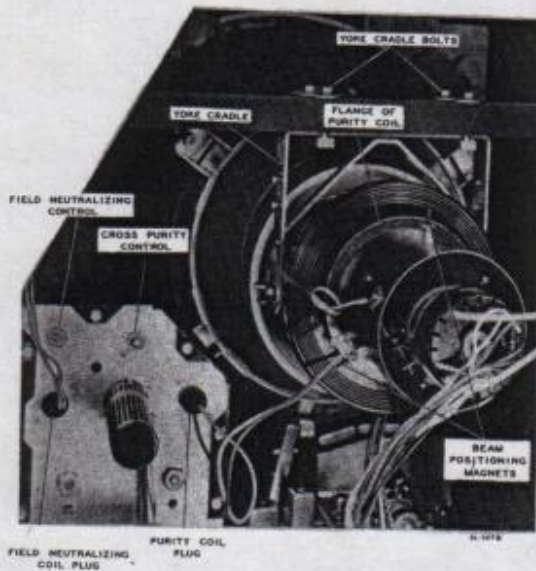


Fig. 85—Purity Adjustments

7. Turn the beam positioning magnets to their outermost position.

8. Rotate flange of purifying coil and adjust Cross Purity Control until the red area is in the center of the screen. Figure 86 shows improper purity adjustment. Use a minimum amount of cross purity adjustment (minimum position is counter-clockwise).

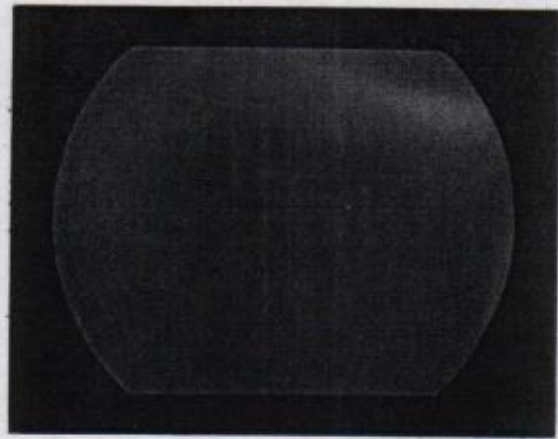


Fig. 86—Preliminary Purity Adjustment

9. Plug in field-neutralizing coil and move yoke assembly forward until an all red raster is produced. If color contamination exists, as shown in figure 87, adjust Field Neutralizing Control.

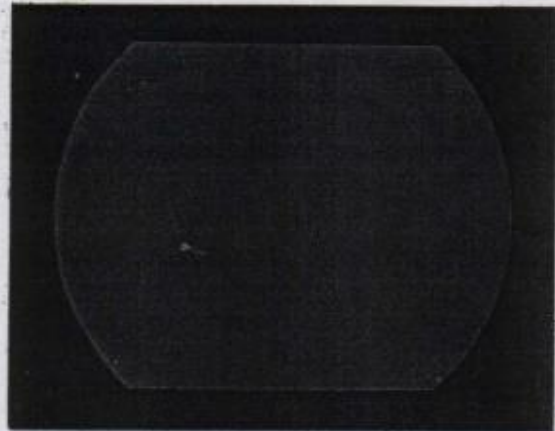


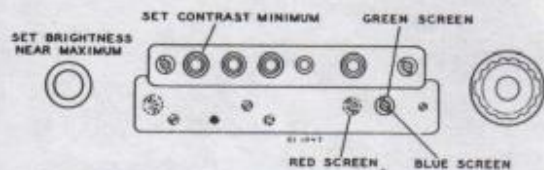
Fig. 87—Color Contamination

10. Check purity of the blue field and green field by turning the Red Screen Control fully counter-clockwise and advancing the Control of the blue screen or green screen separately. If any of the fields are not satisfactory a compromise adjustment must be made.

#### White Adjustment

As indicated in figure 88:

1. Set the Contrast Control to minimum.



1. ADJUST RED SCREEN FOR LOW LEVEL RED RASTER.
2. ADJUST GREEN SCREEN TO PRODUCE YELLOW.
3. ADJUST BLUE SCREEN TO PRODUCE A LOW LEVEL WHITE (GREY).

Fig. 88—White Adjustment

2. Set the Brightness Control for near maximum brightness.

3. Turn all screen controls counter-clockwise.

4. Advance the Red Screen Control to produce a low level red raster. Then, add green by advancing the Green Screen Control to produce yellow and, finally, add blue by advancing the Blue Screen Control to make a low level white (grey).

The grey raster showing at this point of the procedure should not be mistaken for the maximum white to be produced in a black-and-white picture. When a signal is tuned in, the brightness level will be increased. However, it is important that each of the three guns of the tricolor kinescope receive the same amplitude of signal. Otherwise, the gun receiving the largest signal will impart a color tone to the black-and-white picture. Therefore, it is necessary to equalize the gains of the video amplifier (adders).

#### Video Gain Adjustment

1. Tune in a black-and-white picture.

2. Adjust the green and blue Video Gain Controls (see figure 89) for a satisfactory black-and-white picture free from any overall color cast. Disregard any color fringing at this time.

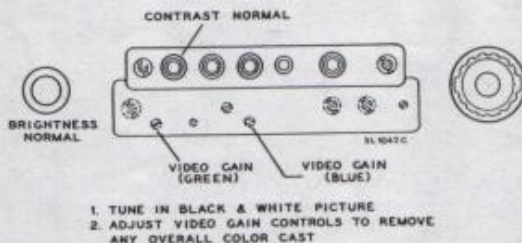


Fig. 89—Video Gain Adjustments

#### Background Adjustment

1. Turn down the Brightness Control to produce a very dark picture.

2. Adjust the Blue and Green Background Controls (see figure 90) to eliminate any overall color cast.

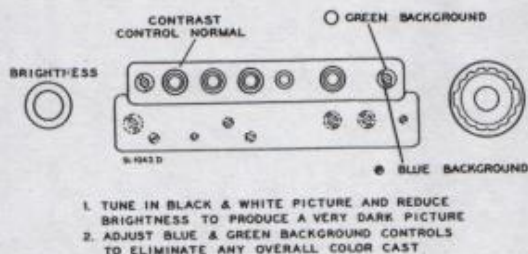


Fig. 90—Background Adjustments

#### Convergence

##### Center Convergence

1. Connect the Dot-Bar generator (RCA—WR-36A) as shown in figure 91. Adjust the generator until the pattern of white squares is synchronized.

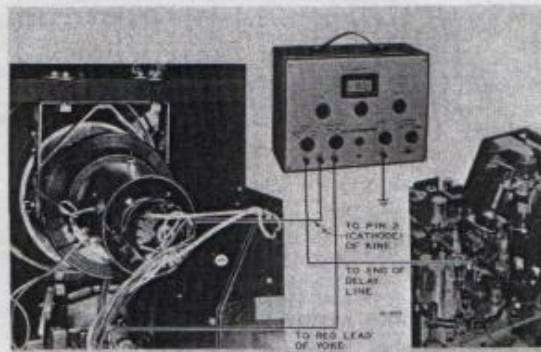


Fig. 91—Dot Generator Connections

2. Adjust the DC (Center) Convergence Control (refer to figure 80) for a minimum amount of color fringing on the dots in the center of the pattern. Adjust the Focus Control when necessary.

3. Adjust the beam positioning magnets on the kinescope neck shield until a single square near the center of the pattern shows no color fringing. Figure 92 shows the direction in which a particular square moves as a result of the magnet adjustment. The screws (which are the magnets) are removable and can be reversed to alter their range of adjustment.

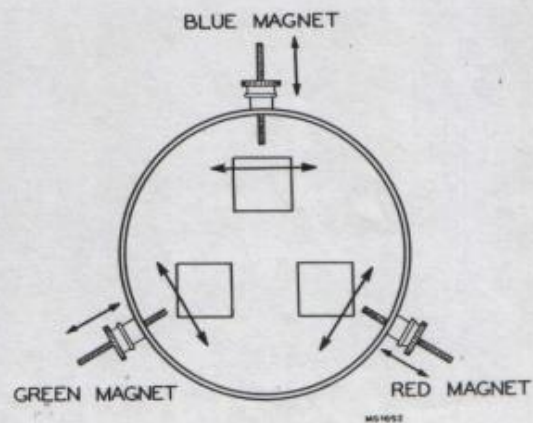


Fig. 92—Beam Positioning Magnet Adjustment

### Edge Convergence

1. Turn the DC Convergence Control to produce a slight displacement of the dots with the blue dot showing at the top.
2. Observe only one vertical line of dots. Figure



Fig. 93—Vertical Mis-convergence

93 illustrates in detail the unequal displacement of the blue dot. By proper adjustment of the Vertical Shape and Vertical Amplitude Controls (see figure 94) an equal amount of blue can be made to appear along the entire vertical line. When equal displacement of these dots is obtained the DC Convergence Control will superimpose the vertical lines of dots without any color fringing.

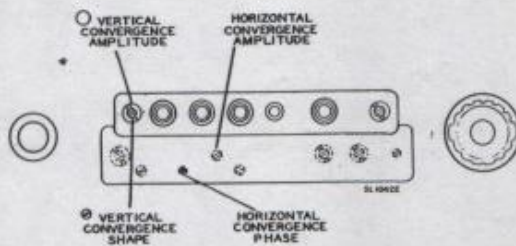


Fig. 94—Convergence Controls

3. Turn the Horizontal Convergence Amplitude Control to maximum. Adjust the Horizontal Convergence Phase Control until a horizontal line of dots appears similar to those shown in figure 95.
4. Re-adjust the Horizontal Amplitude control for equal displacement of the dots along the entire horizontal line.

The DC Convergence Control should now converge the dots over the entire area of the screen. If any area does not appear to be converged, and it can be converged by re-adjusting the DC Convergence Control, the Edge Convergence Adjustments should be repeated.



Fig. 95—Horizontal Convergence Amplitude Incorrect

### Summary

When the above installation and set-up adjustments are made there are a few important considerations to be kept in mind. First of all, the tricolor kinescope should be handled with care at all times. This is necessary not only from the standpoint of breakage but also due to the fact that excessive shock may alter the alignment of the gun assembly.

The bolts on the kinescope mounting assembly should be *only finger-tight* and never tightened with pliers. The clamp on the neck shield assembly should be just tight enough to prevent movement from vibration. It is important that the set-up adjustments be made in the order indicated. For example, the Width and Horizontal Drive Adjustments should be made before the High Voltage Adjustment. A change in horizontal drive could change the high voltage of the kinescope which, in turn, could cause mis-convergence of the three electron beams.

When making color purity an attempt should be made to use a minimum amount of current in the purity coil and field neutralizing coil. However, it must be understood that rotation of the purity coil will have no effect on the electron beams unless some current is passing through the coil.

The procedure for White Adjustment calls for an adjustment of the screen controls to produce a *low level white*. If a high level of white is produced (incorrect adjustment) a blooming effect may be experienced when the picture contrast control is advanced for normal contrast.

## SERVICING THE RECEIVER

Servicing color television receivers can be accomplished as readily and effectively as servicing black-and-white television receivers, when the functioning of each section of the receiver is thoroughly understood and proper service techniques are followed. When the following facts are considered, it can be seen that proper diagnosis can be achieved by following a line of reasoning based upon the knowledge of the functioning of each section of the receiver.

Fundamentally, the RCA Victor CT-100 television receiver functions as a black-and-white receiver. Therefore, if a good black-and-white picture can be produced it is a good indication that the circuits required to produce the picture are in good working order. These circuits include:

- Low voltage power supply
- High voltage power supply
- Horizontal and vertical sync
- Sound and Audio circuits
- Video amplifier and output stages
- Convergence circuits
- Horizontal and Vertical deflection
- Kinescope and Controls

The antenna, R-F Unit and Picture I-F circuits might also be added to this list but there might be occasions when they could affect color reception without noticeable effect on black-and-white reception.

This condition might occur when the R-F or I-F circuits are mis-aligned to the extent that the chrominance information is greatly attenuated. The antenna can be a cause of poor reception of color signals also. Antenna considerations for the reception of color signals are covered in a preceding section.

### Black-and-White Circuits Requiring Color Servicing Techniques

The sections of the receiver listed above, being necessary for black-and-white operation, will require the same servicing as black-and-white receivers. However, some of these circuits will require color servicing techniques to service the receiver when it is producing only a black-and-white picture. Each section is analyzed separately.

#### Video Output

At the time the receiver is set up for operation on black-and-white transmission the video gain controls are adjusted so that each red, green, or blue amplifier drives the grids of the kinescope sufficiently to produce the illusion of white from the red, green, and blue phosphors. It can be seen, then, that the lack of gain or complete loss of video output from one of the adder or output tubes would produce a picture with an overall color cast. A simple demonstration will clearly show this.

Remove the blue adder/output tube, 12BH7 (V136). The black-and-white picture should become a black-and-yellow picture because only the red and green phosphors are being excited. Although the screen appears yellow a magnifying glass will reveal only red and green phosphor dots being excited.

#### Convergence and Deflection Circuits

Convergence circuits are not required in a conventional black-and-white television receiver but are essential in the CT-100 to produce a proper black-and-white picture. As explained in Part II, convergence circuits are necessary to bring together in proper registration the images produced by the three electron guns of the tri-color kinescope.

Whenever the convergence voltages are incorrect, portions of the black-and-white picture will have colored edges. Removal of the 12AU7 Vertical Convergence Amplifier, V119, will produce a good example of this condition. Under this condition the black-and-white picture will have poor convergence at the top and bottom of the picture when the DC (center) Convergence Control is adjusted to give good center convergence.

Horizontal and vertical deflection circuits play a part in obtaining good edge convergence, too. As can be seen by referring to the schematic diagram, a winding of the horizontal output transformer, 3T117, supplies a voltage waveform for modulating the DC convergence anode voltage.

In a like manner a voltage waveform from the plate and cathode of the Vertical Output tube (V128) is applied to the DC convergence anode voltage through the Vertical Convergence Amplifier.

These circuits should not be overlooked when servicing the convergence circuits of the receiver. Before probing into these circuits however, it is well to try the horizontal and vertical convergence adjustments. Very often a few minutes spent in operating controls and adjustments will result in a quick and accurate diagnosis. For example, a receiver badly out of convergence should first be checked by attempting to converge the center of the picture with the DC Convergence Control. If this control has little or no effect the convergence anode voltage should be checked. This voltage might be very low due to an open 50 meg. resistor, 3R253. It is well to remember the relationship between the DC Convergence voltage and the mis-converged black-and-white picture. When the blue portion of a mis-converged picture is higher on the screen than the red or green it indicates that the DC convergence voltage is too high. When the blue portion is lower than the red or green the voltage is too low.



### Low Voltage Power Supply

Two components associated with the power supply must not be overlooked if a condition of color contamination exists on a black-and-white picture. These components are the Field Neutralizing Coil and the Purity Coil. Removing either one of these coils will demonstrate the effect they have on a normally operating receiver. If the amount of current through the coil is small the amount of color contamination may be barely noticeable.

### Kinescope Circuit

The tricolor kinescope and associated controls is another section of the receiver where unwanted color could appear in the black-and-white picture. Inasmuch as the kinescope has been designed to use red, green, and blue phosphors to produce a black-and-white picture, it can be readily seen that improper adjustment or operation could cause unwanted color in a black-and-white picture. Here again, a check of adjustments should be made to aid in the diagnosis of this section. Refer to White Adjustment and Background Adjustment in the Installation and Set-up Procedure.

Up to this point only that portion of the CT-100 necessary for black-and-white operation has been discussed. Now, servicing techniques for the few circuits devoted entirely to color reproduction will be discussed.

### Servicing the Color Circuits

The circuits of the CT-100 that function only during color transmissions are:

- Bandpass Amplifier
- Color Synchronization Circuits
- I and Q Demodulator Section

The following test equipment (or equivalent) should be available to facilitate servicing of the color circuits.

- RCA WV-97A "VoltOhmyst"
- RCA WR-59C Sweep Generator
- RCA WO-78A Oscilloscope
- RCA WR-61A Color Bar Generator
- RCA WG-295 Video Multi-Marker

### Bandpass Amplifier

The Bandpass Amplifier is basically a video amplifier with a frequency response as shown in figure 96. The servicing of this circuit is similar to conventional video amplifiers except that some of the components are adjustable so that the amplifier may be aligned to pass a band of frequencies.

If the Bandpass Amplifier is suspected of having an incorrect frequency response it may be checked as follows:

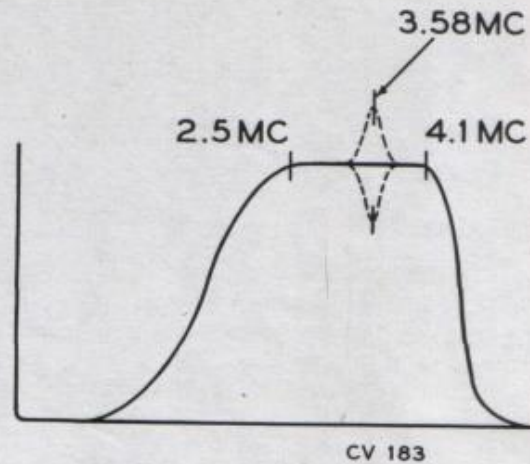


Fig. 96—Bandpass Amplifier Response Curve

1. Remove the fifth picture I-F amplifier tube, V113.

**CAUTION:** This tube operates at a very high surface temperature. Exercise extreme caution to prevent burns when removing tube.

2. Connect a video sweep generator in series with an absorption marker and a .1 mfd. capacitor.
3. Connect the .1 mfd. capacitor to the grid (pin 2) of the Video Amplifier tube, V114.
4. Connect an oscilloscope (using a diode probe) to the Color Control, 2R317.
5. Turn the Contrast Control, 2R204/2R210 and the Color Control, 2R317 to their maximum clockwise positions.
6. Adjust the Bandpass Transformer 2T126 (top and bottom) and the Bandpass Secondary Coil 2L121 (top) for maximum gain and curve shape as shown in figure 96.

### Color Synchronization Section

This section includes the following circuits:

- Burst Amplifier and Keyer
- Phase Detectors and Killer
- 3.58 mc. Oscillator, Quadrature Amplifier, and Reactance Tube.

The Color Sync Section may be sub-divided into two functional sections. One part creates a 3.58 mc. signal and the other maintains this signal in synchronization with the transmitter. If the part that creates the 3.58 mc. signal is not functioning, detection of the color signal cannot take place and consequently the picture will appear without color. This condition may be demonstrated by removal of the 3.58 mc. crystal, 2Y101. It might seem that if the burst signal were

not present in the color sync section the colors would not be locked in place. However, with such a condition, the bias signal is removed from the killer tube, V112B, which will cause the Bandpass Amplifier, V116A, to be cut off. Instead of a loss of color sync, then, a loss of color results. Loss of color sync may be demonstrated, however, by detuning the reactance transformer, 2T124.

Diagnosis in the Color Sync section may best be accomplished by using a color bar generator, such as the RCA WR-61A, and following the color AFC alignment procedure.

#### Color AFC Alignment

1. Connect the RCA WR-61A Color Bar Generator to the receiver antenna terminals.
2. Connect the R-F probe of the "VoltOhmyst" to pin 8 of V130A, Quadrature Amplifier tube.
3. Adjust 2T128 (top) for five volts *peak-to-peak*.
4. Ground the grid, pin 8, of the Burst Amplifier, V129A.
5. Connect the "VoltOhmyst" to terminal "A" of 2T125, quadrature transformer.
6. Adjust 2T125 (bottom) for maximum reading and the top for minimum.
7. Remove ground on the grid of the Burst Amplifier and set the Hue Control to the center of its range.
8. Connect the meter to pin 1 of the Phase Detector, V130B.
9. Adjust 2L141 (top) and 2T122 (bottom) for maximum reading.
10. Ground junction of 2L130 and 2R340. Adjust 2T124 Reactance Transformer for a slow swing of the meter needle.
11. Remove short at the junction of 2L130 and 2R340 and connect the meter to this point.
12. Shunt the 3.58 mc. crystal 2Y101 with a 15 mmf. capacitor.
13. Adjust the AFC Balance Control 2R306 for zero reading on the meter.
14. Remove the 15 mmf. capacitor and the "Volt-Ohmyst" and check the operation of the receiver for proper color reception.

#### I and Q Demodulators

The I and Q channels may be serviced in the same manner as a conventional video amplifier. Proper operation of the I and Q Demodulators may be determined by observing the gain and frequency response of each channel. This may be done as follows:

1. Ground the grid (pin 2) of the fifth picture I-F amplifier, V113. (This will prevent noise from appearing on the oscilloscope presentation.)
2. Remove the 3.58 mc. crystal, 2Y101.
3. Turn the Color Control fully clockwise.
4. Connect the Oscilloscope (using a diode probe) to the test point (2TP103) at the cathode of the I Phase Splitter.
5. Connect a video sweep generator to the grid (pin 1) of the I Demodulator, V132.

The response of the I channel may now be observed and checked with the I response curve as shown in figure 97.

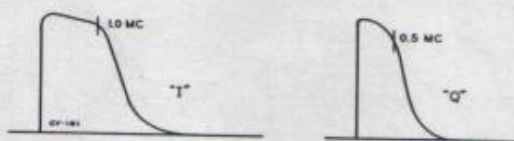


Fig. 97—"I" and "Q" Channel Response Curves

The response of the Q channel may be observed by sweeping the input to the Q Demodulator and connecting the oscilloscope to the cathode of the Q phase Splitter at the test point, 2TP102.

The knowledge that the I and Q Demodulator circuits are responsible for the reproduction of certain colors is of great help to the serviceman. The colors represented in the Q channel may be demonstrated by removal of the I Amplifier Phase Splitter tube, V134, while viewing a color test pattern or other color transmission. The colors reproduced on the tricolor kinescope will be predominantly green and magenta. This can be easily understood by analyzing the schematic diagram of the CT-100. Q of negative polarity (from the cathode of the Q Phase Splitter) is connected to the Green Adder stage. Q of positive polarity is connected to the Red and Blue Adders which will produce magenta. Therefore, whenever the I channel is disabled the reproduced color picture will appear in two colors—green and magenta. The two colors produced by the I channel are orange and cyan. If a condition of hum modulation of the signal should exist in either the I or Q channel the characteristic hum bars present in the picture would be in color! Hum in the I channel causes alternate bars of orange and cyan in the picture. Hum in the Q channel causes green and magenta bars.

### Fuse Data

There are five fuses in the CT-100 receiver. The following list gives the function of each fuse, stock number, and the effect upon the receiver when the fuse is open. Figure 98 shows the location of each fuse.

Symbol No.	Stock No.	Rating	Function
3F101	78798	.45 amp. 250 v.	To fuse 400 volt supply for the high voltage section.
2F102	79358	#26 AWG wire	To fuse the filament circuit.
2F103	79358	#26 AWG wire	To fuse the filament circuit.
2F104	73600	.25 amp. 250 v.	To fuse 400 volt supply.
2F105	79357	4.5 amp. 250 v.	To fuse secondary of power transformer.

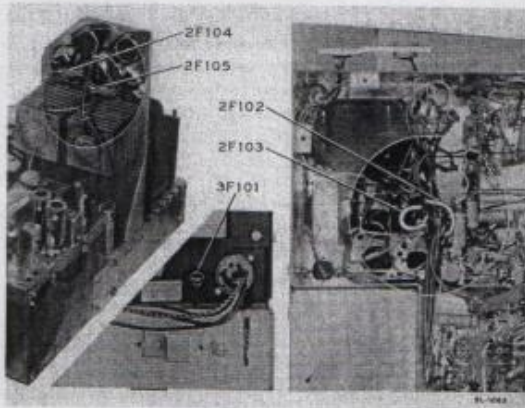


Fig. 98—Fuse Locations

An open fuse will have the following effect on the receiver:

- 3F101—No brightness (no High Voltage) sound normal
- 2F102—No brightness (no High Voltage) no sound. (no filament voltage on R-F unit)

2F103—No brightness (no filament voltage on kinescope) High Voltage normal. No sound. (no filament voltage in sound circuits)

2F104—No brightness (no High Voltage) sound normal.

2F105—No brightness, no sound, no B plus.

### SUMMARY

Service that may be required by the RCA Victor Model CT-100 color television receiver can be performed with the same ease as service for black-and-white television if the points listed below are followed.

1. Learn the function of each section of the receiver. You should be able to tell what is a normal operating condition and what is not.
2. Know what each adjustment or control is supposed to do. This knowledge leads to a quick diagnosis.
3. With the help of instruments, become familiar with the various waveforms as they appear normally.
4. Become proficient in alignment. (Complete Alignment Data appears in the Service Data for the Model CT-100 receiver.)
5. Know your color combinations.

Every effort has been made to include in this booklet, information which will facilitate understanding and intelligent servicing of the RCA Victor Model CT-100 color television receiver.

Although it is impractical to list every possible cause and remedy for all service requirements, a chart is included which shows some of the remedies for service that may be required.

As an additional aid for familiarization with tube layout and component location, the following pages show each section of the receiver and the chassis location of the major components in that section.

Consideration of the points listed above, together with previous television servicing experience, will enable the service technician to render to his customers the best color television service possible.

SERVICE SUGGESTIONS

<i>Service Required For</i>	<i>Indication on Screen</i>	<i>Probable Cause</i>	<i>To Remedy</i>
No Color	Black-and-white picture OK	High plate voltage V132, V133.	Check 2R320.
		Station not transmitting color signal.	Check station to make sure color is being transmitted.
		R-F oscillator off frequency.	Adjust fine tuning.
		Color Control not correctly adjusted.	Adjust Color Control.
		3.58 mc. crystal oscillator not operating or out of frequency range.	Read 5 volts peak-to-peak at pin #3 V131 (use VTVM with calibrated R.F probe).
		Color signal not reaching chrominance channels of receiver.	Check Bandpass Amplifier (V116) and components up to grids of V132 and V133.
	Antenna system not providing color signal information.	Check antenna.	
Color weak	"Washed-out" picture almost black-and-white.	Lack of color signal at V132 and V133.	Check antenna, fine tuning, Color Control, Brightness, AGC, Contrast.
		Weak signal.	
		Too much light in room.	
Colors separated	With DC Convergence at best setting, all three colors separated by about one inch. No control of high voltage by adjustment of high voltage control.	Low Plate Voltage V119.	Check 3R253, 3R255.
		V124 3C218 3R259 3R260 3C219 3R383	Check for leakage. Check resistance. Check resistance. Check for leakage. Check resistance.
Picture has wrong colors.	Picture in shades of red and blue only. (Black-and-white picture appears magenta.)	Green gun in kinescope not operating.	Check V135A, V125B. Check 1R155A Green Screen Control.
		Short in green gun of kinescope.	Replace kinescope.
	Picture in shades of green and blue only. (Black-and-white picture appears blue-green.)	Red gun in kinescope not operating.	Check V137A, V137B. Check 1R139A Red Screen Control.
		Short in red gun of kinescope.	Replace kinescope.
	Picture in shades of red and green only. (Black-and-white picture appears yellow.)	Blue gun in kinescope not operating.	Check V136A, V136B. Check 1R155B Blue Screen Control.
		Short in blue gun of kinescope.	Replace kinescope.
	Picture in shades of green and violet only.	"I" signal missing.	Check V132, V134 and "I" channel components. Check 2R361 "I" gain.
Flickering in color areas.	Loss of color sync.	Check V131A, 2T124 Reactance Transformer. Check V129B, V130B and associated circuit components.	

### SERVICE SUGGESTIONS

<i>Service Required For</i>	<i>Indication on Screen</i>	<i>Probable Cause</i>	<i>To Remedy</i>
Color "ghosts" in picture.	Severe color fringing (red, blue and green fringes).	Mis-convergence.	Check DC convergence Control. Check V128 and components.
	Color fringing (one color).	Low emission from kinescope gun of the fringing color.	Replace kinescope. (Check all kinescope voltages thoroughly before replacing tube.)
Light grey screen with no picture.	Picture blooming.	High voltage incorrect.	Measure and adjust High Voltage to 19,500 volts.
		Contrast and/or Brightness Control misadjusted.	Adjust Contrast and Brightness control.
		White level set too high. Raster OK with no signal; blooms off when signal present.	Readjust red, green and blue screen controls. Re-adjust low-light and high-light.
		High voltage OK (19,500 volts); pix still blooms.	Check V124.
Lines in picture.	Vertical lines at left side of screen. (Horizontal foldover.)	Too much horizontal drive.	Reduce horizontal drive. Check value of 3R268.

## RECEIVER OPERATING INSTRUCTIONS

### Black-and-White Reception

Turn On-Off—Volume Control to the right (clockwise) to turn set "on" (allow about 30 seconds warm-up) and advance halfway for medium volume.

Make sure Contrast Control is advanced (to the right) at least one-quarter turn.

Turn Channel Selector until desired UHF or VHF channel numbers appear in the lighted window.

Turn the Brightness Control fully left (counter-clockwise) and then slowly right until the picture appears. At this point, if picture is moving up or down, diagonally, sideways, or is split into segments, correct according to the following instructions.

For UHF—Turn Fine Tuning Control to the most counter-clockwise position; for VHF turn to the most clockwise position, until the picture starts to disappear. Then turn back slowly to the point where sound bars have just disappeared. After the picture is on a few minutes, further fine tuning adjustments may be required.

If use of Brightness Control (described above) does not render a suitable picture, adjust the Contrast Control in conjunction with the Brightness Control.

Select Tone preference—emphasize bass, normal or treble tones as Tone Control is turned to the right.

If picture is moving up or down on the screen, correct by turning the Vertical Control fully right then slowly left until picture become steady.

If the picture is moving sideways, diagonally, or contains many black and white lines, turn Horizontal Control slowly left, or right, until the correct picture appears; then turn slightly beyond.

If bars are flickering across the picture in time with the speech or music adjust the Fine Tuning Control until the bars disappear.

### Color Reception

Turn On-Off—Volume Control to the right (clockwise) to turn set "on" (allow about 30 seconds warm-up) and advance halfway for medium volume. Make sure Contrast Control is advanced (to the right) at least one-quarter turn.

Select a channel on which a color program is being broadcast. Should sound bars, or no color appear on UHF channels, turn the Fine Tuning Control to the most counter-clockwise position (on VHF channels, to the most clockwise position) until picture starts to disappear. Then turn back slowly to the point where sound bars have just disappeared and color is in the picture.

If still no color, advance the Color Control at least one-quarter turn. Adjust Hue (redness, blueness) quality of the picture for most pleasing flesh tones or color of some familiar object.

Adjust the Color Control for desired saturation or strength.

Alternately adjust the Color Control and Hue Control to obtain the most pleasing color rendition.

If color fringes appear on large objects, when receiving a black-and-white picture, adjust Convergence (on side of cabinet) for minimum fringing in the center of the picture.

If the picture is blurred, adjust the Focus Control (on side of cabinet) for clearest detail.

Note: When turning the receiver "off", picture controls may be left undisturbed to facilitate future tuning.

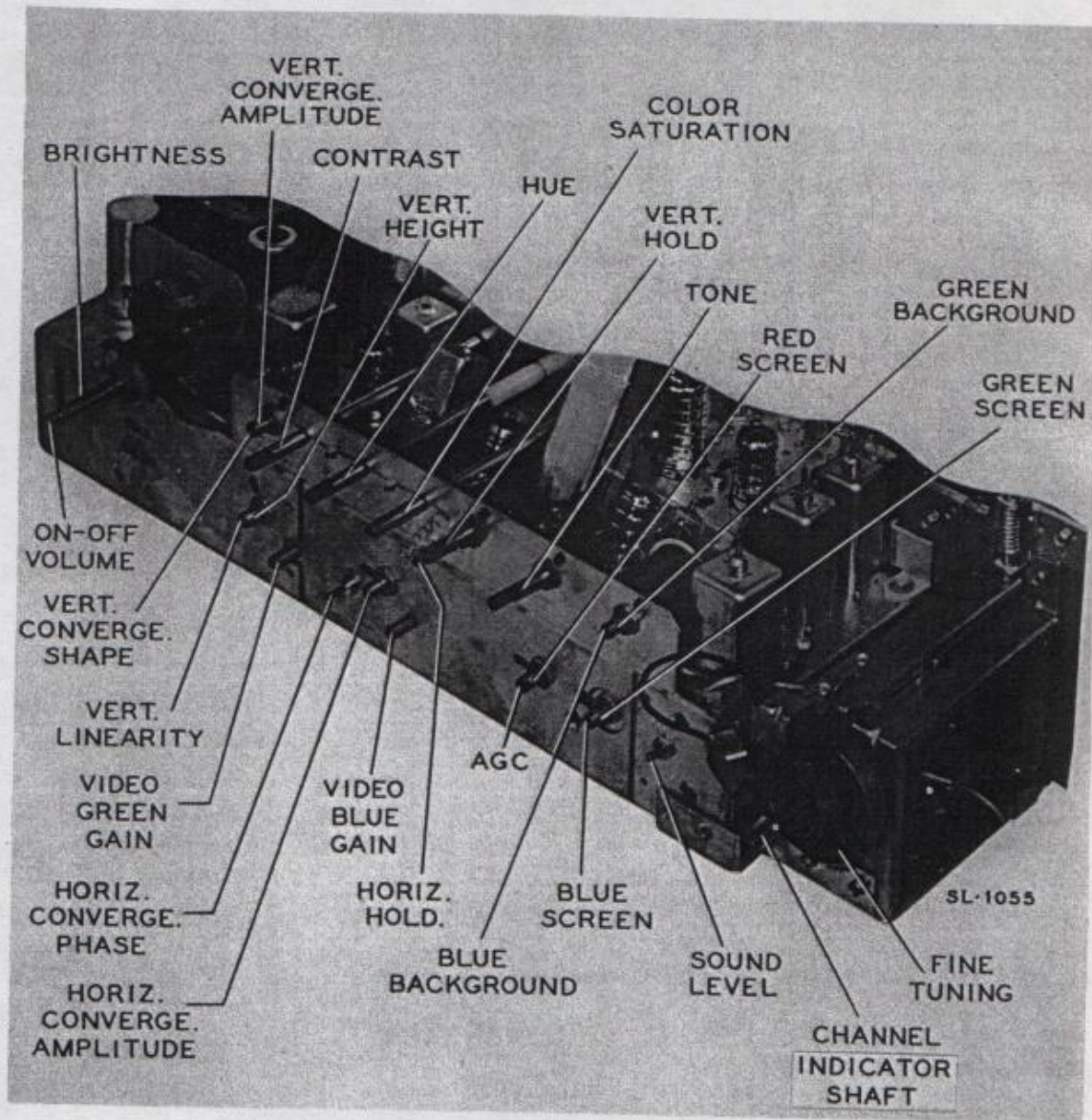


Fig. 99—Front Panel Operating Controls and Service Adjustments

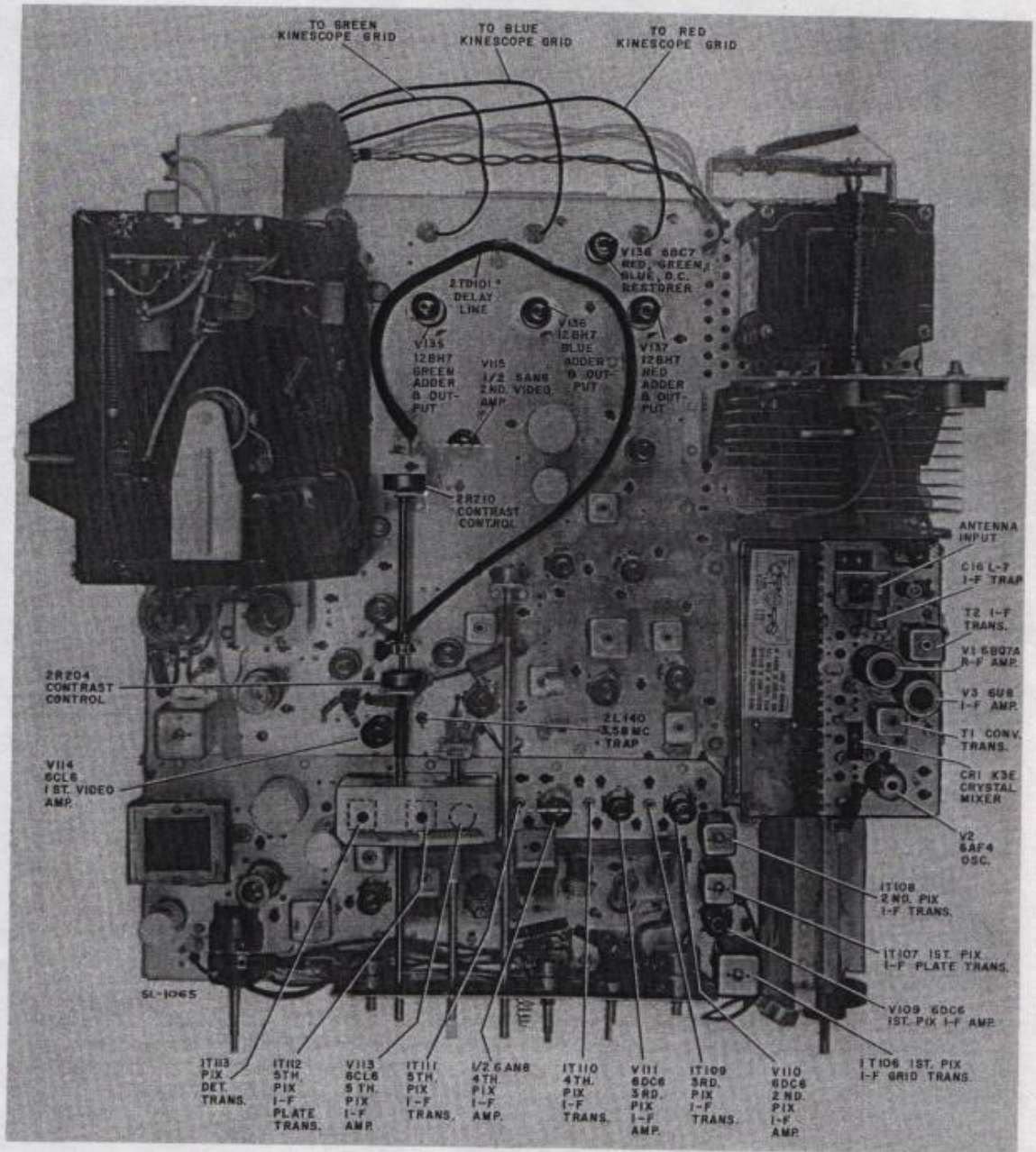


Fig. 100—R-F, I-F, Detector and Video Amplifier Component Locations



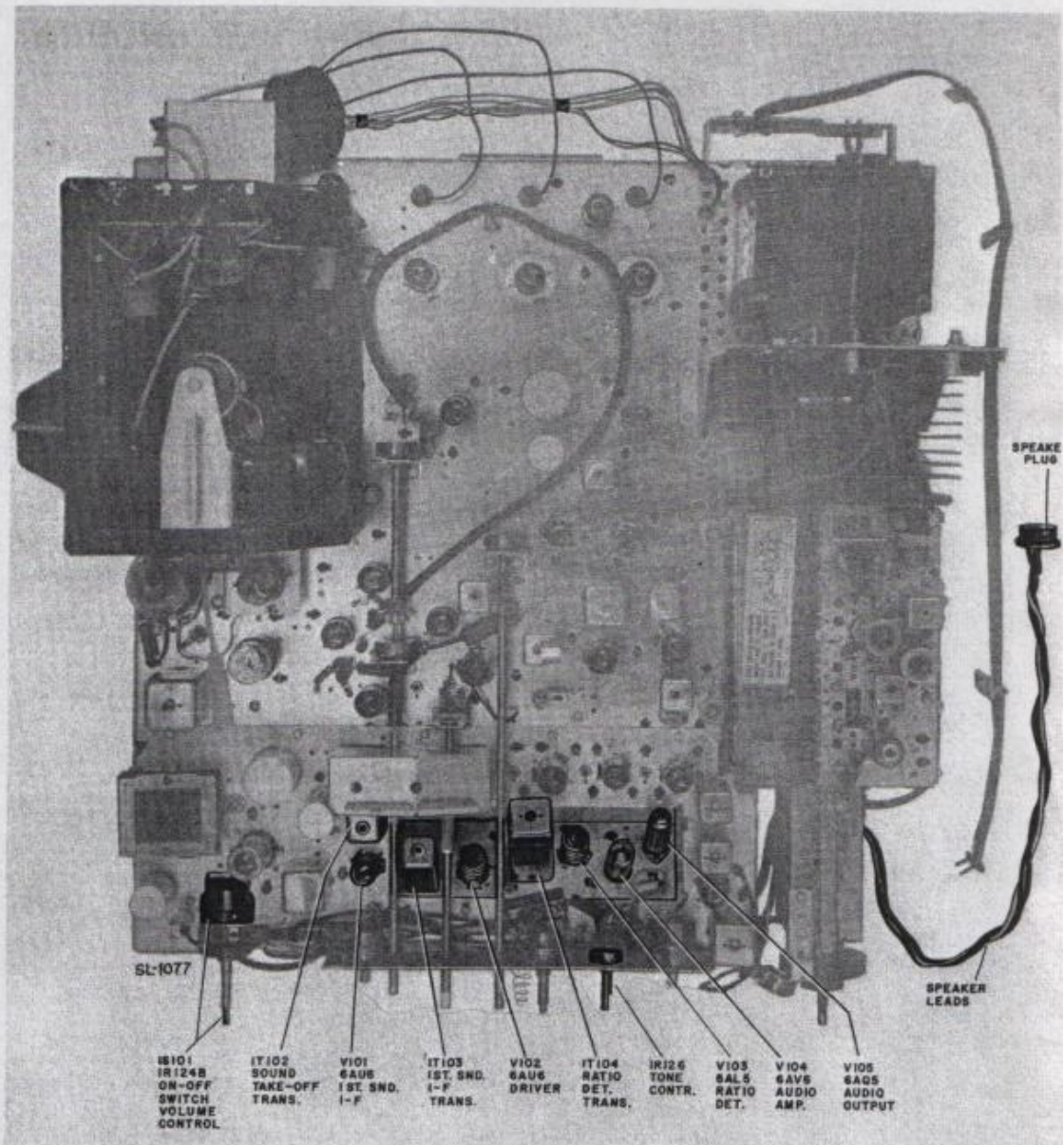


Fig. 101—Sound I-F and Audio Amplifier Component Locations

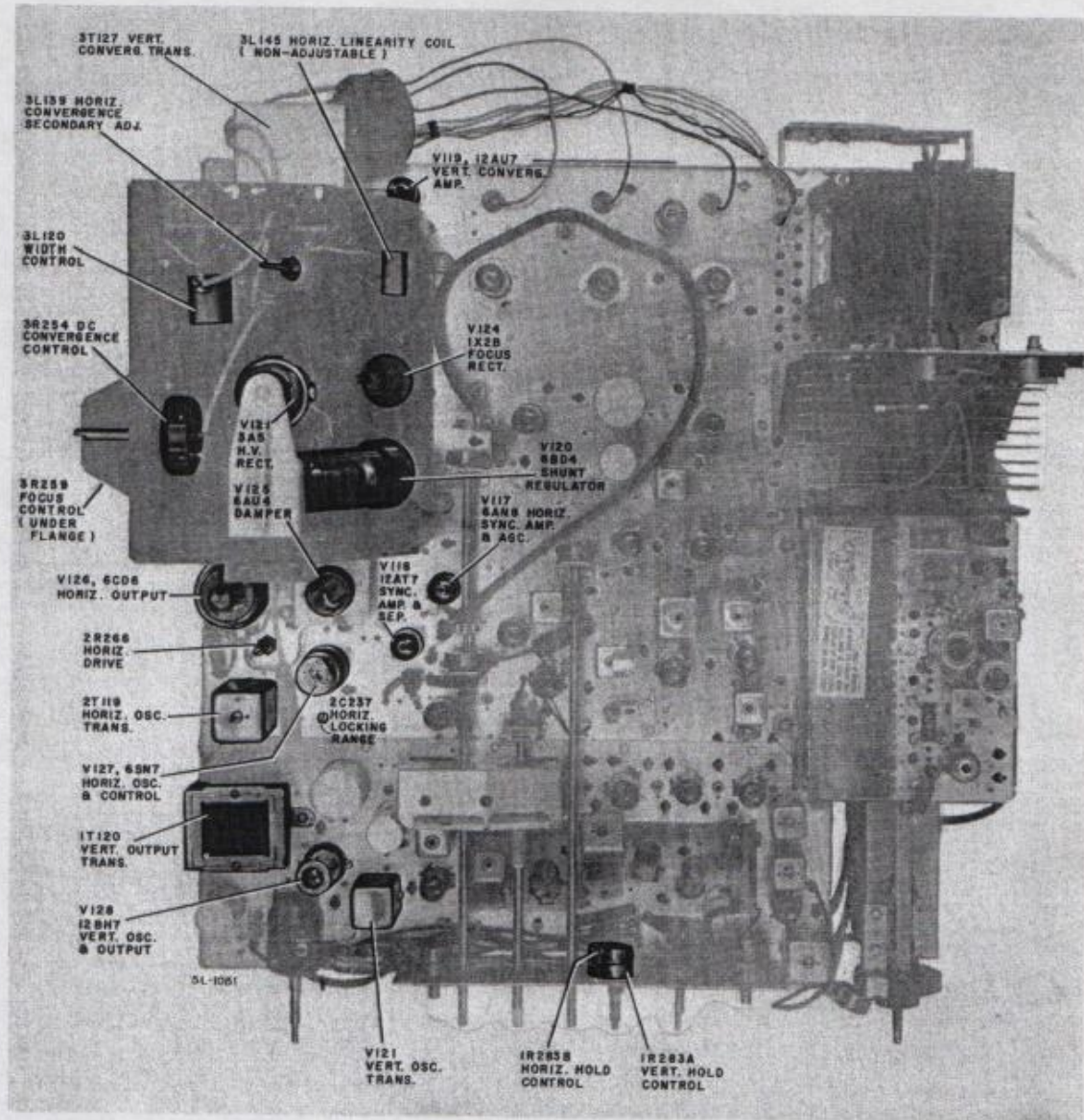


Fig. 102—Horizontal and Vertical Sync, High Voltage, and AGC Component Locations

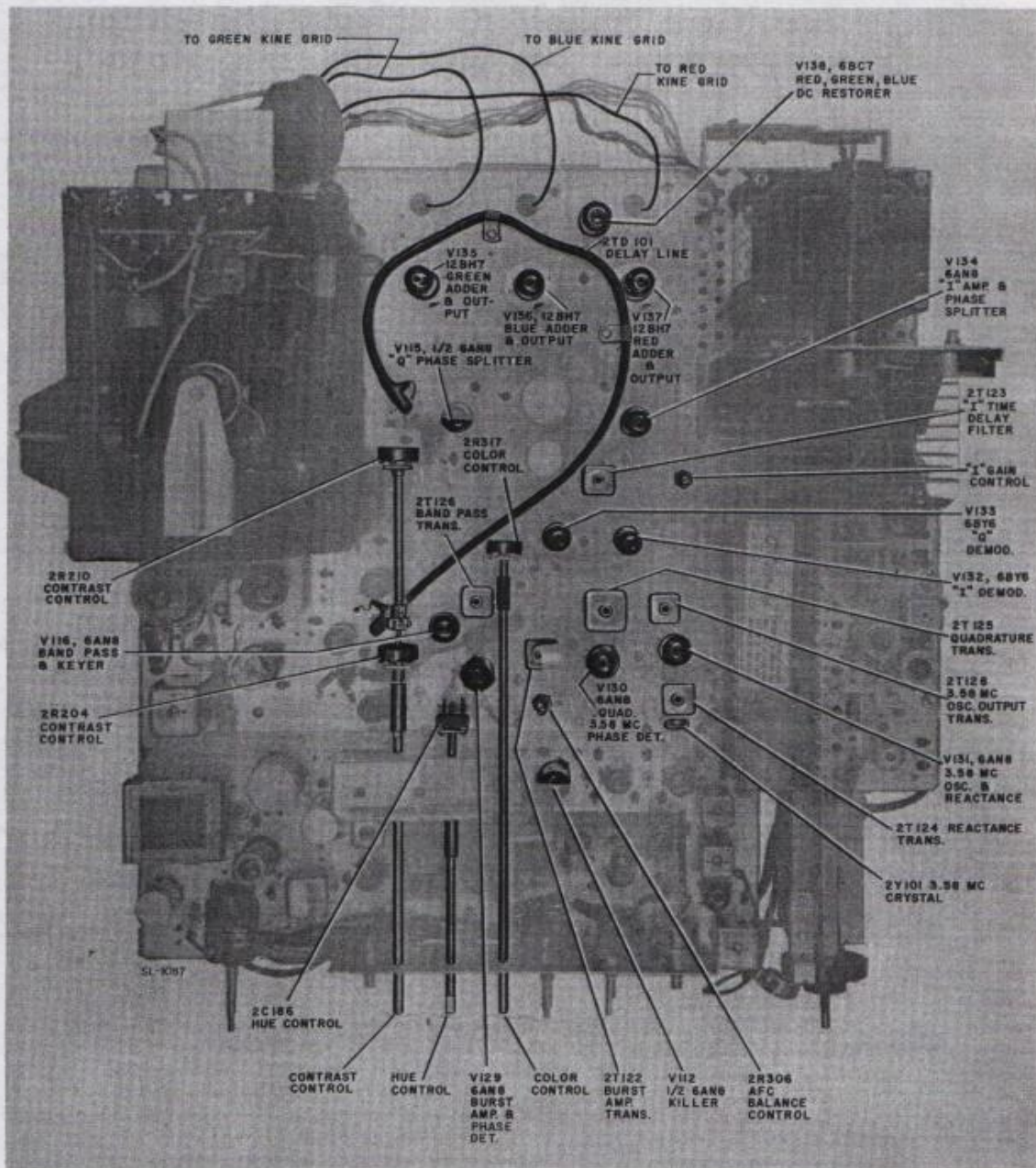


Fig. 103—Chrominance and Color Sync Component Locations

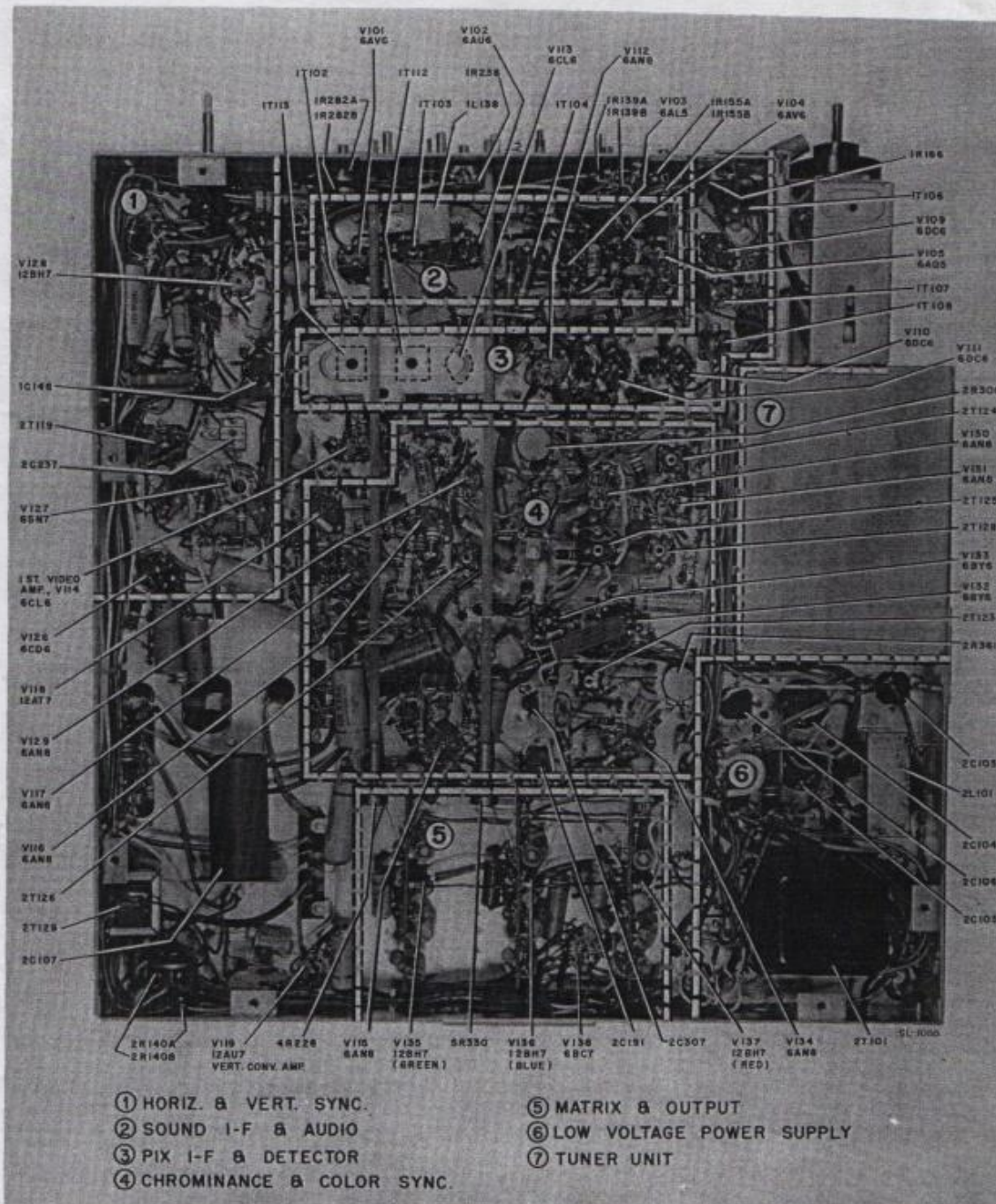
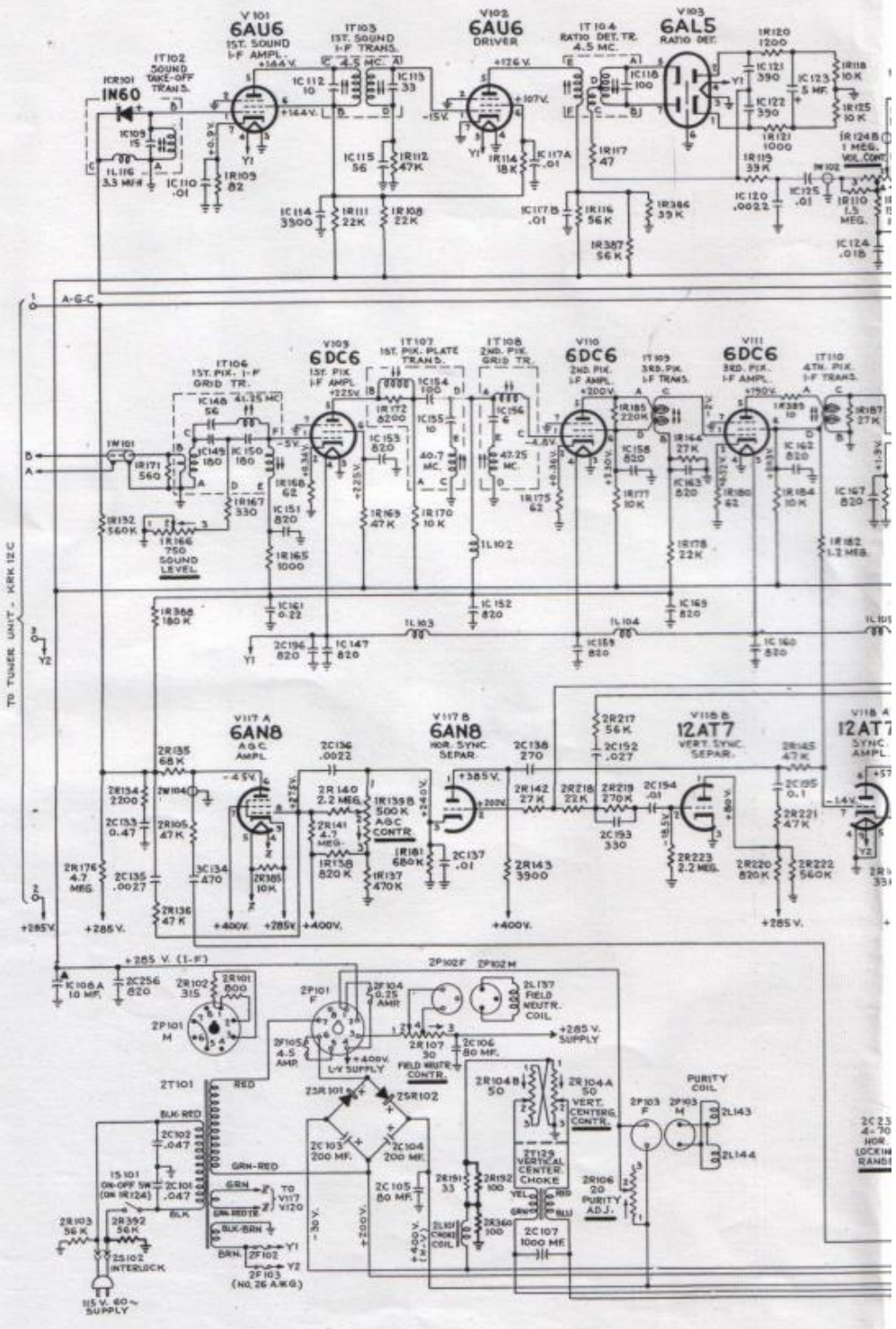
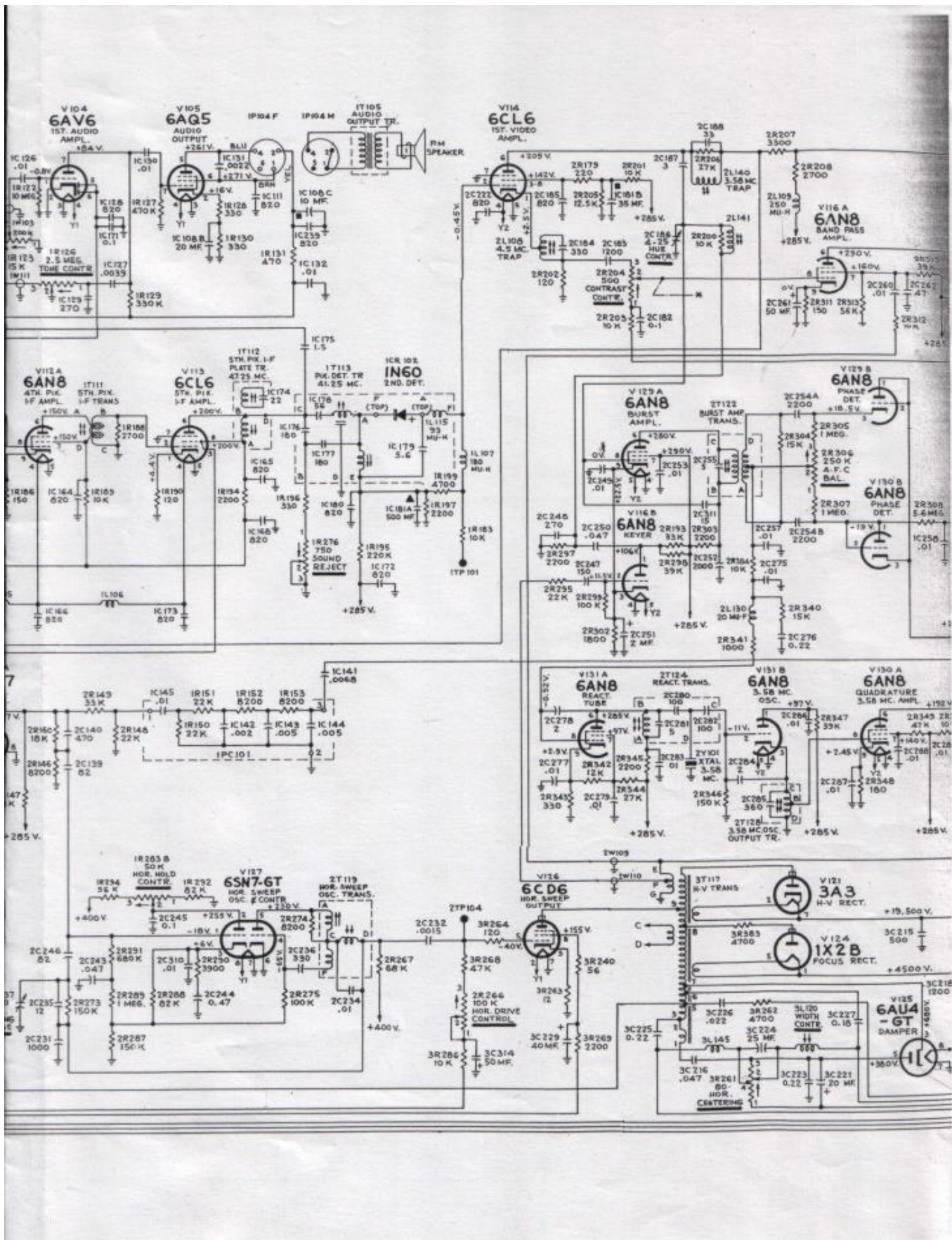
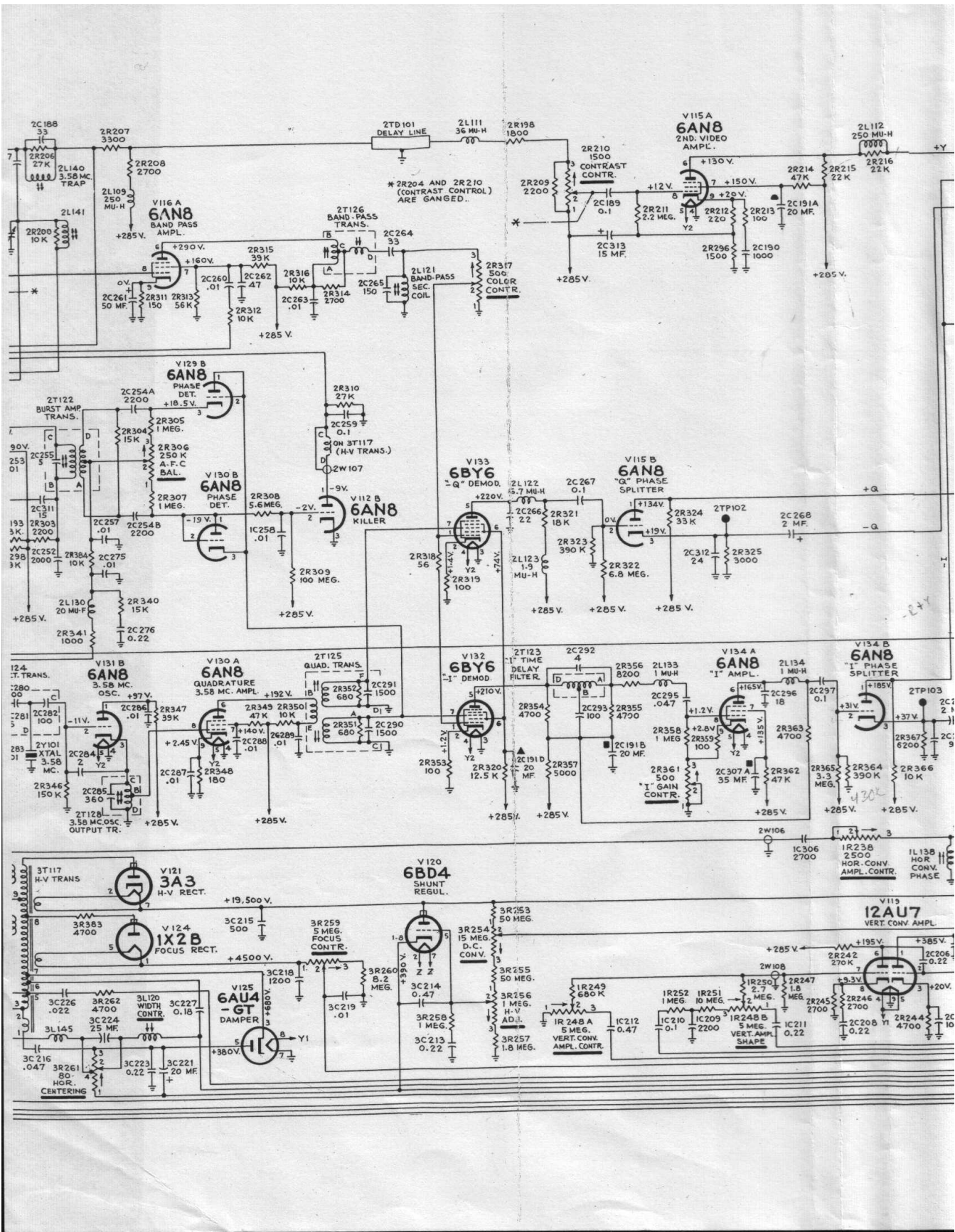


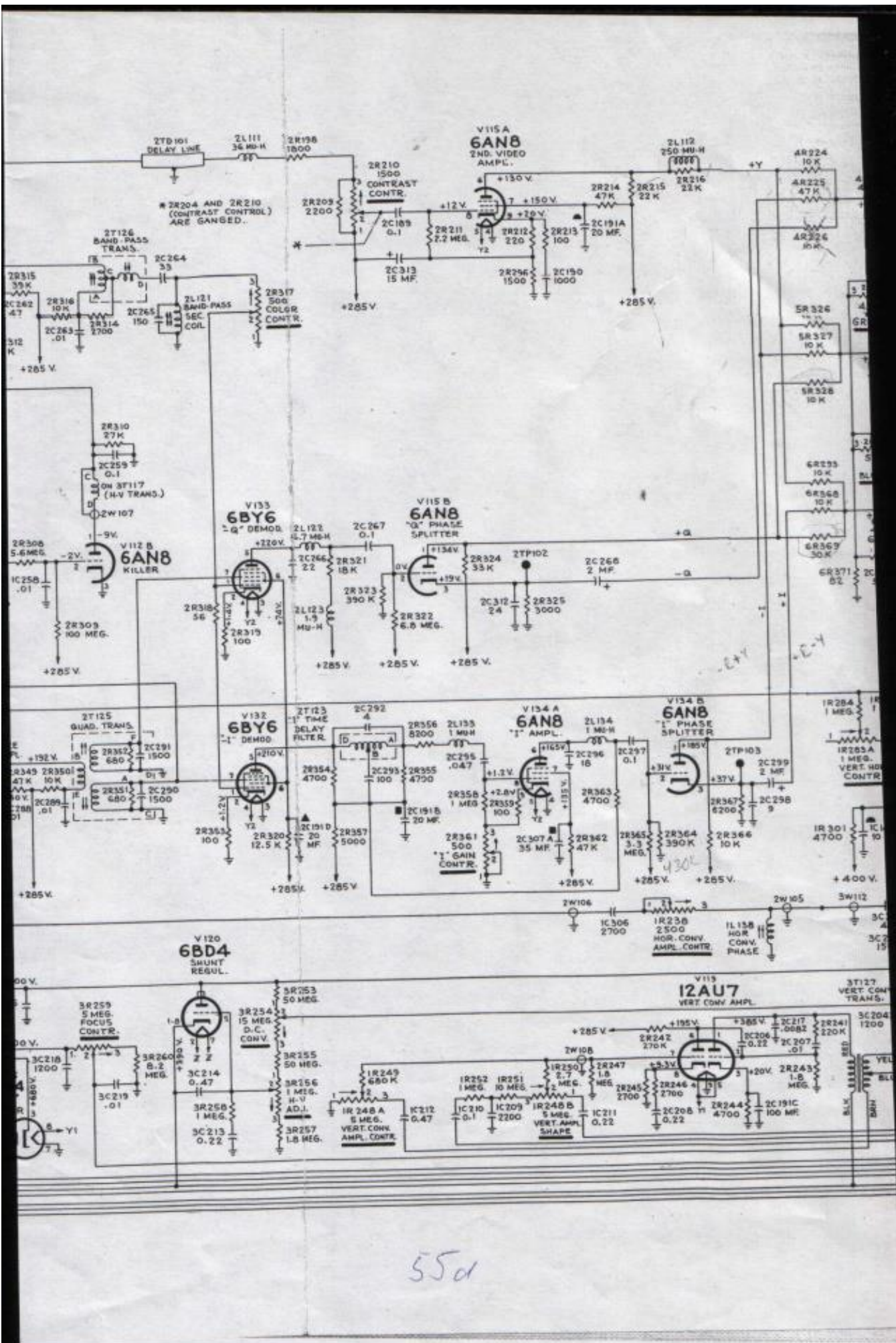
Fig. 104—Bottom Chassis View CT-100, Circuit and Component Locations



NOTE: Circuit Schematic Diagram for KRK-12C Tuner Unit appears on page 19.







55a



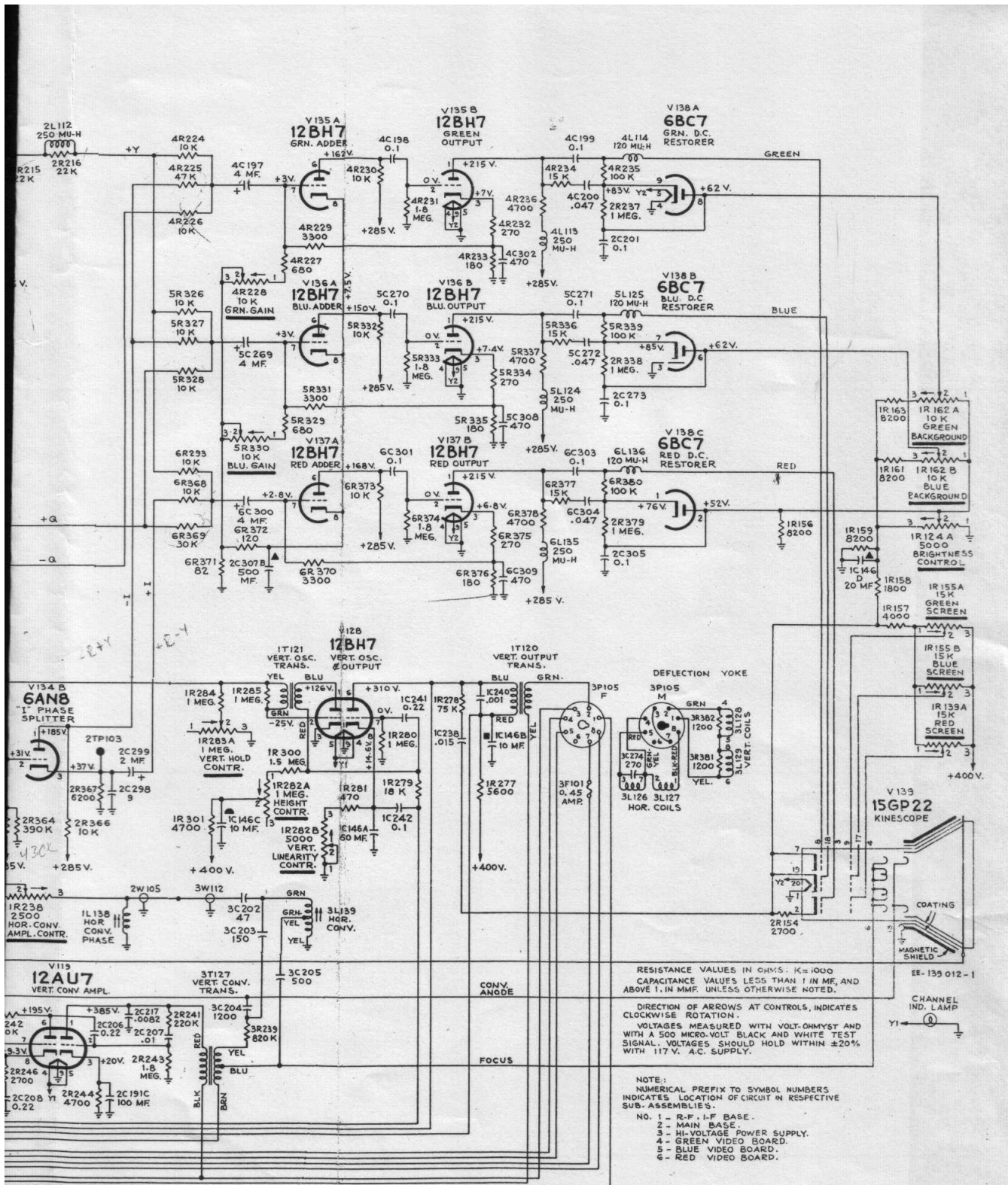


Fig. 105—Circuit Schematic Diagram—CT-100