the monthly REPORT to the ELECTRONIC SERVICE INDUSTRY

COLOR TV

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PHOTOFACT ENDEX

JANUARY



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Featured in this issue of the PF INDEX are several articles which deal with the subject of color television. For purposes of discussion, the color receiver has been separated into sections according to the function that is performed in each section. By dividing the color receiver into sections and discussing each one separately, it is hoped that a clearer understanding of the subject will result. Also, when a subject is presented in this manner, each article can serve as a good means of reference. The reader may desire to refer to a particular discussion covering only a certain portion of the color receiver. However, this does not mean to imply that each section is completely separate and apart from the remainder of the receiver. This is not true, since each section is needed for the over-all operation of the receiver.

Since color television is an outgrowth of black-and-white television, we have as much as possible used black-and-while television for comparative purposes. By starting with something that is known and then introducing the new subject which parallels the old one, it is felt that a more thorough understanding of the new circuits can be obtained. This has been done throughout the discussions as much as the situation would allow.

The featured articles which pertain to the subject of color television in this issue are the following:

1. Comparing Monochrome and Color Receivers.

2. Picture Tubes for Color TV.

3. Color Synchronization.

4. Color Decoding and Mixing.

5. Monochrome Reception by the Color Receiver.

The order of this listing was chosen for a purpose. We feel that certain aspects of color reception may be better understood if the reader has first studied other phases of the subject. Therefore, we have listed the articles according to what we believe is their logical sequence for reading.

* * Please turn to page 5 * *



the monthly REPORT to the ELECTRONIC SERVICE INDUSTRY

VOL. 4 · NO. 1

JANUARY • 1954

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HOWARD W. SAMS, Publisher

Business Department : Donald B. Shaw, V. P. Treasurer; F. T. Dobbs, Secretary; Joe H. Morin, Sales Mgr.; Ann W. Jones, Advertising; Shirley A. Owens, Literature Service Mgr.; J. C. Keith, V. P. Charge of Circu-lation. Printed by The Waldemar Press, Joseph C. Collins, Mgr.

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The PF INDEX is published monthly by Howard W. Sams & Co., Inc., 2201 East 46th Street, Indianapolis 5, Indiana. The PF INDEX is on sole at 25¢ a copy at 1093 jobbers of Electronic Ports throughout the United States and Conada (In Canada 30 cents.) When available, back numbers may be obtained by sending 35¢ for each copy desired. Acceptonce under Section 34.64 P. L. & R. authorized at Indianapolis, Indiana

SUBSCRIPTION DATA: For those desiring the convenience of delivery to their homes or shops, each issue of the INDEX will be moiled direct, promptly upon publication. The subscription charge is \$4.00 annually in the United States and U. S. possessions.

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Looking Ahead to Color TV

(Continued from page 3)

How the color receiver differs from the monochrome receiver is pointed out in the article entitled, "Comparing Monochrome and Color Receivers." In this discussion, the similarities of the two receivers are first presented and then the additional stages which are needed for the production of color are shown. The purpose of this article is to offer to the reader an introduction to the color receiver before entering into the detailed discussion of the new sections of this receiver.

Since the heart of a television receiver is considered to be the picture tube, it is suggested that the article "Picture Tubes for Color TV" should be read next. Contained in this discuss on are requirements for color reproduction, the way these requirements are met in the color picture tube, and descriptions of two experimental color tubes.

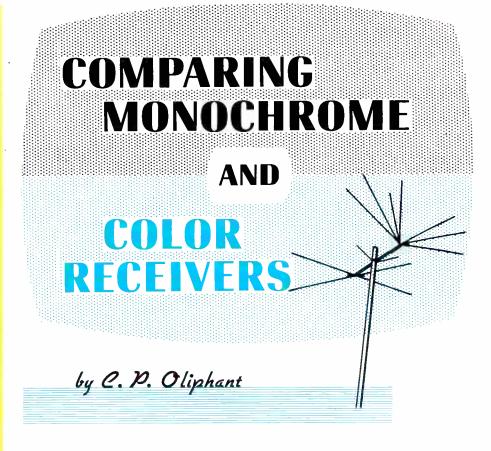
The signals which control the operation of the color tube are obtained from the output of the section for color decoding and mixing; but before the operation of this section is studied, it should be known how the receiver is synchronized for the proper decoding of the color signal. This subject is covered in the article entitled, "Color Synchronization."

"Color Decoding and Mixing" should be read after the article on synchronization. Presented in this section is a method for detecting the color signal and the mixing process by which three signals representative of the transmitted colors are obtained.

The color-television standards have been set up so that the color signal can be received by the monochrome receiver. This results in a compatible system. To further the idea of compatibility, the color receiver should be capable of accepting the standard monochrome transmission and of producing a black-andwhite picture. The color receiver is designed for this additional purpose. The method by which this is accomplished is given in the article entitled, "Monochrome Reception by the Color Receiver, '

Although it may be several months before the service technician is called upon to service a color receiver, any knowledge gained at this time should help to equip him for the task when it is undertaken.

Acknowledgement is given to the Radio Corporation of America for supplying information on their experimental color receiver and to CBS-Hytron and RCA for information on their respective color tubes.



The color receiver is a more complex unit than the monochrome receiver, since several additional stages are required for the reproduction of the picture in full color rather than in black and white. The purpose of this discussion is to present the over-all differences between the two receivers. Although the circuits used for the production of color may be new to the service technician, they consist basically of amplifiers, oscil lators, and detectors all of which are designed to respond to a particular type of signal.

Let us first investigate the similarity of the two receivers and then the differences. Shown in Fig. 1 is a partial block diagram of a color receiver. The section shown performs functions that are essentially the same for both types of receivers. The block diagram shows the RF-IF-Video section, the sound section, and both the horizontal- and the vertical-deflection sections.

The sound section serves the same function as in a monochrome receiver; however, there are a couple of differences in the design, as shown in Fig. 1. These differences are: (1) the location of the takeoff point for the sound and (2) the presence of a detector at the input of the sound section. In most monochrome intercarrier receivers, the sound is taken off at a point after the video detector. The optimum ratio of picture carrier

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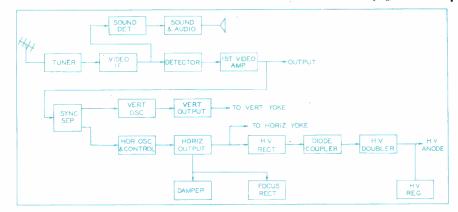


Fig. 1. Partial Block Diagram of a Color Receiver.

Picture Tubes For Color

The Basic Principles of Reproducing Television Pictures in Color and the Structural Details of Color Picture Tubes Which Conform to These Principles

The heart of the present-day television receiver, whether monochrome or color, is the picture tube; for it has the difficult task of accepting a varying electrical signal and producing the picture which that signal represents. The monochrome picture signal varies only in respect to the variation in light content of the transmitted picture; thus, the black-andwhite picture tube has only to follow this one variation. The signal applied to the color picture tube is a combination of the monochrome signal, as outlined above, and three color signals. Each of the color signals varies according to the color present in the televised picture. To fulfill the standards of a compatible system, the color picture tube must also be capable of producing a black-and-white picture when only the monochrome signal is present. It is evident, then, that the picture tube in a color receiver must necessarily be a much more complicated device than its monochrome counterpart, even though outward appearances may not give this impression. With the assumption that the reader is familiar with the basic operation of the black-and-white picture tube, we may start with a few

facts about the nature of color and then proceed to a description of the color picture tube.

Color Fundamentals

The results obtained from mixing color pigments or paints may be recalled from school experience. For example, mixing a blue and a yellow paint produces green. This is referred to as a subtractive process: Pigments absorb or subtract colors from the illuminating light source, and the eye sees only the color or colors that are reflected. Yellow paint reflects red, orange, and green light in addition to yellow. Blue paint reflects green, indigo, and violet light in addition to blue. When the two paints are mixed, green is the only light that is reflected by both paints and not absorbed by one or the other; therefore, the eye sees green.

Color TV uses a different principle to provide the eye with a sensation of color. Sources which emit light of different colors are employed. The color lights are added directly to produce intermediate colors in the spectrum. No reflection or absorption process is involved.

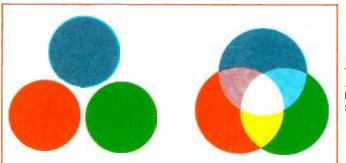


Fig. 1. Addition of Three Primary Colors As Shown by Overlapping Light Sources.

WILLIAM E. BURKE and GLEN E. SLUTZ

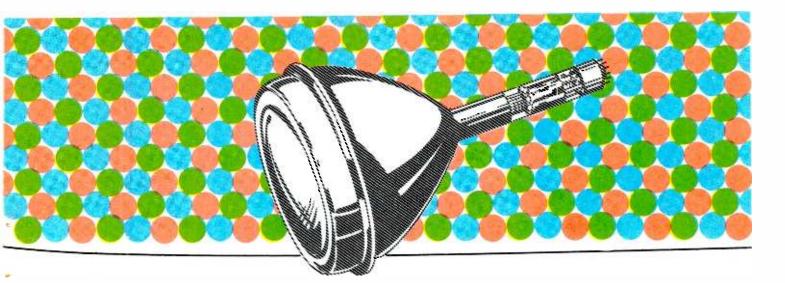
There are certain terms used in discussing color as it applies to color TV; therefore, it may be well to define a few of these. Hue is a property which is described by words such as blue, red, or yellow. Degree



Fig. 2. Arrangement of Phosphor Dots on the Screen of the Color Picture Tube (As Seen Under Magnifying Glass).

of saturation in color light is denoted by such expressions as pastel, deep, or pale. Brightness or luminosity is given by values ranging anywhere between bright and dim. With these in mind, let us examine how certain color lights may be mixed, by addition, to produce various other colorsfor use in color television.

There are three colors, which when added in certain proportions will produce nearly all colors in the visible spectrum. These are called the additive color primaries and consist of red, green, and blue. When these three primaries are added together in proper proportions, the eye



registers a sensation of white. Fig. 1 illustrates this and also shows the colors which can be produced by adding pairs of lights of the primary colors. Other hues can be obtained by changing the brightness or intensity of one or more of the primary colors. If the blue light were cut off in Fig. 1, the red and green lights would combine to produce yellow as indicated; then, if the red light were decreased in brightness, the resultant color

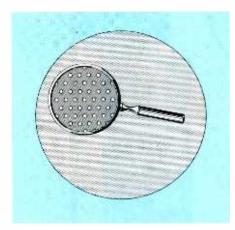


Fig. 3. Pattern of Holes in Shadow Mask (As Seen Under Magnifying Glass).

would change to a yellow-green. Any one primary color may be varied in saturation by increasing or decreasing the intensities of the other two primaries in unison.

Phosphor Screen

In the color picture tube the light sources of the primary colors do not overlap as shown in Fig. 1, but they are so small and closely spaced that the eye blends them together to give the sensation of seeing a single color. These light sources are composed of three phosphorescent materials which are energized by electron beams within the tube. The materials have been so chosen that the red, green, and blue colors which they emit are deeply saturated. This makes it possible to produce nearly all colors in the visible spectrum provided the excitation of each phosphor is properly controlled.

The phosphor on the screen of a monochrome picture tube consists of a mixture of differently colored phosphors combined in the proper proportions to produce a white light when activated. The phosphor screen in a color picture tube contains three phosphors, each separate from the others. This is to allow the excitation of any color individually or of any desired combination of colors.

Tubes employing several arrangements of the three phosphors are in the experimental or developmental stage. The system which has enjoyed the greatest acceptance at this time is one using a dot pattern of the color phosphors. Thus the description that follows pertains to this type of tube.

Picture tubes with the dotphosphor type of screen are now being produced in the pilot-plant stage by some manufacturers. This type of phosphor screen is made by a process involving photoengraving or photographic techniques and the separate application of the various phosphors. The screen in its final form bears a pattern of dots in three colors positioned as shown in Fig. 2. The color tubes now nearing production contain approximately 7,000 dots per square inch of screen surface. A dot density of this order makes it possible for the color tube to provide a picture having a resolution only 10 to 15 per cent less than that possible with a monochrome tube. This deficiency is more than offset by the improved quality of the picture that is televised under color standards and by the improved design of the color-receiver circuits. After the phosphors are deposited on the dot screen, an aluminized coating is applied. This produces a screen having greater durability, increased light output, and protection from ion burns.

Shadow or Aperture Mask

The color picture tube employing a dot-phosphor screen requires a selective method of screen excitation; that is, the tube must be able to excite the red, green, and blue phosphor dots separately. This is done by assigning an electron beam to each of the three colors and by employing shadow techniques to insure that the beams strike only their respective color dots. Shadow techniques are usable with electron beams because the latter behave in a manner similar to light rays.

A mask having a pattern of holes through it, as illustrated in Fig. 3, can be inserted in the electron path; and the mask pattern will be produced on the phosphor screen by those electrons which pass through the holes. The placement of the reproduced pattern on the screen is fixed by the position of the electron-beam source. Fig. 4 shows how electron beams from the separate sources S_1 and S_2 can be directed through a single hole so as to illuminate separate points on

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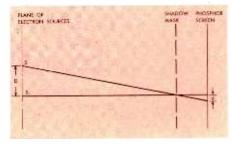


Fig. 4. Geometry of Shadow-Mask Principle.







President, Television Communications Institute

A fair proportion of the television receivers now in use operate under what are known as fringe-area conditions. That is, the received signal is so weak (generally under 100 microvolts) that the picture is clouded by a considerable amount of snow. Note that the set itself need not be located any great distance from the transmitter. As a matter of fact, it may be no more than 2 or 3 miles away; yet because of the shielding effect of surrounding terrain or nearby structures, the actual signal available to the receiver is no more than what the set might receive if it were out in the clear 100 miles away. Such are the vagaries of television transmission.

To cope with this and similar conditions, many manufacturers have issued special service bulletins that outline certain circuit changes designed to improve reception. These include reducing the AGC bias, particularly to the tuner, increasing videoamplifier load-resistance values, altering sync-separator operating conditions, and otherwise boosting the sensitivity of the receiver beyond its normal value. Each manufacturer tackles the problem in his own way, and the specific recommendations of each should be considered in preference to a generalized procedure.

There is one most important step that should be performed before any of these circuit modifications are carried out. This is to make certain that the receiver is in top operating condition. This means more than turning on the power and seeing that a picture appears and that sound is heard. It includes these plus a comprehensive series of checks which will assure you that you are getting all you can from this particular receiver. Of course, the best in some sets will not equal the best in others; but this we all know and expect. The tests to be described require no special knowledge or equipment; any service man can carry them out. Furthermore, they need not be restricted solely to receivers operating in weak-signal areas. Any set no matter where used should be in peak condition, because only then will it perform as its designer intended.

The steps should be carried out in the order given. This will tend to prevent a subsequent step from disrupting a previous one.

The equipment required includes an AM generator and an oscilloscope. With the receiver set up on the bench, connect the generator signal lead to an ungrounded antenna terminal. The generator ground terminal is connected to the receiver chassis. If the receiver is of the transformerless variety, use an isolation transformer between the receiver and the power line. The generator frequency is set to the center of one of the local channels. Thus, if channel 3 (60 to 66 mc) is the one chosen, the generator frequency is set to 63 mc. The audio modulation is also turned on.

Next, take the oscilloscope and connect its vertical-input terminal to either the grid or cathode of the picture tube, depending upon which element receives the video signal. Use a series .1-mfd blocking capacitor if the oscilloscope does not incorporate one in its input circuit. Complete the scope connection by grounding the instrument to the receiver chassis.

The final preparatory step is to insert a fixed bias voltage across the AGC line of the receiver. Do this with batteries or a DC supply. Adjust the bias to a value which the system normally develops. This can be determined by a prior measurement when the set is in operation.

Turn on the set and the test equipment. Adjust the generator out-

put and the vertical-gain control of the oscilloscope until the audio modulation (usually a 400-cycle sine wave) occupies about one half of the scope screen. A ruled mask should be placed over the screen, and the number of spaces covered vertically by the modulation signal should be carefully noted. If a mask is not available, use a soft pencil or crayon to indicate the positive and negative peak of the wave.

Keep the generator signal as low as possible and still be consistent with the above requirements. Do not overload receiver or oscilloscope, as evidenced by a distorted wave.

The following tests may be made:

1. Try a new set of rectifier tubes in place of those in the receiver. Note carefully whether the modulation wave on the scope screen increases in height. If it does, note by how many vertical squares. Try a number of rectifier tubes, leaving in the one that provides the greatest signal increase.

If the set uses seleium rectifiers, it may not be amiss to try another unit even though the one in the receiver is apparently functioning properly. Rectifier output decreases with age, and it is often possible to increase set sensitivity considerably by raising the B+ voltage only 10 or 20 volts.

2. Next, starting at the RF amplifier, replace each tube in turn noting after every substitution whether or not the wave on the scope screen had increased in height. When the oscillator tube is changed, be sure to retune the set for maximum output. Proceed in this manner until every tube in the RF system, video IF sys tem, video second detector, and video-



A Description of the Color-Receiver Circuits Which Synchronize Deflection and Color Selection at the Picture Tube With Camera Operation at the Transmitter

The color-television receiver employs two distinct channels of synchronization. These are the deflection-synchronization channel and the color-synchronization channel. It will be found that the system for synchronizing the deflection system closely approximates the method now employed in monochrome receivers. Improper operation of this section is characterized by unstable horizontal sweep, vertical sweep, or a combination of both. The colorsynchronization system, however, has no direct parallel in monochrome television receivers. Improper functioning of the color-synchronization system will result in false color information being fed to the picture tube. A discussion of these systems follows, with particular emphasis being placed upon the color-synchronization channel.

Deflection Synchronization

The two stages shown in the block diagram of Fig. 1 constitute the principal items of the deflectionsynchronization (sync) channel. The sync-separator inverter performs two functions and requires three sources of information to accomplish these operations. A noise-immunity

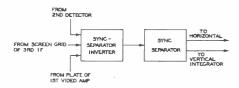


Fig. 1. Block Diagram of the Deflection-Sync System.

action is provided by this stage and is dependent upon information received from the second detector stage and the third IF stage.

The schematic diagram of Fig. 2 shows that a varying plus voltage from the screen grid of the third IF stage is applied to the No. 1 control grid of the sync-separator inverter and determines the operating point of this grid. The level of this voltage is dependent upon the strength of the received signal. A negative composite-video signal from the second detector is also coupled to this grid. Strong noise pulses contained in this signal are sufficient to drive the sync-separator inverter to cut off. The combined effect of these two signals therefore provides the noise-immunity action in the sync-separator inverter stage. Separation of the sync pulses from the composite signal is also achieved here. A positive composite signal from the first video amplifier is applied to the No. 3 grid. A separated sync signal appears at the plate of the sync-separator inverter. Occasional holes appear in this signal because of noise pulses driving the tube to cut off. These sync pulses are in turn fed to the sync separator, where additional clipping action takes place. A triode is utilized in this stage. The sync separator feeds the resultant signals to the horizontalsweep system and to a verticalintegrator network. It may be seen from the foregoing discussion that the deflection-sync system does not depart appreciably from the system employed in monochrome receivers.

Color Synchronization

Proper operation of the colorsync system is partially dependent upon certain information contained in the transmitted signal. The portion of the transmitted signal utilized by the color-sync system is referred to as the burst. Reference to Fig. 3 shows that the burst is positioned on the back porch of the horizontalblanking pedestal. The burst is composed of approximately eight cycles of a 3.579-mc signal. It is noted that the frequency of the burst is identical to the frequency of the color subcarrier. The burst contains phase information as well as frequency information.

The recovery of color information contained in the transmitted

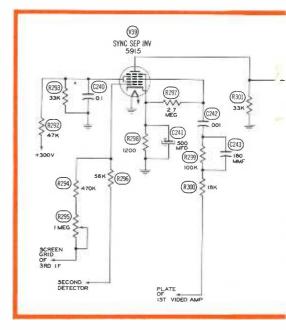
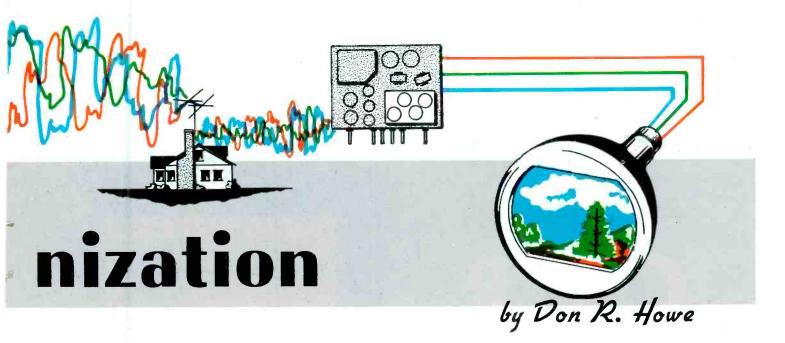


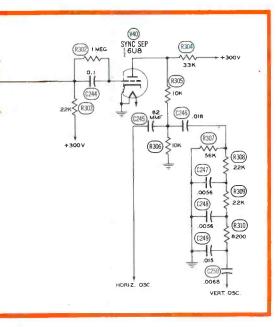
Fig. 2. Schematic of the

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signal requires the generation of a 3.579-mc signal in the receiver. This signal is fed to the color demodulators where the actual recovery is accomplished. This locally generated signal must be at the same frequency and must posses the proper phase relationship to the color subcarrier of the transmitted signal. It is the function of the color-synchronization section of the receiver to see that these requirements are fulfilled. This is accomplished by comparing the locally generated signal with the burst signal described previously and by making appropriate corrections to the locally generated signal.

The over-all functioning of the color-synchronization system may be more easily understood by reference to the block diagram of Fig. 4.



Deflection-Sync System. January, 1954 - PF INDEX

The first block encountered represents the burst amplifier. The burst signal is fed into this stage from the first video amplifier. Since the burst signal is of relatively short duration and is transmitted immediately following the horizontal sync pulse, the burst amplifier is held at cutoff during transmission of the video portion of the signal. The burst amplifier is restored to an operating condition by a pulse obtained from the horizontaldeflection circuit. After the burst signal is amplified by the burst amplifier it is then transferred to the phase detector.

As previously stated, a 3.579mc signal must be generated in the receiver. The generation of this signal is accomplished by the 3.579mc oscillator shown in the block diagram of Fig. 4. It is noted that the output of this oscillator is fed to the color-phase amplifier. The amplified RF signal appearing in the output of this stage is coupled to the phase detector where it is compared with the incoming burst signal from the burst amplifier. The comparison of these two signals in the phase detector results in a DC error voltage being fed to the reactance tube. The performance of a reactance tube can be compared to that of a capacitor in that it presents capacitive reactance to the circuit to which it is connected. The capacitive reactance of the reactance tube is varied by the DC error voltage from the phase detector. This varying reactance controls the phase and frequency of the 3.579-mc oscillator.

The above discussion shows how the stages function to maintain the proper phase and frequency relationship of the 3.579-mc oscillator with the color burst. The block, shown as the color killer, is controlled by a voltage generated in the phase detector. This voltage is such that the color killer is inoperative during reception of a color signal. The purpose of the color killer is to disable the color channels during monochrome reception. A detailed explanation of this stage appears in the article entitled, '' Monochrome Reception by the Color Receiver'', and contained in this issue of the PF INDEX.

The block diagram indicates two additional outputs from the 3.579-mc oscillator. One of these outputs goes directly to the I demodulator; the other output goes to the quadrature amplifier. This stage provides phase shift and amplification. A phase shift of 90 degrees is introduced so that the signal may be properly utilized by the Q demodulator. *

The functioning of the various stages making up the color-sync system has been shown by use of the block diagram. In order to gain a more complete understanding of how

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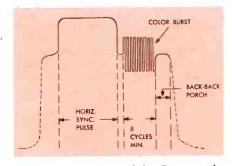
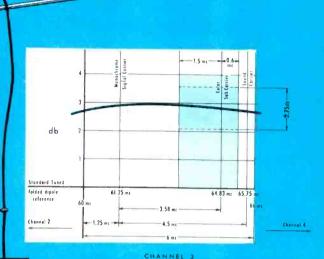


Fig. 3. Location of the Color Burst on the Transmitted Signal.



you're ready for COLOR TELEVISION With an AMPHENOL -INLINE*

Color television is fast becoming a reality! Sets are expected to be available the first part of next year and stations are purchasing the necessary transmitting equipment. Initial costs, unfortunately, will be high but as improvements in design and production are achieved the price of color television will become within everyone's reach.

The consumer is concerned with the problems presented by television in color. He has read reports on prices and availability; all have been conflicting. He knows, however, that his set will have to be replaced or converted. What he does not know is that if he has an AMPHENOL INLINE*, there will be no extra expense in antenna or installation! AMPHENOL engineers provided for color in the original design of the INLINE*.

Every dealer, distributor and installer will want to acquaint their customers with this reassuring information. The color television market is potentially tremendous. It certainly will prove of benefit if the consumer can be reassured on one part of the cost of conversion to color.

The fact that AMPHENOL INLINEs are able to receive color television so well reflects favorably upon the engineering ability of AMPHENOL. For in ordinary black and white television the same level-gain design has proved valuable. Set owners know, now, that their AMPHENOL INLINE* is providing them with the best black and white picture their sets can deliver.

*Reissue U.S. Pat. No. 23,273

Antenna Electrical Requirements for COLOR TELEVISION

Information now available on color television has made it clear that the receiving antenna must have these characteristics:

- Antenna gain must be flat, no gain or loss greater than one db, within 1.5 mc below and 0.6 mc above the color sub-carrier* (a width of 2.1 mc).
- 2 Antenna gain must be held down across the FM frequencies. Rejection of FM signals is much more important in color than in black and white television.

*Channel frequency widths are at present divided between the monochrome amplitude modulation picture carrier and the frequency modulation sound carrier. The addition of the color sub-carrier is made at 3.58 mc above the monochrome carrier.

The AMPHENOL INLINE* fully meets the two conditions listed above. Besides being engineered to reject FM signals, from 88 mc to 108 mc, the IN-LINE provides very level gain across all channels, particularly over the color sub-carrier. Typical of the INLINE's performance on all channels is the gain chart⁺ illustrated above for channel 3. †Measured in accordance with proposed RETMA standards.

AMERICAN PHENOLIC CORPORATION chicago 50, illinois

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RECORD CHANGER SERVICING

Set-Down Adjustment Procedures for Several Popular Models of Record Changers

PART II

One of the most common troubles with record changers is that of improper set down of the tone arm, and this trouble is brought about usually because of misuse by the operator. The set-down mechanism of many changers can be adjusted without removing the changer from the cabinet. The location and availability of the set-down adjustment is the determining factor. Regardless of the make of the changer to be repaired, the service technician should also find out if the set-down point of the tone arm is in a positive position each time or if it changes position erratically during several trials.

The locations of adjustment points on several makes and models of changers are given in the following material. Procedures for adjusting the set down of the tone arm on these changers are discussed with the hope of making the service technician's job easier and faster.

Admiral

RC210, RC211, RC212, RC220, RC221, RC222, RC320, RC321, RC322, RC500

These Admiral automatic record changers differ somewhat in design

and operation, but the location of the tone-arm set-down adjustment is the same in all units. Using the changer illustrated in Fig. 1 as a guide, we will describe the method used to make the set-down adjustment.

By observing Fig. 1, it can be noted that the set-down adjustment is made by inserting a screwdriver into a hole in the side of the tone arm; therefore, unless cabinet design is such that this cannot be done, adjustment of the set down in these models can be performed without removing the changer from the cabinet.

A. If the tone-arm set-down point is slightly off but the needle lands each

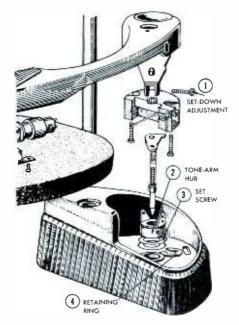


Fig. 1. Set-Down Adjustments on Admiral Changers.

time in a positive position, the follow - ing procedure is recommended:

by Lester W. Caudell and Glen E. Slutz

1. Set the changer to play 10-inch records.

2. Place a 10-inch record on the turntable.

3. Press down on the REJECT knob momentarily. Rotate the turntable by hand in a clockwise direction until the tone arm moves in over the record and starts its downward movement.

4. At this point a fairly accurate adjustment can be made by rotating adjustment screw (1), shown in Fig. 1. Turning this adjustment screw clockwise moves the set-down point of the tone arm farther away from the spindle. Turning the screw counterclockwise moves the point closer to the spindle. When correctly adjusted, the needle should land approximately 1/8 inch in from the edge of the record.

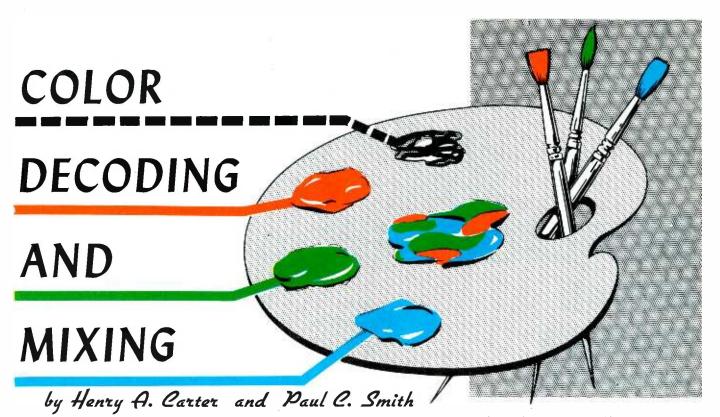
5. After this adjustment has been made:

a. Load a stack of 10-inch records on the spindle and record shelf.

b. Apply power to the record changer, then reject each record after observing the landing point of the tone arm. Repeat step 5 if necessary until the set-down point is correct.

If this procedure for adjustment is made carefully, the set-down point for 7-inch or 12-inch records will be automatically correct.

* * Please turn to page 88 * *



Circuits Used in the Color Receiver to Separate the Color Information from the Picture Signal and to Prepare This Information for Use by the Color Picture Tube

The circuitry and operation of a color receiver and the normal black-and-white television receiver are essentially the same up to the video-amplifier stages. At this point the signal in color TV is divided and fed into the luminance and chrominance channels.

A brief review of color properties should be useful at this point. The three properties of major importance in their application to a color receiver are:

- 1. Hue.
- 2. Saturation.
- 3. Brightness or luminosity.

Other names exist for the above terms. Hue is also referred to as color, and is that property which distinguishes one color from the other, such as red, green, or blue. Saturation has also been called chroma, and the chrominance channel gets its name from this term. This channel is responsible for the color which appears on the picture tube. Saturation refers to the intensity of the color. Brightness or luminosity is that characteristic of a color which makes it appear as bright or dull. To take the viewpoint of a physicist and deal with wavelengths of light in the color spectrum, hue is determined by the dominant wavelengths or frequencies present, saturation by the degree to which these frequencies are reduced toward a single frequency, and luminosity by the amount of power represented therein.

By the proper combination of three well-chosen primary colors all other colors can be matched in hue, although full saturation of all colors cannot be reached in this manner. In developing such a system as the NTSC color system, the engineers are faced with physical limitations in the available tube phosphors, color filters, and associated equipment. The resultant choice of primary colors is therefore a compromise, calculated to best meet all requirements. The three primary colors selected in that manner are a certain red, green, and blue.

Chrominance Channel

A block diagram of a portion of an RCA developmental color television receiver appears in Fig. 1. This diagram shows that the composite video signal takes two paths from the video-amplifier stage: one is from the plate circuit to the delay network and the luminance channel, the other is from the contrast control in the cathode circuit to the bandpass amplifier and its associated filter network.

Let us first consider those sections of the diagram which deal with the chrominance signal.

The bandpass filter network has a frequency characteristic calculated to pass only the chrominance subcarrier and its sidebands. This signal is then applied by a common connection to the demodulators where the color information is extracted by a process of synchronous detection. The detected Q signal passes through a low-pass filter to the Q phase splitter where two signals of opposite phase are obtained; and the output of this stage is applied to each section of the matrix, the negative-going signal being applied to the green section of the matrix and the positive-going signal being applied to the red and blue sections where they are added to the other signals from the I channel and the luminance channel. The chrominance signal, applied to the Q demodulator, is also applied to the I demodulator; and the detected I signal passes through a combined lowpass filter and delay network, then an amplifier stage. The signal output of this stage takes two paths, one to the red section of the matrix while the other is to the input of a phaseinverter stage. The output of the inverter stage is then applied to the green and blue sections of the matrix.

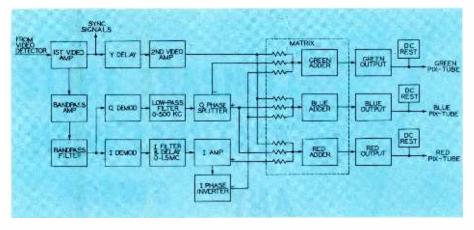


Fig. 1. Block Diagram of Luminance and Chrominance Channels and Their Associated Circuits in a Color TV Receiver.

The luminance signal is combined with the color signals at each section of the matrix; and the three resultant color signals receive further amplification in the red, green, and blue output stages before being applied to the grids of the color tube. Each signal is subjected to DC restorer action to restore the correct background level.

The nature of the luminance and chrominance signals and the operation of the afore-mentioned circuits are described in more detail in the following paragraphs.

Luminance and Chrominance Signals

The luminance signal is made up of monochrome picture information of all transmitted frequencies plus some of the higher frequencies that would normally be color detail. The chrominance signal contains the lower frequencies representing the larger color areas. These lower frequencies are limited to a range of from zero to approximately 1.5 mc. Subjects containing fine detail in color normally will require higher frequencies than 1.5 mc if the color is to be very accurately represented. However, a peculiarity of color vision makes it possible to reproduce these color details as monochrome without serious loss in the quality of the color reproduction. It has been demonstraed that as color details become smaller and smaller the ability of the eye to distinguish one color from another becomes less and less. If the color detail is small enough, no color difference will be noted by the eye; only the brightness or luminance difference will be seen. This detail, then, can be supplied in the luminance signal along with all the monochrome information.

The complete monochrome range, from white to black, is obtained at the color picture tube by a proper combination of the three colors

in the following proportion: 59 per cent green, 30 per cent red, and 11 per cent blue. Whenever the chrominance signal is absent, leaving only the luminance signal to affect the color tube, the resulting picture will be colorless or neutral. This luminance or neutral signal is referred to as the Y signal. The above percentages of the primary colors (59, 30, and 11 per cent) are based on the actual contribution of the three colors to the luminosity (brightness) of any subject. When chosen in this manner. these values result in constant luminance operation of the receiver. This is another way of saying that the brightness of the picture as a whole depends upon the luminance signal and will not be materially affected by a change in hue of some sizable color area. The constant luminance property is also useful in reducing the annoyance caused by interfering signals or cross talk among the receiver channels, since such signals will then appear as color variations rather than brightness variations.

In addition to all the brightness information, the luminance signal contains the standard horizontal and vertical-synchronization pulses and the color-synchronization bursts.

As mentioned in the opening paragraph of this article, the lumi-

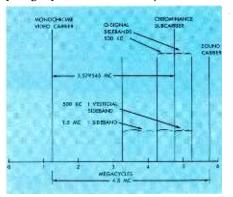


Fig. 2. Signal-Frequency Distribution of NTSC Compatible Color System.

nance and chrominance channels follow the video-amplifier stages. The transmitted chrominance signal is a combination of the Q signal and the I signal. According to NTSC specifications, the Q and I signals have the following composition:

$$E_{Q} = 0.41 (E_{B} - E_{Y}) + 0.48 (E_{R} - E_{Y}),$$

$$E_{I} = -0.27 (E_{B} - E_{Y}) + 0.74 (E_{R} - E_{Y}).$$

By substituting the value of

$$E_{Y} = 0.59 E_{G} + 0.30 E_{R} + 0.11 E_{B}$$

in the above equations, we obtain:

$$E_Q = -0.53 E_G + 0.21 E_R + 0.31 E_B$$
,

and

$$E_{I} = -0.28 E_{G} + 0.59 E_{R} - 0.32 E_{B}$$

These signals are impressed on the chrominance subcarrier as amplitude modulation with this important qualification: the I signal modulates a subcarrier which is advanced 90 degrees in phase with respect to the ${\bf Q}$ subcarrier. In this manner both signals can be applied to the same subcarrier frequency, with a saving of channel space. This quadrature feature is also the basis of the demodulation process which allows one signal to be separated from the other. It can be seen that the three color properties are represented in the complete video signal in this manner: the luminance or brightness information is contained in the Y signal, the hue is determined by the phase of the subcarrier, and the saturation of the color is dependent upon the amplitude of modulation of the subcarrier.

In Fig. 2 is shown the frequency distribution of the monochrome video or Y signal, the Q, and the I signals. The monochrome video signal is in accordance with FCC standards for black-and-white transmission. The chrominance subcarrier is 3.579545 mc above the monochrome carrier frequency. The Q signal has two sidebands approximately 500 kc wide. The I signal has one sideband approximately 1.5 mc wide; and the other sideband is vestigial, being approximately 500 kc wide.

As stated before, the separation of the two carriers is approximately 3.6 mc. The modulation of the monochrome carrier may extend to frequencies as high as 4.2 mc in the direction of the chrominance subcarrier. The modulation of the chrominance subcarrier extends 1.5 mc in the direction of the monochrome carrier. Under these conditions,

* * Please turn to page 53 * *

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Cascode Tuner installation

There are several reasons why the service technician might be required to convert a television receiver by replacing the original tuner with the more modern, cascode type of tuner. During the course of a tuner repair job, he may find that the total cost of labor and parts for a major repair such as replacement of a broken multiwafer switch will approach or equal the cost of instal ling a cascode tuner. Then, too, an exact replacement for the original tuner may be difficult to obtain in contrast to the cascode tuner which is available at most radio and television parts distributors.

The cascode tuner, with its superior signal-to-noise ratio, is a logical choice when the service technician is confronted with the problem of improvement of fringearea reception. Any noise originating in the tuner will be amplified by the succeeding stages; and if the noise level is high compared to the signal (low signal-to-noise ratio), the result will be snow in the picture.

Some cascode tuners are designed to permit installation of UHF strips, which is certainly a worthwhile consideration when making a tuner replacement.

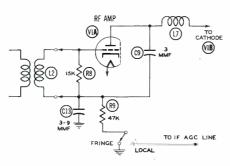


Fig. 2. RF Stage of Cascode Tuner Showing Application of "Local-Fringe" Switch.

One of the first points to be considered when planning the conversion is the physical placement of the tuner. Usually the space occupied by the original tuner will be sufficient to accommodate the newer type. If the use of the new tuner dictates addition of another hole in the cabinet front, that is a decision which lies with the service technician and the set owner. In many cases the new tuner will mount easily in the space vacated by the original one, and no alterations of the cabinet front will be necessary. Universal replacement tuners of this type are equipped with tuning and switching shafts of ample length to be cut to the necessary dimensions. One tuner has a removable shaft that

by PAUL C. SMITH

may be replaced with one of extra length, if required. In any case the technician should be sure that the tuner will fit before proceeding with the conversion.

One of the most important considerations when connecting the tuner is the matter of the bias or AGC voltage supplied to the RF stage. For best sensitivity to weak signals this bias should be approximately -1 volt or less, and it should increase with strong signal input in order to prevent overloading of the video IF amplifier stages. To prevent this increase of bias until a certain signal strength is reached, some form of delay is desirable. This delay may be subject to manual control in the form of a "Local-Fringe'' switch, or it may be obtained through the use of a nonadjustable delay circuit.

A partial schematic of a circuit using the first-mentioned, or manual-delay system, is shown in Fig. 1. The dotted-in parts are used in some models; and when they are used, points marked X are broken.

The 6AL5 tube V6 functions as a combined video detector and AGC rectifier. A portion of the video IF signal is applied to that half of V6 represented by pins 2 and 5, and the rectified voltage is developed

* * Please turn to page 72 * *

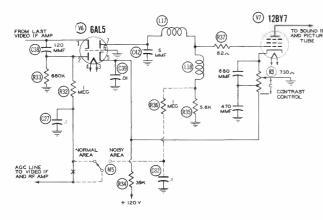


Fig. 1. AGC Circuit Using Manually Controlled Delay System.

TO RF AMP

Fig. 3. AGC System Using a Keying Tube and AGC Delay.



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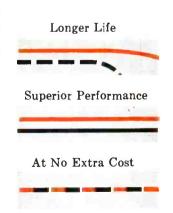
For instance, the RCA-5U4-G features a new electrolytic coating on its channel filament which produces a uniform, hard emitter, leading to greatly increased life over the older version.

Or take the RCA-6W4-GT. This type now uses a new RCA-developed carbonized plate-coating material which has improved heat-dissipating properties, thus contributing to longer tube life and increased reliability. The RCA-6AL5 now utilizes double helical heaters to insure low hum and pinched cathodes to minimize cathode shift within the mount. These features make possible greatly reduced microphonics.

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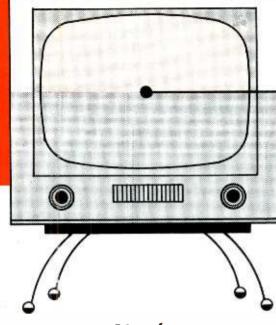
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by Don R. Howe

Maximum utilization of the color receiver cannot be realized unless it is capable of receiving monochrome as well as color transmissions. The original design of the color receiver already incorporates all of the necessary stages for the reproduction of a black-and-white picture. In addition, the receiver employs many stages for color reproduction; however, these additional stages could constitute a source of interference to the faithful reproduction of a black-and-white picture on the color receiver. One method employed in the color receiver for overcoming this difficulty is explained in the following discussion.

If reception of a monochrome signal is desired, some method must be provided for disabling the color-videosystem. In order to provide maximum simplicity, this disabling action is made entirely automatic and therefore eliminates the necessity of adding an additional front-panel control. This automatic operation, however, requires one additional stage in the receiver. This added stage is termed the color killer.

During reception of color transmissions, all color information must pass through the bandpass amplifier. Therefore, this stage presents a logical point to disable the color system. If this stage is cut off during reception of a monochrome signal, extraneous signals are prevented from entering the color system. This cutoff is accomplished by the color killer. The ability of the color killer to distinguish between a color or a monochrome signal is dependent upon the presence or absence of the color burst on the transmitted signal. Actual derivation MONOCHROME RECEPTION

THE COLOR RECEIVER

How the Color Receiver Accepts a Standard Monochrome Signal the plate circuit of the co

and Produces a Black- and-White Picture

of this information is accomplished by the phase detector.

In order to analyze properly the color-killer operation, a schematic diagram of the system is presented in Fig. 1. Investigation of this schematic diagram will show how the colorkiller system is utilized under conditions of color or monochrome reception.

Reception of a color transmission is assumed for the first analysis. Under this condition, normal operation of the phase detector results in a negative voltage at point A. This negative voltage is dependent upon a burst signal being present in the phase detector. The voltage at point A will also be present at the grid of the color killer, and under these conditions this negative voltage is sufficient to cut off the tube. The plate circuit contains a winding of the horizontal-output transformer, and this winding introduces a positive pulsating DC voltage. No current will flow through the tube because the grid is held at cutoff. Point B in

the plate circuit of the color killer is connected to the grid of the bandpass amplifier. The condition of no-current flow in the color killer allows the grid of the bandpass amplifier to remain at a normal operating point, and color information is allowed to pass through this stage.

The second analysis deals with the condition existing during the transmission of a monochrome signal. This transmission does not contain a burst signal; therefore, it is obvious that no burst signal is applied to the phase detector. As a result, the voltage present at point A does not place the colorkiller tube at cutoff.

As a result, the color-killer tube is in a state of conduction and plate current will flow. This plate current flows through resistor R58 and places point B at a negative potential with respect to ground. This negative potential appears as bias on the control grid of the bandpass amplifier. As a result, the bandpass amplifier is cut off and no signals are permitted to pass through this stage. Therefore, there will be no signal applied to the color demodulators.

Under the conditions outlined, for monochrome reception, the video

* * Please turn to page 92 '* *

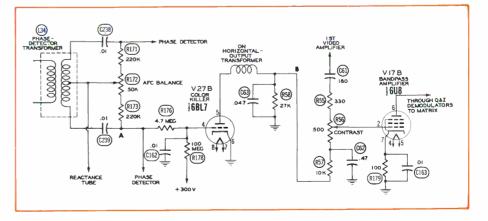


Fig. 1. Schematic Diagram of the Color-Killer Section and Associated Stages.

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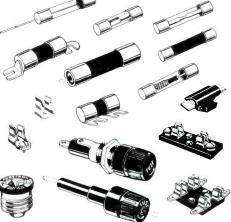
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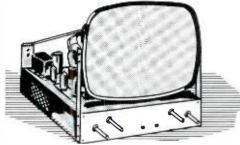
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Stocking the Tube Kit



The servicing of television receivers in the home has become an important phase of the servicing business. Efficient and rapid trouble shooting provide the keynote of this type of servicing. In order to meet this requirement, it is necessary for the service technician to have the tools and parts needed when making a service call. However, it is impossible to have all of the facilities that are provided in the shop. The question arises as to what may be taken and what must remain at the shop. In an effort to alleviate this problem, the following service kits have been devised.

The '' Deluxe Kit'' illustrated in Fig. 1 is designed for the service

SUGGESTED MINIMUM STOCK REQUIREMENTS FOR DELUXE OR STANDARD TUBE KITS



Fig. 1 The Deluxe Tube Kit

technician making a large number of service calls before returning to the shop. It contains items which allow a very high percentage of repairs to be made on home service calls. This kit contains 117 tubes

* * Please turn to page 75 * *

CHART I

CONTENTS OF THE DELUXE KIT

TUBE TV MODELS TYPES 52-53 46-53 (quant.)		TUBETV MODELSTYPES52-53 46-53(quant.)		TUBE TV MODELS TYPES 52-53 46-53 (quant.)		TUBETV MODELSTYPES52-53(quant.)		TUBES TYPES	TV MODELS 52-53 46-53 (quant.)					
1B3GT	2	2	6AQ7GT	1	1	6BK5	1	1	6SL7GT	1	1	12AT7	2	2
1V2	0	1	6AS5	1	1	6BK7	ī	î	6SN7GT	4	4	12AU6	0	1
1X2A	2	2	6AT6	ī	1	6BL7	1	1	6507	Ō	1	12AU7	2	2
5U4G	4	4	6AU5GT	1	1	6BN6	1	1	6SQ7GT	1	1	12AX4	1	1
5V4G	0	1	6AU6	4	4	6BQ6	3	2	6T8	2	2	12AV7	1	1
5Y3GT	1	2	6AV5GT	1	1	6BQ7	2	2	6T4*	1	1	12AX7	1	1
6AB4	1	1	6AV6	2	2	6C4	2	2	6U8	1	1	12AZ7	1	1
6AC7	2	2	6AX5GT	1	1	6BZ7	1	1	6V6GT	2	2	12BH7	1	1
6AF4*	2	2	6AX4	0	1	6CB6	3	3	6V3	1	1	12BY7	1	1
6AG5	2	2	6BA6	1	2	6CD6	2	2	6W4	3	3	12SN7GT	1	1
6AG7	1	1	6BC5	2	2	6J5	1	1	6W6GT	1	1	25BQ6GT	1	1
6AH4	1	1	6BE6	2	1	6J5GT	1	1	6X5GT	1	1	25L6GT	1	1
6AH6	1	1	6BF5	1	1	6J6	3	3	6X8	1	1	25W4GT	1	1
6AK5	1	1	6BG6G	2	2	6K6GT	2	2	6Y6G	1	1	25Z6	0	1
6AL5	2	2	6BH6	0	2	6S4	1	1	7C5	0	1	5642	2	2
6AQ5	2	2	6BJ6	0	1	6SH7	0	1	7N7	1	1			
*For UH	F Areas		·						^					
Tube Kit			Flashlight			Hover	lino Wron	ah Cat	Fuses			Hand Dril	& Dril	le
Television Tube		Power-Line Cords			Hex & Spline Wrench Set Alignment-Tool Kit			Hardware (Misc. nuts,			Picture-Tube Cleaner			
Location Guides,		Pliers, Long Nose			Screwdriver 1/8'' x 6''			bolts, washers, etc.)			Contact Cleaner			
TGL 1-2-3-4		Pliers, Combination			Screwdriver 1/4'' x 6''			Pin Straightener,		Wiping Cloths				
Mirror				Screwdriver 3/32'' x 3''			7 & 9 Pin			Cement				
Volt-Ohm Milliammeter					Screwdriver, Phillips #2			Electrical Tape			Pilot Lamps			
Test Leads		Knife			Screwdriver,			Tube & Parts Extractor			Knob Springs			
Soldering Gun		Hex-Nut Drivers,			Copper Beryllium			AC Plug			Tube Price List			
Solder		#6-7-8-9-10-11-12			Drop Cloth			AC Receptacle, TV			Crosshatch Generator,			
Bolder		"` ' 0-9	TO IL	14	Drop Ctor			AC Recep	tatie, 1	v	(Desirab		,	

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RECEIVING ... TRANSMITTING ... SPECIAL-PURPOSE AND TV PICTURE TUBES . GERMANIUM DIODES AND TRANSISTORS

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In the Interest of ... Quicker Servicing

by DON R. HOWE

Observing Deflection-Coil Waveforms

The tracing of troubles in television sweep systems often requires acquisition of as much information as possible from the circuit involved. It is often desirable that this information include waveforms present in the deflection coils; however, no point is readily available where these waveforms may be observed. By a relatively simple method, such a point can be provided. This is accomplished in the following manner. A 15-to 20-ohm resistor is placed in series with one of the leads to the verticaldeflection eoils. Consequently, all current flowing through these coils must pass through the resistor. The resultant voltage developed across this resistor will provide a waveform corresponding to the current in the vertical-deflection coil. An oscilloscope is then connected across this resistor. The oscilloscope presentation will be that of the desired waveform and is shown in Fig. 1A.

A similar method is employed for the horizontal-deflection coils. The current in these coils is greater than that in the vertical coils; therefore, a smaller resistor is used. The value of this resistor is from 10 to 15 ohms. The resultant waveform will be similar to the one appearing



(A) Vertical-Deflection-Coil Waveform.

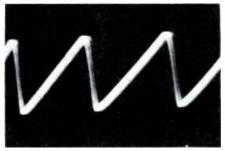
in Fig. 1B. A shorted section of the horizontal-deflection coils produced the waveform shown in Fig. 1C.

The foregoing method may be useful in localizing difficult troubles in the sweep circuits and will assist in determining the condition of the deflection coils.

A Yoke-Removal Problem

Problems intelevision servicing are frequently encountered in which both ingenuity and knowledge are required in their solution. Since the methods employed for solving these problems are often unusual, they may benefit other service technicians who encounter the same or similar problems. Such a condition is described in the following which is from a case history submitted by Mr. Al Lustig of the Navarre Radio and Television Laboratory, 4218 Avenue ''S,'' Brooklyn, New York.

A television receiver was encountered in which excessive heat had been present in the deflection yoke. This heat had resulted in a melting of the yoke insulation. This insulation then flowed onto the neck of the picture tube and became hardened, thus forming a strong bond between the yoke and the picture tube. The problem was to remove the defective yoke without damaging the picture tube.



(B) Horizontal-Deflection-Coil Waveform.

Cutting away the insulation would be a laborious process and might easily result in breaking the neck of the tube. Therefore a simpler and faster method was desired. The following is a description of an effective solution to this problem.

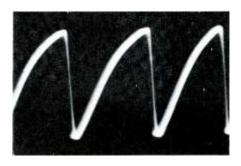
It was determined that the best method of removing the yoke would be by melting the bond formed between the yoke and the picture tube. The application of heat to melt this bond must be made in a manner that will not damage the picture-tube neck.

The four deflection-yoke leads were first disconnected from the receiver. The leads from the horizontal-deflection coils were then connected in series with a 1,200-watt electric heater, as shown in Fig. 2. Application of 117 volts AC caused current to flow through the deflection coils. This current generated enough heat to melt the insulation. After only 30 seconds, the yoke was easily removed; and the picture tube remained undamaged.

Safety-Glass Removal

In some television receivers, the safety glass may be removed from the front of the cabinet without removing the receiver chassis. Re-

* * Please turn to page 85 * *



(C) Waveform With Shorted Turns in the Horizontal-Deflection Coils.

Fig. 1. Deflection Current Waveforms.

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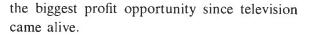
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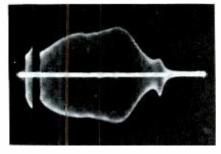
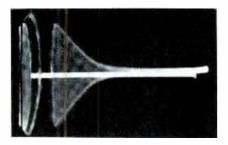


Fig. 1A. Response Curve With Generator Connected Directly to Wide-Band Oscilloscope.

(below)

Fig. 1B. Response Curve With Generator Connected Directly to Narrow-Band Oscilloscope,



A Practical Procedure for Determining the High-Frequency Response of Video Amplifiers and for Setting 4.5-Mc Traps

A complaint frequently encountered by service technicians is that a television receiver produces a picture lacking in fine detail. Since the finely detailed portions of the picture are produced by the higher video frequencies, this indicates that these high frequencies are not being presented to the picture tube. If the RF amplifier, mixer, and IF stages have been checked and are found to be operating satisfactorily,



the trouble must lie in the video amplifier. A check of the video amplifier can be made with a voltmeter, but this will not give conclusive proof that the operation is normal. A further check is herein presented to give the service technician a quick, convenient method for determining whether or not a defect is present in the video-amplifier section. Also, several clues are given on the effects that various troubles will have on the high-frequencies-signal amplification.

The requirements imposed on a video amplifier are very strict. It must amplify equally all frequencies from 30 cycles to over 4 mc and still maintain an average gain of 20 to 30. That is, the amplifier must have a flat frequency response and sufficient gain. It is difficult to produce both; for if one is increased, the other will decrease, and vice versa.

Any variation in component values is likely to produce a change in the frequency response of the

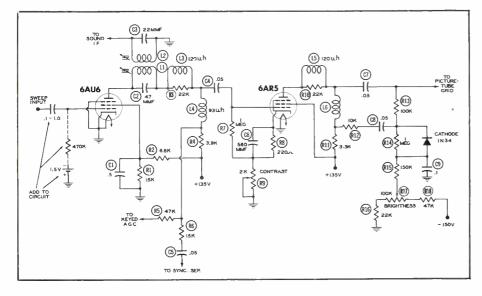


Fig. 2. Schematic Diagram of Video Amplifier Used in Test.

by William E. Burke

amplifier; and to detect this change, it is necessary that the frequency response be known. It is possible to construct a graphic curve from

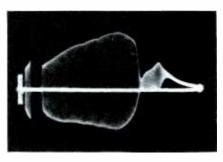
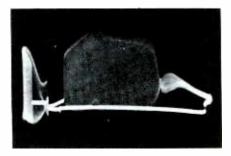


Fig. 3, Normal Response of Video Amplifier,

(below)

Fig. 4, Response Curve Showing Distortion Introduced by Input Capacity of Oscilloscope.



values obtained by measuring the amplification at various fixed frequencies, but this can become a laborious and time consuming process. A much simpler and easier method of determining the videoamplifier response is to employ an oscilloscope and sweep generator in much the same manner as is done in video IF alignment.

The output of an FM signal generator is a frequency-modulated signal that varies between upper and lower frequency limits which are

* * Please turn to page 61 * *

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...because CR tubes are electrically and physically different from all other types of electron tubes! Some of the more obvious differences include:

PICTURE PRODUCING BEAM CURRENT EXTREMELY LOW ANODE CURRENTS DIFFERENT, MULTIPLE OPERATING VOLTAGES HIGH LEAKAGE and SHORT CHECK LIMITS MORE and DIFFERENT TUBE ELEMENTS ELECTROSTATIC FOCUS ELEMENT ELECTROSTATIC DEFLECTION PLATES ELECROMAGNETICALLY FOCUSED GUN ELECTROMAGNETICALLY DEFLECTED BEAM ETC., ETC., ETC.

AND THE PRECISION CR-30 WAS SPECIALLY DEVELOPED FOR THIS VERY IMPORTANT PURPOSE!

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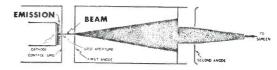
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- Receiving tube checkers were made for testing receiving tubes and NO CABLE ADAPTER can adapt them to do the job of the CR-30.
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You can't afford to guess when you test the most expensive component of a TV set. Be sure with PRECISION Model (R-30! IT IS THE ELECTRON BEAM (and NOT total cathode emission) which traces the pictures on the face of the CR tube.



Cathode emission can be high, and yet Beam Current (and picture brightness) unacceptably low. The CR-30 will reject such tubes because it is a Beam Current tester. Conversely, cathode emission can be low and yet Beam Current (and picture brightness) perfectly acceptable. The CR-30 will pass such tubes because it is a Beam Current Tester.

The CR-30 incorporates additional special test facilities necessary for overall performance evaluation of the CR tube as will permit positive answer to the question "Is it the Picture Tube or the TV Set?" And the CR-30 gives the answer in but a fraction of the time required to test the other 2 dozen or so tubes in the set.

SERIES CR-30: In hardwood, tapered, portable case, with hinged, removable cover. 171/4" x 133/4" x 63/4". Complete with standard picture tube cable, universal CR tube test cable and detailed instruction manual. Shipping weight: 22 lbs. NET PRICE \$104.75

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Examining

by HENRY A. CARTER

Automatic Tractor Radio Model TR-12

The Automatic Model TR-12 shown in Fig. 1 is designed and built specifically for installations in farm tractors. The set is housed in a rugged, weather-sealed, steel case and is



Fig. 1. View of Automatic Tractor Radio Model TR-12.

mounted on a base using rubber shock mounts. Supplied with the set is a one-foot length of pipe and a floor flange for mounting the set on the tractor. There is a pamphlet packed with the unit showing four suggested methods of mounting on different types of tractors. Some of these suggested methods may require the use of additional pipe, lumber, and hardware which are readily available. The TR-12 employs eight tubes, including the rectifier. The 6-by 9inch speaker is driven by two 6AQ5 tubes connected in a push-pull circuit. The manufacturer states in the specifications that the set is capable of delivering 5 watts of undistorted audio output or 6 watts maximum.

The mounting mechanism is so designed that the receiver can very eaisly be removed from the tractor. If the tractor is left in the field overnight, the radio can be removed to prevent exposure to the elements or to guard against possible theft. This is done by simply loosening the set screw under the mounting plate and uncoupling the wire at the fuse.

As can be seen in Fig. 1, a telescoping antenna is provided as an integral part of the assembly. No separate antenna mount is required. This arrangement eliminates the need for an antenna cable which might interfere with the operation of the tractor.

Emerson Pocket Radio Model 747

The Emerson Model 747 shown in Fig. 2 has several features which should be of great interest. The most significant one is its extremely small size. Its 6-inch width, 3 1/2 inch height, and 1 1/4 inch depth earn for it the name of pocket radio. It weighs only 1 1/3 pounds complete with batteries.

The set uses a superheterodyne circuit consisting of four miniature tubes, one each of the following types:

1V6 converter

1AH4 IF amplifier

DESIGN FEATURES

1AJ5 detector, AVC, and AF amplifier

1AG4 power output

Almostall of the components including the volume control and output transformer are miniature in size, as can be seen in Figs. 3 and 4. The speaker is 2 3/4 inches in diameter. The set is powered by an A battery and a B battery which are 1.5 and 45 volts,



Fig. 2. Cabinet View of Emerson Pocket Radio Model 747.

respectively. The B battery used is an Emerson EM 86 or equivalent.

The Emerson Model 747 has molded into the cover two civiliandefense symbols which identify proper tuning points for civilian-defense services. These frequencies are to be used during a national emergency in

* * Please turn to page 82 * *

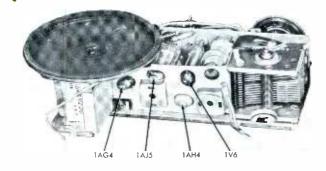






Fig. 4. View of Emerson Model 747 Showing Output Transformer and Volume Control.

January, 1954 - PF INDEX

JFD's JeT 213S outperforms all other VHF antennas covering the channel 2-13 spectrum.

Rugged, completely pre-assembled, the design of the SUPER-JET COM-BINES THE BEST OF BOTH THE BALINE YAGI AND THE JETENNA for unequaled deep fringe performance and flat-high gain no-dip response.

response. Narrow side lobes in the SUPER-JET provide highly directive UHF coverage equal in gain to stacked bowtie and reflector. An extra feature at no extra cost.

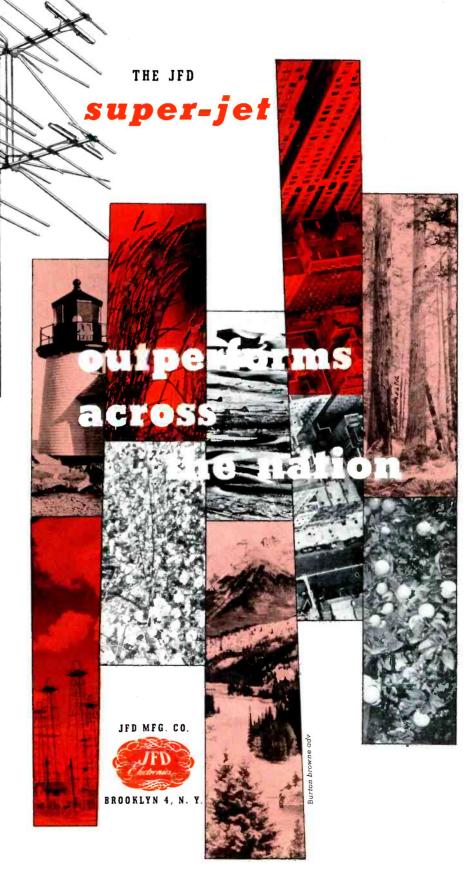
Delivers single 10-element Yagi performance on each channel. Write for Form 230.

HERE ARE THE FACTS-COMPARE FOR YOURSELF.

JFD JeT 213 S	Competitor D CHS 2-13 YAGI	Competitor C RADAR SCREEN TYPE B	Competitor B RADAR SCREEN TYPE A	Competitor A MATTRESS (4 STACK)	C H A N E L S
6.5	4.50	0.75	0.0	4.0	2
7.5	5.00	3.25	3.0	5.0	3
9.5	5.75	4.5	4.0	7.0	4
8.5	3.00	3.5	3.25	6.25	5
8.5	2.50	3.5	3.0	5.0	6
11.0	3.50	6.0	4.5	5.25	7
11.0	1.00	7.0	7.0	6.0	8
12.0	0.0	6.5	7.0	5.25	9
12.0	.875	7.75	8.0	7.25	10
11.25	.875	8.0	10.0	9.25	11
12.75	.50	7.5	10.0	6.5	12
12.0	7.5	6.0	9.0	7.0	13
	DB	G P	IN		
YES	NO	NO	NO	NO	1" Square Cross Arm - Completely
YES	NO	NO	NO	YES	Pre- Assembled
\$42.5	\$ 65.90	\$47.50	\$34.95	\$55.00	LIST PRICE

Worlds' largest manufacturer of TV antennas and accessories.

Model JeT 213 • single • \$20.75 list Model JeT 213S* • stacked • \$42.50 list *Complete with stacking transformers.





Introduction

In the past issues of this publication, "Audio Facts" has discussed in some detail the construction, operation, and purpose of several pieces of equipment used in high quality sound systems. Having been concerned with the design and application of these certain units, we have neglected to cover the broader considerations of the how and why of this field of audio now popularly called high fidelity. Since such an approach is certainly worth while, we will now consider some of the things constituting this field, why it is so popular at this time, and also what is required when assembling a high quality audio system. Before going into detail as to the specific units needed for a complete system, it might be well to go into some past audio history and find how and why the present-day high-fidelity system differs from the sound systems of past years.

Why We Have Increased Activity

There are some definite reasons why we have the increasing activity in audio at the present time. Probably one of the most important is that program material of high quality is now available. FM and TV transmissions furnish us with some excellent program material, but no doubt the largest and most often used source is the present-day disc recording. Recording techniques and methods have progressed to such an extent that modern records have been improved to a degree that would have been thought impossible a few years ago. The music recorded on these records now has the desired qualities of full frequency response and wide dynamic range, with distortion and surface noise present only in negligible amounts.

Tape recorders have also had an influerce and have gained a prominent place in the high-fidelity field because of their many advantages over other methods of recording. Although they are widely used for home recording and playback, their most important application has been in the professional field where their use in all manner of recording is nearly universal. For instance, practically all material now found on disc recordings was originally recorded on tape.

Sound Reproduced by Old Systems

The sound reproduced by the older type of audio systems that were in general use a few years ago was restricted in frequency response and limited in dynamic range. The absence of the higher frequencies and most of the extremely low tones resulted in sound that lacked naturalness and balance, to mention only two of the many qualities difficult to name or descrive but so essential to satisfactory reproduction of music. The limited dynamic range in volume between the quietest and loudest portions also reduced the effectiveness of the music

If an effort was made to bring out the higher frequencies, the usual result was a lot of noise and distortion. This was principally because that was about all which was there to be heard, since a very small portion of these higher frequencies was transmitted or recorded. Higher percentages of distortion were also tolerated in audio equipment of that time. Noise and distortion are much more evident and disturbing at the higher frequencies.

To minimize these undesirable effects the so-called tone control (the type which functions by cutting out the highs) was brought into use. This practically eliminated the higher frequencies and gave an apparent boost in the bass response, producing the well-known bassy "juke-box effect." In most instances, the really low tones were not reproduced, but enough of the higher and medium bass frequencies were present to make it seem so.

The important thing is that the ears of the listener became so ac-

customed and conditioned to this restricted response that it was accepted as being normal and the desired reproduction.

In connection with ears becoming conditioned to restricted sound reproduction, it might be well to consider the fact that we seldom hear an actual live musical performance any more. Some method of sound rein forcement is used in nearly all instances, whether it is indoors or out doors, a dance band or symphony orchestra. We have the influence of the microphones and all of the associated equipment; and if they give poor reproduction, that is what we hear. It does not sound as real as it should, although we can see the performers.

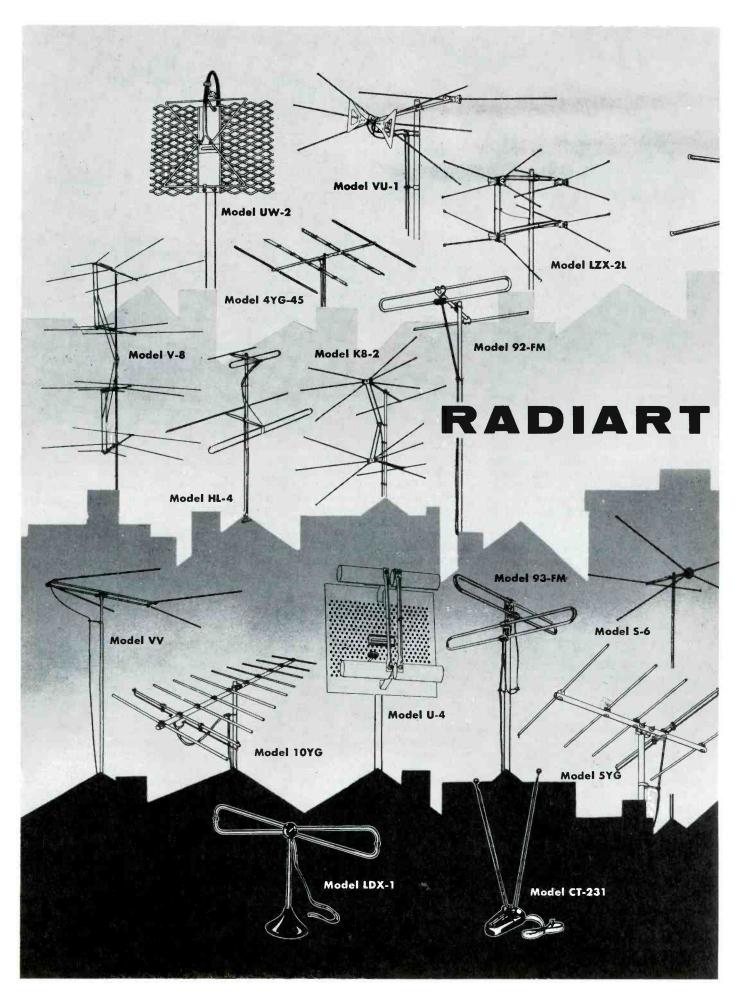
This is one reason why highfidelity reproduction may sound strange to some one hearing it for the first time. It sounds strange, since actual or real sound is unfamiliar to him because he never hears it.

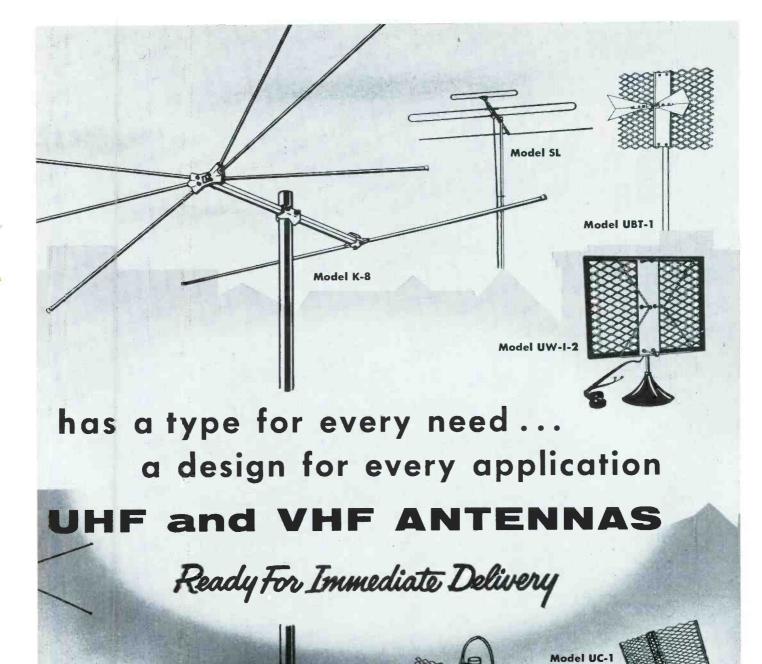
Modern Sound Systems

The modern high quality sound system is necessary if we are to reproduce faithfully the excellent program material available from the sources mentioned previously. This faithful reproduction is the purpose our system and the end result to be obtained. If the music fed into the system is effective and pleasing, it should come out of the loudspeaker just as effective and pleasing.

It might have been noticed that we have mentioned high quality sound often rather than high fidelity (Hi Fi). We have had a tendency to shy away from the term, because high fidelity has been applied so often to equipment which is that in name only but far from it in performance. A true high-fidelity system is one that faith fully reproduces the program material fed into it; so, whenever we use

* * Please turn to page 76 * *



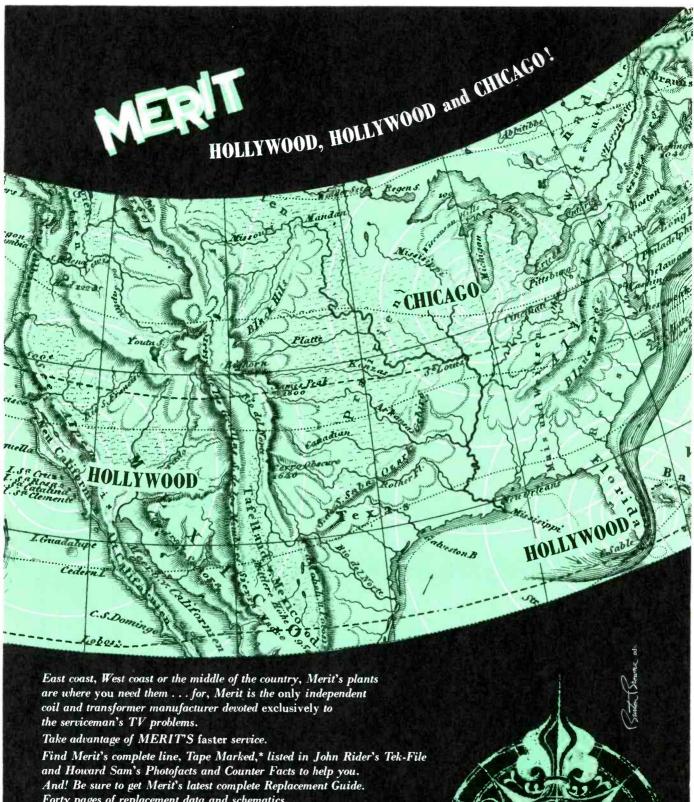


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Model UW-4

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Guying

A Handy Reference for Calculating Guy-Wire Lengths

100

80

60

40

TOWER HEIGHT (FEET)

by William E. Burke

A common trouble encountered in the installation of antenna towers is the determination of the length of guy wire that is required. The average installer will usually make a rough calculation and then add an extra length so that the guy wires will always be longer than actually needed. This is then cut off after the tower is erected. The installer thus has left a number of short, almost useless lengths of wire. This chart (Fig. 1) is presented with the intention of eliminating all calculations and waste. It is also useful for determining the values of other variable factors encountered in antenna installations.

Chart

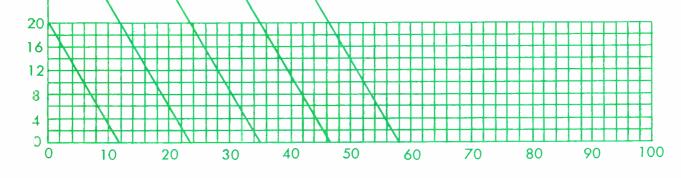
There are several stipulations that are applicable to this chart.

SCALE: 1/16 INCH = 1 FOOT

The angle formed between the tower and any guy wire should never be less than 30 degrees. The lines on the chart are drawn at this angle and are intended to serve as a minimum limit for any guy wire. If the line drawn on the chart by the installer to determine the guy-wire length should be parallel to or in a more horizontal plane than the lines present on the chart, the installation is suitable. The installation is not recommended when the resultant line on the graph lies in a plane more vertical than the lines shown. This particularly applies when guy wires from various heights on the tower are returned to a common anchor. The wire connecting to the highest point on the tower should not produce an angle of less than 30 degrees. It can be seen that all those below this point will then form angles greater than 30 degrees. An increase of 3 to 5 feet should be made to each guy-wire length determined from the chart in order to allow for sag and fastenings.

The tower height in some installations may be limited wher. any or all guy-wire-anchor locations are confined to a given area. The maximum height of tower which can

* * Please turn to page 81 * *



HORIZONTAL DISTANCE (FEET)

Fig. 1. Guying Chart

CBS-COLUMBIA GENERAL ELECTRIC PHILHARMONIC WESTINGHOUSE MOTOROLA SYLVANIA HOFFMAN EMERSON PHILCO ADMIRAL MUNTZ

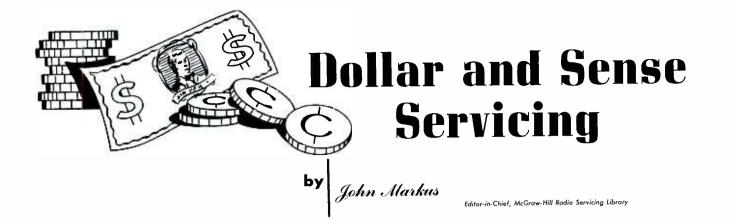
Designed for quick, simple installation, these Stancor flybacks save your time. There are no holes to drill, no leads to splice. Terminal board layouts duplicate the original units—even include choke coils, resistors, tube sockets and any other components that are on the original.



Stancor TV replacements are listed in Sams' Photofact Index, Counterfacts, Rider Manuals and Tek-Files

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CALLS. Latest average we've heard for TV, though not backed by survey statistics, is 2 calls per year per set with replacement of 4 tubes during the first 12 months of use. This is quite a drop from the 3.5 average of a year ago and the 5.5 average of 10-incher days. Likely reasons are that manufacturers are making sets and parts better these days, and at the same time users are becoming more tolerant to minor defects in pictures. In addition, transmitters are using higher power, which gives a reserve of signal strength at most receiver locations. As a result, tubes can weaken and parts can drift off value quite a bit before the effect on the picture becomes noticeable.



TREASURE. Heard that one publisher of a popular scientific magazine sold some 45,000 plans for building a radio treasure finder, at a dollar a piece. Wonder how many of these purchasers actually built the thing, and how many had to call on servicemenfor help in making it work? The eternal hope of finding buried treasure—the lure of the hunt—is what makes such sales records possible.

Sales of commercial radio metal detectors build up steadily from year to year, too. Units selling for around \$400 are giving excellent performance during rigid tests by engineers, but radically cheaper models are reported to be rather useless unless you already know the location of the buried metal to within a few feet. When properly overhauled and adjusted, the war-surplus SCR-625 mine detector that has been selling for around \$70 comes close to matching the expensive units.

Primary requirements of a good treasure finder are sensitivity and

stability. Sensitivity determines maximum depth of reliable detection of a given size of object and also determines into how many strips a given field has to be divided and walked over.

Secondary requirements are portability, ease of maintenance, over-all weight, and ability to discriminate between ferrous and nonferrous metals. The latter feature can save digging up tons and tons of scrap iron. In one commercial unit (Fisher Laboratories, Inc., Palo Alto, California), weight is kept down by using apple-box board, painted bright red, for the carrying case as well as for the chassis. Good circuit stability is essential to eliminate having to stop and rebalance the thing every 15 minutes or so.

What more interesting way is there to spend a vacation than seeking ancient treasure on some wavewashed Caribbean Island? There, it doesn't matter much whether the search is successful; the hunting alone will have made the vacation a thousand times more enjoyable than one at a traditional social-events resort.



MINES. One of the greatest military electronic needs of this country today is equipment for detecting the new pressure-sensitive mines that are believed to be perfected now by Soviet Russia. These mines can be dropped from airplanes or submarines; are immune to all mines sweeping, detecting, and countermeasure techniques of World War II; and can even be selectively set to respond only to ships bigger than a certain size.

A ship floating right over such a mine, no matter how huge, will not set off the mine because the weight of the ship is distributed uniformly over all the bottom of that ocean. As soon as the ship starts moving, however, it creates a pressure wave pattern that is related to the size and speed of the ship; this has one peak just ahead of the ship and another, slightly weaker, trailing along behind the ship. These two pressure waves are what trigger off the pressure mine.

So far, the only way of faking the waves is with a dummy ship of the same speed and size; this is far too expensive, because the dummy gets blown up each time it finds a mine. To become a technical hero, figure out a countermeasure for pressure mines. For more non-technical information, read "The Threat of the Pressure Mine" on page 129 of the "Reader's Digest," for September 1953.



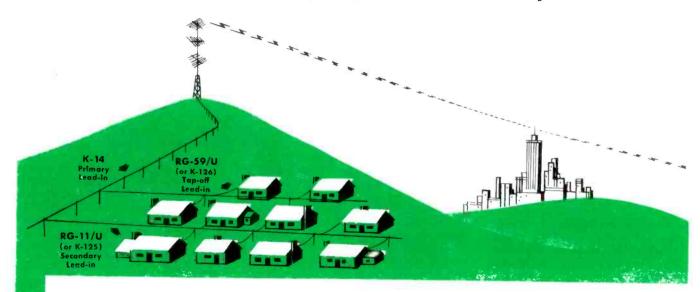
HISTORY. The change from a wood radio chassis to today's metal inverted-cake-pan chassis took place along about 1925. Before that small as well as large parts were basemounted on a wood breadboard with connections provided by spade lugs, binding posts, spring clips, or end caps. Interconnections were usually made with heavy bare bus bar, though some insulated wire was used. Assembly of such sets was expensive, resulting in the change to pigtail leads for small parts and use of a metal chassis that permitted mounting these right on the terminals of the tube sockets and large top-chassis parts. If you ever see one of these pre-1925 sets that's in good condition, grab it; they're getting scarce and will have real collector value as antiques of radio someday.

* * Please turn to page 93 * *

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RG-59/U-73-ohm coaxial TV lead-in cable. Highly efficient as a community system pole-to-house tap-off. Meets all needs wherever a high-grade installation is a must. Capacitance: 21 mmf/ft. Attenuation DB 100/ft: 2.7-50 Mc; 4.0-100 Mc; 5.7-200 Mc; 8.5-400 Mc.

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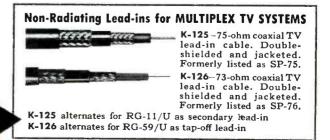
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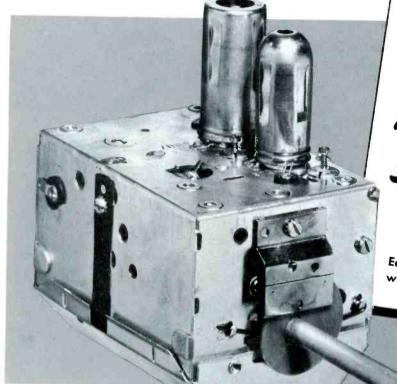


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Monochrome and Color

(Continued from page 5)

to sound carrier at this point is approximately 15 to 1. This ratio provides the best results in a monochrome receiver. In a color receiver, it is necessary to attenuate the sound carrier greater than 15 to 1 for the purpose of reducing the 920-kilocycle beat between the sound carrier and color subcarrier. This beat note would cause an unwanted pattern on the picture.

The sound is taken off at the output of the last video IF in the receiver of Fig. 1 for the purpose of attaining the most possible sound IF gain before the sound-carrier trap is inserted. The additionally needed sound-carrier rejection is provided by a filter network after the takeoff point. After the sound information is taken off, it is detected at the input of the sound section.

The stages comprising the RF-IF-Video section are fundmentally the same for both receivers; that is, they both serve the same purpose. The difference between the two lies in the design of the stages. Most of the IF strips used in monochrome receivers are designed to provide an over-all bandwidth of less than 4 megacycles. Usually they are about 3.2 to 3.5 megacycles. For optimum reproduction of color, the IF strip is designed for a bandwidth of at least 4 megacycles and upwards to 4.2 megacycles. The first criterion of an IF strip for color is that it must pass the color subcarrier with a frequency of 3.579545 megacycles. Another criterion is that the IF strip for color must be able to pass all sidebnads of the color subcarrier; therefore, since the width of the upper sideband of the subcarrier is .5 megacycle, the bandwidth of the color IF's should approach 4.2 megacycles.

The sync-separator stage in the color receiver performs the same function as in the monochrome receiver. The signals are taken from the video amplifier, separated into horizontal and vertical sync pulses in the sync-separator section, and fed to their respective sections. The design of the sync-separator section in a color receiver is essentially the same as that in a momechrome receiver.

The high-voltage section of a color receiver serves the same

purpose as that in a monochrome receiver. It must be designed to provide an output of about 20,000 volts, because the color picture tube requires this high value of second anode voltage. A flyback high-voltage system is employed; and in order to produce this level of voltage, a specially designed horizontal-output transformer must be used. This transformer must be capable of storing the considerable amount of energy that is needed for this purpose. More stages are also necessary in the high-voltage section of the color receiver. In one model, the high-voltage section contains four stages. These stages are a rectifier, a diode coupler, a doubler, and a regulator (see Fig. 1). The tubes being used for these functions are of recent design. To provide constant high voltage, a regulator is employed at the output of the high-voltage section.

As can be seen from the foregoing discussion, the sections of a color receiver, as shown in Fig. 1, are very similar to a conventional black-and-white receiver. Each stage performs the same function in both receivers. The difference lies in the design of some of the stages. The greatest difference is in the video IF

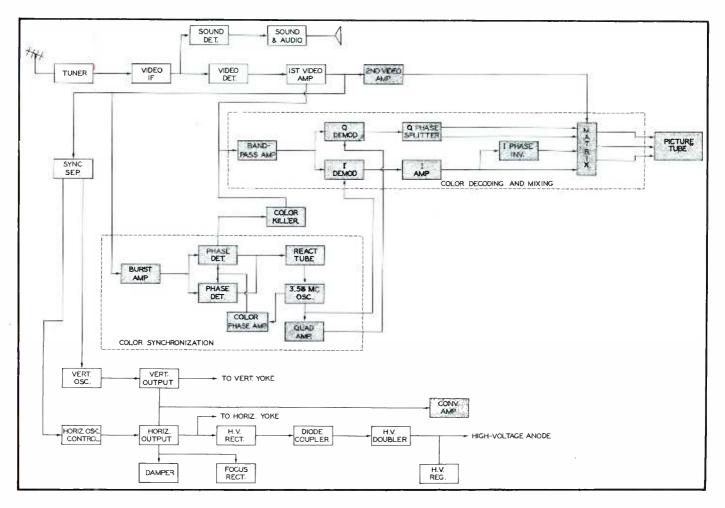


Fig. 2. Complete Block Diagram of a Color Receiver.

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stages which must be designed to provide adequate bandpass.

Let us add to Fig. 1 the stages that are needed for the reproduction of color. This has been done in Fig. 2 which is a complete block diagram for a color receiver. From this point on, this discussion will concern only the sections not similar to those of the monochrome receiver.

Turning attention to the portion called the color-synchronizing section, it is seen that a signal is taken from the output of the first videoamplifier stage and fed into the stage designated as the burst amplifier. This signal is a reference burst which is transmitted on the back porch of the horizontal-blanking pedestal. It consists of a minimum of eight cycles at the same frequency (3.579545 megacycles) as the color subcarrier. It is employed in the color-sync section as a reference for the generation of a local subcarrier at proper phase and frequency. By the use of this burst, the receiver subcarrier is maintained in step with the transmitted subcarrier.

The color-sync section consists of six stages. These are a burst amplifier, a phase detector, a reactance tube, a color-phase amplifier, a 3.58megacycle oscillator, and a quadrature amplifi€r. These stages produce in the output a CW signal. which is applied to the color demodulators to be used for the detection of the transmitted color information. The operation of this section is discussed in detail in the article, '' Color Synchronization,'' appearing elsewhere in this issue.

Another entirely new portion is the section for color decoding and mixing. This is shown in Fig. 2 as that portion from the input of the bandpass aniplifier to the output of the matrix. The six stages up to the input of the matrix are a bandpass amplifier, a Q demodulator, an I demodulator, a Q phase splitter, an I amplifier, and an I phase inverter. The combination of these stages is referred to as the chrominance channel. The purpose of this channel is to detect the color information which provides a separation of the I and Q color signals. These signals are amplified to a useful value and applied to the matrix in the proper phase. They are then mixed in the matrix unit with the luminance signal which is obtained from the output of the second video amplifier.

A second video-amplifier stage is employed in the color receiver for the purpose of amplifying the luminance portion of the color picture signal. (See Fig. 2.) Only the luminance signal passes through this amplifier, because the synchronizing and color signals are taken off at the first video amplifier. This additional stage is required in order to provide a luminance signal of sufficient amplitude and proper phase for application to the matrix.

Although not shown in the block diagram of Fig. 2, the matrix unit consists of three separate adder and amplifier stages. One section is provided for each primary color.

A detailed discussion on the operation of the portion of the receiver from the second detector to the output of the matrix is given in the article entitled, "Color Decoding and Mixing," appearing elsewhere in this issue.

The color picture tube differs greatly in physical and electrical aspects from the monochrome picture tube. It must be capable of accepting three varying signals and of producing a picture on the screen of the tube in full color. A discussion of how this is accomplished is given in the article, '' Picture Tubes for Color TV,'' apearing elsewhere in this issue.

Two other new stages which are present in a color receiver are the color killer and convergence amplifier. The purpose of the color killer is to provide an automatic method of disrupting the operation of the color channel during the reception of a standard monochrome signal.

The convergence amplifier is employed to provide better convergence of the picture-tube beams when they approach the outer edges of the screen. A signal is taken from the deflection section and amplified in the convergence amplifier stage. The output modulates the DC potential on the convergence electrode. The potential which controls the convergence of the beams is the difference of voltage that exists between the coating of the picture-tube envelope and the convergence electrode. The potential on the tube coating is a fixed value, while the potential on the electrode is a varying one. The tubecoating potential is higher than the convergence-electrode potential. Therefore, when the electrode potential is increased, the difference voltage decreases and allows the beams to converge properly at the aperture mask when they are scanned toward the outer edge of the screen.

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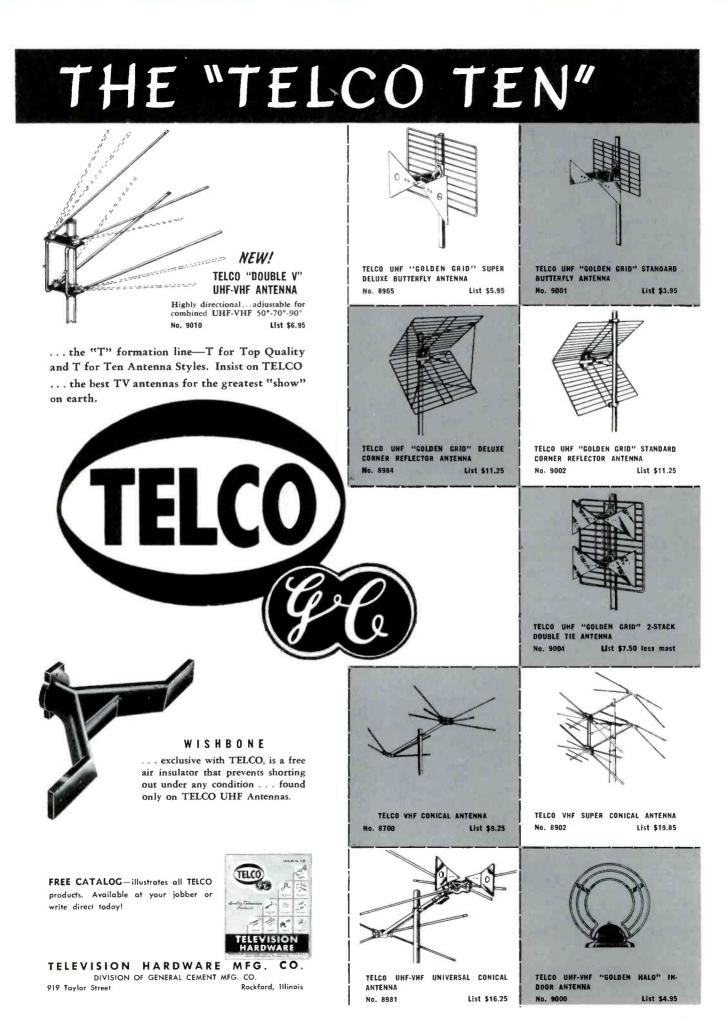
As a result, the convergence modulating voltage from the output of the convergence amplifier increases the potential on the electrode as the beams are deflected toward the outer edge of the screen. This provides proper convergence of the beams as the angle of deflection increases.

This completes the comparison of the stages in a color receiver with those in a monochrome receiver. It can be seen that the color receiver contains almost twice the number of stages of a monochrome receiver. Current experimental color receivers contain a total of 36 to 44 tubes. This is a large number of stages when compared with monochrome receivers which have a tube complement of 20 to 24 tubes.

Physically, the color receiver is larger and heavier than the present monochrome receivers. This statement is made with a standard 16- or 17-inch monochrome-picture reproducer used as a comparison. At the present time, most experimental picture tubes for color TV are heavier than a 16-inch monochrome picture tube. This added weight of the picture tube plus the added weight of a larger number of component parts in the circuit will result in a more bulky receiver. The greater number of stages contained in a color receiver will probably result in a larger chassis.

Most experimental color receivers produced to date contain a picture tube that forms a picture which is approximately equivalent in area to that of a 12-inch monochrome picture. The tube envelope being used has a 15-inch diameter. Although there have been larger experimental tubes, the first production run of color receivers will probably incorporate a tube of the 15-inch variety.

The expected selling price of the first color receivers has been estimated by some TV receiver manufacturers to be about \$700 to \$1000. The major part of the cost of a color receiver will be the picture tube; however, after production of the color picture tube is stepped up, its cost will undoubtedly become less. In creased production of the chassis and improved circuit design will also effect a further decrease in production cost.



Picture Tubes for Color TV

(Continued from page 7)

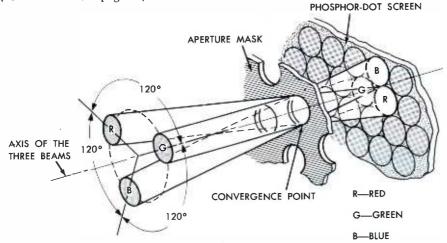


Fig. 5. The Relation Between Electron Beams, Shadow Mask, and Phosphor Screen in the Color Picture Tube.

a phosphor screen. The displacement "d" between the points on the phosphor screen is proportional to the placement "D" between the sources. The mask is placed very close to the screen so that the points on the screen are much closer together than are the sources of the beams which energize these points. The reader must bear in mind that the displacement "D" of the sources can be in any direction within a plane perpendicular to the paper at the indicated dotted line.

The foregoing principle is used in color picture tubes where three patterns of one mask are reproduced on a screen by three electron beams. The pattern produced by any one beam is displaced from the patterns produced by the other two beams by an amount proportional to the spacing between the guns which generate the beams. A solid illuminated area is formed on the screen by the three interwoven patterns. The arrangement is such that one electron beam impinges only on dots of one color over the entire screen. This relationship means that there must be three phosphor dots on the screen for each mask hole. A detailed drawing of this method of color selection is presented in Fig. 5.

One of the requirements of the shadow-mask tube is that the three beams must converge or come together at the mask. The adjustment which is used to bring this about is called the convergence adjustment. If the beams did not converge properly at the mask, one or more of the beams would strike portions of phosphor dots of the wrong color. For example, the beam associated with red dots might energize blue or green dots as well as red dots. This would produce incorrect hues in the picture.

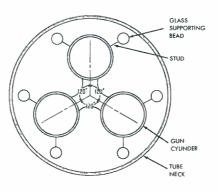


Fig. 6. End View of the Three-Gun Assembly in the Color Picture Tube.

Another requirement of the shadow-mask technique is that the phosphor screen must be at a fixed distance from the mask at all points. This eliminates any variation in dot size or in spacing between dots on different areas of the screen.

The principle behind the shadowmask technique demands that the three sources of the beams be fixed in position relative to the mask holes and screen dots. Referring again to Fig. 5, the beam sources are located equidistant from a common axis and 120 rotational degrees apart. This triangular placement of the beams conforms to the triangular arrangement of the dots on the screen.

If the axis of the beams were not in a precise position relative to a particular aperture hole, each beam would strike the edges of phosphor dots adjacent to and in addition to the dot it should strike. This undesirable condition would result in color dilution in the reproduced picture.

Keeping in mind these requirements of the system, let us next consider the electron-gun assembly and the manner in which the beams are generated and controlled.

Electron-Gun Assembly and Beam Control Prior to Deflection

The early stages of color television development witnessed an attempt to use a single electron gun for the color presentation by incorporating a time-sharing process with the electron beam. That is, the

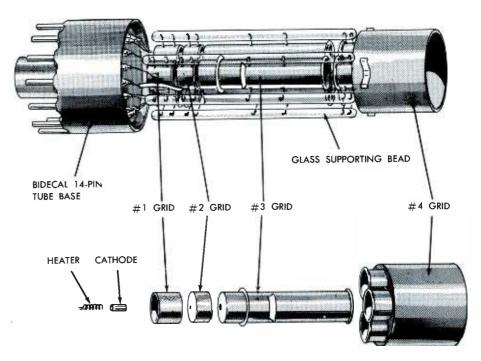


Fig. 7. Three-Gun Assembly With an Exploded View of One of the Guns.

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operational cycle was divided into three time intervals, one interval being assigned to each of the three primary colors. Through the use of a suitable switching means, the electron beam ϵ xcited only one color for each interval. Because of the persistence of vision of the human eye, the three colors combined to give a resultant color — that of the picture section being scanned.

In contrast to the single-gun tube, the three-gun tube illuminates the three primary colors simultaneously by utilizing three separate electron guns. The three guns are assembled so that they are mutually parallel and their axes are equiddistant from and spaced 120 degrees around the central axis of the picture tube. An end view of the three-gun assembly is shown in Fig. 6. A side view of the same assembly and an exploded drawing of one of the guns are presented in Fig. 7.

The individual guns are all identical to ϵ ach other and somewhat similar to the gun used in the 5TP4 projection tube. The differences lie in the electrodes added to accomplish focus and convergence of the beams and in the shorter gun lengths. Each electron gun consists of a heater, cathode, No. 1 grid, No. 2 grid, No. 3 grid, and No. 4 grid. The No. 3 grids are individual electrodes in each gun but are electrically connected to each other. These grids are designated as the focus electrodes. The No. 4 grid is a single element which serves all three guns as a convergence electrode. The inside coating on the tube envelope, the mask, and the screen are electrically connected; and these three parts constitute the high-voltage anode of the tube.

It has been stated that one of the requirements for proper shadowmask operation is that the beams be properly positioned with respect to the common axis and to each other. This requirement is established for the most part by the close manufacturing tolerances which are observed in the color ube. To overcome any gun misalignment which may exist in the finished tube, three beam-positioned magnets are mounted on the neck of the tube near the base. These magnets, one for each gun, may be adjusted separately so that each beam is in the proper relationship to the other two. The magnets are shown in the drawing of Fig. 8, which pictures the external components necessary with the color tube.

The heater, cathode, No. 1 grid, and No. 2 grid in each gun function as they do in the black-and-white tube. The three heaters are connected internally in parallel. Focusing of the individual beams so that they come to sharp focus at the point of beam convergence at the mask is accomplished by the electron lenses existing between the individual No. 3 grids and the common No. 4 grid.

Up to this point the three beams are traveling parallel to each other; however, it is necessary that the beams be bent toward each other so that they converge and meet at the mask. The inside coating on the tube envelope extends down into the neck. The potential difference between this coating and the No. 4 grid forms an electron lens which converges the three beams. The amount of convergence is determined by the magnitude of the voltage difference between the two grids. Since the high voltage on the neck coating is a fixed value. the No. 4 grid potential is the adjustable voltage for convergence. It is also true that the No. 4 grid potential serves as part of the focusing lens. therefore the beam focusing changes when the convergence is varied. This makes it necessary that the No. 3 grid potential be variable for focusing and that the convergence and focus controls be varied alternately whenever adjustments are made.

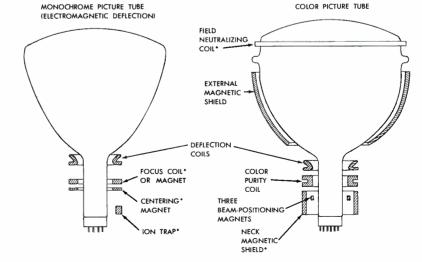
It may be of interest to mention the high voltages which are present in the gun structure of the typical color tube. Under average operating conditions, the voltage on grid No. 4 is about 10,000 volts and that on grid No. 3 is about 3,000 volts. Both of these voltages are applied through connections in the tube base. The voltage on the high-voltage anode is approximately 20,000 volts.

Mention has been made of the fact that color dilution occurs if the common axis of the beam system is not properly oriented. While the beam-positioning magnets are used to control the beams with respect to each other, a color-purifying coil is needed to position correctly the combined system of beams within the neck of the tube. The color-purifying coil fits around the neck of the tube, as shown in Fig. 8. Adjustments of the location of this coil and of the current through it make possible the accurate orientation of the system of beams so that the red beam strikes only red dots, the green beam strikes only green dots, and the blue beam strikes only blue dots.

Adjustment of the color-purity coil is recommended as one of the initial steps following installation of a color picture tube. This alignment can be accomplished as follows: cut off two of the three electron beams and then rotate the purifying coil on the neck of the tube while varying the current through the coil. Proper alignment will produce a uniform field of color over the central area of the screen. The color at the center must be the particular color associated with the conducting gun. Establishing color purity on areas of the screen away from the center necessitates adjustments involving other beam-controlling components.

Deflection and Its Problems

The deflection coils for the color tube serve the same purpose as they do for the black-and-white tube. They deflect the system of beams from the three electron guns so that a raster is produced on the phosphor screen. The line pattern in the color picture is exactly the same as it is in the black-and-white picture, though to the eye it may be concealed somewhat by the dot structure of the screen. The design requirements of the deflection yoke used with a color picture



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- Power Supply: 105-125 volts, 50-60 cycles. • Size 131/2" high, 9" wide, 161/2" deep. Weight only 25 lbs. (net).

 ${
m T}_{
m he}$ WO-88A has built-in voltage calibrating facilities which permit simultaneous waveshape display and peak-topeak voltage measurements. Frequently, the shape of the TV waveform under observation will be correct but its amplitude will be low and, consequently, cause improper operation. Therefore, a TV 'scope is complete only if it can measure the peak-to-peak voltage of the displayed waveform. Check this feature on the "88"!

On the WO-88A, sync polarity may be reversed instantly by simply clicking a front-panel switch. This feature is important because TV pulses may be either positive or negative, depending upon where the 'scope is connected. To avoid waveshape "jitter" or distortion, use a 'scope which will "lock in" readily on all types of TV waveforms. Check this feature on the "88"!

When you use the low-capacitance probe supplied with the WO-88A, the over-all input resistance is raised to 10

megohms! Because many TV circuits are extremely sensitive to resistive loading, normal circuit operation may be seriously disrupted by loading of the average'scope. With the low-capacitance probe, however, loading problems are minimized. Check this feature on the "88"!

In addition, the low-capacitance probe supplied with the WO-88A decreases the over-all input capacitance to less than 10 uuf! Excessive capacitance loading can cause the horizontal oscillator to change frequency or stop oscillating. When the WO-88A is connected, the low over-all input capacitance leaves receiver operation essentially unaffected. Check this feature on the "88"!





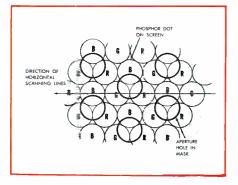


Fig. 9. View of Phosphor Screen As Seen Through Shadow Mask.

tube are more stringent because the presence of three beams in the tube, instead of one, demands that a uniform magnetic field be established over a broader portion of the space inside the yoke. Therefore, the color deflection yoke differs slightly in structure from the yoke employed with monochrome tubes.

In regard to the adjustment of deflection yokes on color picture tubes, one or two points can be mentioned. One item of interest is that the deflection yoke can no longer be used by itself to correct a titled picture. This is true because the proper rotational position of the yoke is fixed by the requirement that the horizontal scanning lines must be parallel within close tolerance to the rows of holes in the aperture mask. This is illustrated in Fig. 9. It is possible that a tube may be mounted so that these rows of holes are not horizontal, which might result in a moire effect in the raster. To correct this, the tube must be rotated with respect to the yoke. Proper positioning of both tube and yoke produces a picture devoid of moire effect or tilt. The approximate deflection angle required to scan color tubes now in development is only 45 degrees, which is a somewhat smaller angle than is used in most present-day monochrome tubes.

As previously stated, the point at which the beams converge must be in the plane of the mask. Until now, we have considered the problems of convergence and focus as though they were static or unchanging. In practice, though, this is not the case. The beams are continually being deflected over the raster, and the distance from the plane of deflection to the mask varies with the scanning. Thus, some means must be provided to vary the focal lengths of the electron lenses which focus and converge the beams.

The problem can be seen by referring to Fig. 10 which illustrates this condition as it exists in a color tube having a flat mask and screen. In order to obtain dynamic convergence and focus (that is, to focus and converge the beams at the edges as well as at the center of the raster), it is necessary that the focusing and converging electron lenses be changed constantly according to a set pattern. This can only be done by applying certain AC voltages to the No. 3 and No. 4 grids. Since these voltages must be synchronized with the scanning, they are usually derived from the horizontal- and vertical-sweep sections of the color receiver. The voltages are of the proper amplitude, waveform, and phase to provide dynamic convergence and focus correction over the entire raster. Consequently, the potentials on the focus and convergence electrodes consist of two parts: (1) DC voltages for static convergence and focus and (2) AC voltages to accomplish dynamic correction.

There are six controls which have to do with the nature of these voltages: (1) the horizontal-dynamicconvergence amplitude control; (2) the horizontal-dynamic-convergence phase control; (3) the vertical-dyna mic-convergence amplitude control; (4) the vertical-dynamic-convergence shaping control; (5) the focus control; and (6) the DC convergence control.

The control exerted on the beams in the color tube must be much more precise than in the monochrome tube. It was found during early development that even the relatively weak magnetic field of the earth had a distinct effect on the beams in the color picture tube. After a color receiver was once properly adjusted in a certain position, it could not be turned 90 degrees without needing readjustment. To eliminate the effects of the earth's magnetic field and other stray magnetic fields, external magnetic shields are placed around portions of the color-tube envelope as shown in Fig. 8. As a further means of counteracting such effects, one make of color tube has a field-neutralizing coil encircling its face. The current through this coil is adjusted for optimum color purity of all color fields.

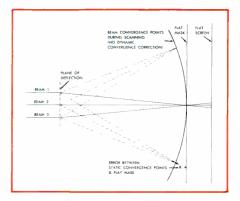


Fig. 10. Drawing Illustrating Necessity for Dynamic Convergence and Focus Correction.

Another adjustment required with color picture tubes is that of color balance. Because of the fact that the various phosphors used in the make-up of the dot screen do nothave equal luminosity efficiencies, different beam currents from the three guns are required to achieve equal and blue. This insures that various shades of gray in a screen image will not be color tinted and that flesh tones will be accurately reproduced. Color balance is achieved by the proper selection of DC voltages on the No. 1 and No. 2 grids of each gun.

Summary of Beam-Control Points

The various operations performed on the electron beams from the time they are formed until they reach the mask and screen of the color picture tube can best be summarized by a step-by-step method. The drawing in Fig. 11 shows a modified block diagram of one of the guns and the operations which take place. The dotted lines outline the electron beam, and the arrows indicate the direction of forces exerted on the beam at each point in its path. The points of control are lettered and positioned roughly, not exactly, in their order of occurrence.

The electrons are emitted by the cathode which is shown on the left side of Fig. 11. The No. 1 grid is the control grid, and the force "A" which

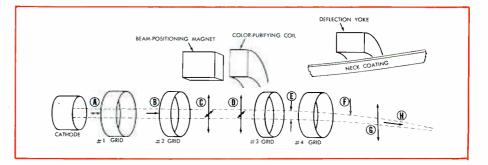
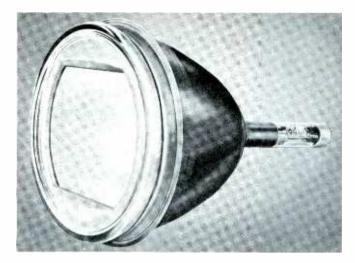
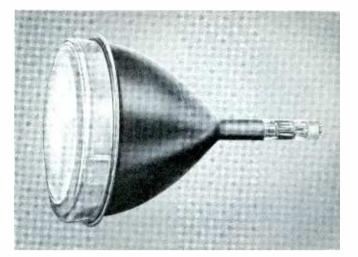


Fig. 11. Beam Path Showing Control Points.





(A) RCA Developmental No. C73599. (Photograph Courtesy of RCA Tube Department)

(B) CBS-Colortron Type HD-187. (Photograph Courtesy of CBS-Hytron)

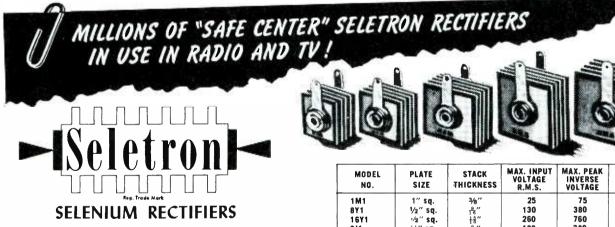
Fig. 12. Typical Color Picture Tubes.

this grid exerts on the electrons is one of repulsion in varying degrees as indicated by the arrow symbol. Force "A" determines the amount of energization which is imparted to the screen phosphor and varies according to the modulating signal applied between the cathode and the No. 1 grid.

Force "B" is an accelerating force in the direction of the screen

and has a magnitude determined by the voltage on the No. 2 grid (accelerating anode). The beam-positioning magnet exerts a force "C" on only the one beam in any direction at right angles to the path of the beam. The direction of force depends upon the position of the magnet. This force "C" is used to align the beam with the beams in the other guns. It contributes to satisfactory convergence by this particular beam.

The color-purity coil applies a force "D" which is similar in nature toforce ''C.'' Force ''D,'' however, is exerted alike on all three beams. If the direction of force "D" were upward, all three beams in the gun assembly would move upward. This force is employed to direct the system of beams to the proper point in the deflection plane, so that after being deflected the beams will strike their respective color dots on the screen



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1M1	1" sq.	3/8″	25	75	100 MA
8Y1	1/2" sq.	<u>9</u> ″	130	380	20 MA*
16Y1	1/2" sq.	18"	260	760	20 MA*
8J1	11/ sq.	9"	130	380	65 MA
5M4	1" sq.	Hi"	130	380	75 MA
5M1	1" sq.	7/8″	130	380	100 MA
5P1	1 1 3 " sq.	7/8″	130	380	150 MA
6P2	1-3-" sq.	1 <u>3</u> ″	156	456	150 MA
5R1	11/2" x 11/4"	7/8″	130	380	200 MA
501	11/2" sq.	11/a″	130	380	250 MA
601	11/2" sq.	11/a″	156	456	250 MA
602	11/2" sg.	13/8″	156	456	250 MA
6Q4 (†)	11/2" sq.		130	380	300 MA
5QS1	11/2" x 2"	1 1⁄a″	130	380	350 MA
6QS2	11/2" x 2"	11/4"	156	456	350 MA
551	2" sq.	11/8"	130	380	500 MA
6S2	2" sq.	13/8″	156	456	500 MA

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of the tube. The direction of force "D" is set by the position of the purity coil and by the magnitude and direction of the current through the coil.

Force "E" is applied by the electrostatic field between the No. 3 and No. 4 grids. It is a compressing force on the beam and has a focusing action determined by the nature of the potential between the two grids.

The electrostatic field between the neck coating and the No. 4 grid exerts a force "F" on the beam which is in a direction toward the axis of the three beams. This is the force which converges the beams so that they meet at the mask. The magnitude of the force is proportional to the instantaneous potential existing between the neck coating and the No. 4 grid.

Force "G" is produced by the deflection yoke and acts upon all three beams in directions at right angles to the axis of the beams. This force causes the beams to scan the screen horizontally and vertically to form the raster. Force "H" is the accelerating force contributed by the high voltage on the picture tube.

RCA Three-Gun Tricolor Kinescope and CBS-Colortron

Of the several makes of color picture tubes which have been or are now being developed, we have obtained data on two — the RCA Tricolor Kinescope and the CBS-Colortron, both shown in Fig. 12. Each tube employs the dot-phosphor screen, the shadow mask, and the three-gun assembly.

The RCA tube uses a flat mask and a flat phosphor screen. A flat screen provides a good viewing surface, and it would be an ideal situation if the flat screen could also be used as the face plate of the tube. This would be impractical because of the high vacuum in the picture tube. On the face of any sizable tube, there is a pressure of a ton or more due to atmospheric pressure; and a flat faceplate would collapse unless it were extremely thick. For this reason, the flat mask and screen must be mounted inside the tube and a curved glass faceplate is used to complete the envelope of the tube. A decorative mask is included inside the envelope just in front of the phosphor screen. This serves the same purpose as the mask on the cabinet of a monochrome receiver.

The CBS-Colortron employs a curved mask and a curved phosphor screen. The screen in this tube is deposited on the inside surface of the faceplate as in a monochrome tube. For this reason, a decorative mask is not needed within the tube envelope. The use of the curved shadow mask reduces the values of dynamic focus and convergence voltages required in this tube.

In summary may we say that although the color picture tube appears to be rather complicated, procedures for installing and adjusting the tube and its associated components are being developed and simplified. We trust that this discussion of color-picture-tube fundamentals will serve as a foundation block for the service technician who is building his background of knowledge to meet the challenge of color TV.

William E. Burke

and

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tings. The HICKOK Non-Parallax dial can be viewed from any angle without intro-ducing error. The 45 inches of dial can be self calibrated to within crystal accu-racy (0.5%) since the unit includes a self contained crystal calibrator.

contained crystal calibrator.
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(3) Complete R.F. coverage up to and including channel 83. All channels have picture and sound settings marked directly on the scale—this eliminates checking on these values when they become applicable.

(4) The marker can be modulated by a self contained 400 cycle signal. This is especially valuable in stage - by - stage alignment and eliminates the introduction of another instrument.

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crystal which is included. (6) It is possible to view two markers at once on the response curve. This will include the main marker and a marker corresponding to the crystal value se-lected. For instance, a 4.5 MC crystal may be used to obtain two markers with a 4.5 MC separation. This will greatly speed up alignment procedures since it is not necessary to re-set dials to check re-sponse curve width. (7) Both an electronic-eye tube and a

(7) Both an electronic-eye tube and a headphone jack are available for either visual or audible indications of zero beat.
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This unit, in conjunction with the Model 695 Sweep Generator and Model 690 Mark-er Generator provides the utmost in tele-vision alignment techniques. It takes the guesswork out of receiver alignment and eliminates any errors previously intro-duced by overloading due to markers. The 691 provides a marker visible at all times (including trap points) and will not change in amplitude or distort the re-sponse curve what-so-ever. This feature, in addition to the accuracy and minimum leakage of the other units (600 - 695), will greatly simplify any alignment. The outputs of the sweep generator and marker generator are heterodyned and applied to an oscilloscope in such a man-ner that the marker signal will never pass through the receiver itself—there-fore cannot cause overloading. In short, we can say that we are cali-brating the oscilloscope with a marker which is visible at all times—even on the base line.

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microvolts or more. Many leading TV engineers have tested this new HICKOK equipment and highly compliment its frequency, stability and ease of use in offering today's fastest, most complete and accurate solution to TV alignment tasks. See your jobber today or write factory direct for com-plete technical information.



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maximum output of 300,000 microvolts.
(2) A bias voltage, variable from 0 to 12 volts, and metered directly by the voltmeter on the front panel, eliminates the usual time-consuming method of obtaining bias voltage from dry cells. Since this bias voltage is variable with continuous tuning, one can determine more accurately the effects of bias on the overall response curve and can align sets to "more sensitive" for "fringe area" reception or align them to prevent "overloading" when the station signal is very powerful.
(3) Three RF oscillators provide com-

(3) Three RF oscillators provide com-plete VHF coverage (Channels 2 - 13) on fundamentals and heterodyned output IF frequencies 0 - 50 MC. This assures a strong signal necessary for aligning "front ends."

(4) Continuous tuning and an easy-to-read scale marked off in channels liter-ally provides the serviceman with a fool-proof method of alignment.

(5) An internal method of "retrace blanking" provides a reference base line and eliminates confusion sometimes brought about by retrace curves.

(6) Even though the sweep width is varied, it will not be necessary to read-just the phasing control.

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(8) The instruction manual accompanying the unit gives complete, detailed and easy-to-follow instructions on cor-rect alignment procedures, uses of the instrument, and a thorcugh understand-block of the standard standing of alignment.

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Color Decoding and Mixing

(Continued from page 15)

considerable overlap results, and one would expect the two signals to interfere with each other.

That would be the case, except for the minimizing effect of the frequency-interleaving principle. This principle is based on the fact that the frequency spectrum of a scanned subject is concentrated about the points that are whole multiples of the linescanning frequency. Halfway between these points that is, at odd multiples of half the line-scanning frequency, are frequency bands containing little information. Therefore, if two modulated carriers both subject to the same line-scanning rate are separated infrequency by an odd multiple of half the scanning rate, the concentrated bands of one carrier will occur at the vacant spaces of the other and the two will interleave.

The actual value of the horizontal-scanning frequency proposed in the NTSC standards is $15,734.264 \pm 0.047$ cycles per second. If this value is divided by 2 to obtain onehalf the line frequency and then multiplied by 455 (which is an odd number) the result will be 3.579545mc, the frequency of the chrominance subcarrier.

Chrominance Circuit Details

A partial schematic up to the point of application to the matrix appears in Fig. 3 showing the first video-amplifier stage with the bandpass amplifier take-off point, the bandpass amplifier, the Q demodulator, and phase splitter.

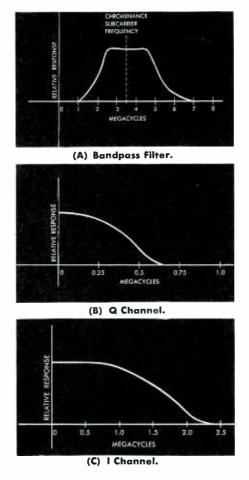


Fig. 4. Response Characteristics.

The signal for the bandpass amplifier is taken from one section of the contrast control. The other section of the contrast control is in the luminance channel, with the two sections ganged in such a manner that a constant relationship is maintained between both signals throughout the range of the contrast control. The sound signal is attenuated by a trap in the cathode circuit of the first video amplifier V9. The composite video signal is applied to the grid of the bandpass amplifier V17B.

Note that the screen grid of V17B is connected through R181 and C164 to a winding on the horizontaloutput transformer. During the hori zontal-retrace period, a negative pulse is thus applied to the screen. As a result, V17B is cut off and the synchronizing pulses are blocked. The signal grid of this tube is returned to ground through three resistors in series: the contrast control, R57, and R58. The last-mentioned resistor is also used as the plate load for the color-killer tube V27B. In the absence of a color signal (that is, dur ing reception of a monochrome broadcast), V27B conducts and a negative voltage of sufficient value to cause cutoff of V17B is developed across R58. In this manner, the chrominance channel is prevented from functioning during monochrome reception.

The output signal from V17B is applied to a bandpass filter with the frequency characteristic as shown in Fig. 4A. The signal out of the bandpass filter is applied to the chroma control and thence to the No. 1 grids of the Q and I demodulators, these grids being connected directly to each other. The chroma control, with R185, forms the ground return for these grids.

The Q demodulator V29 is a type 6AS6, dual-control, RF pentode functioning as a synchronous detector. The chrominance signal is applied to the No. 1 grid; and an unmodulated

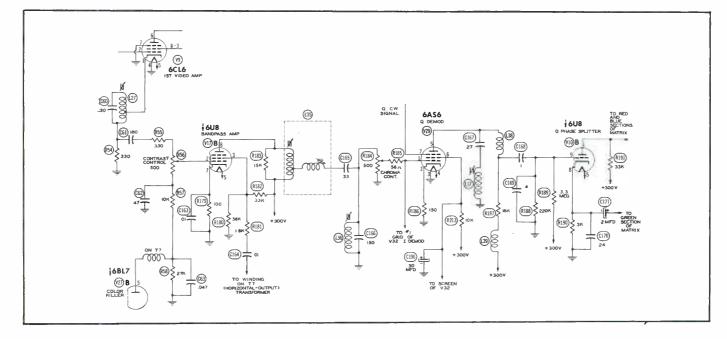


Fig. 3. First Video-Amplifier Stage, Bandpass Amplifier, and Q Channel.



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CW signal from the quadrature amplifier is applied to the suppressor grid, pin No. 7 of V29. The frequency of the quadrature signal is the same as that of the chrominance subcarrier, 3.579545 mc; and its phase is such that the detected signal in the plate circuit of V29 is the Q signal. After passing through the low-pass filter, the Q signal is applied to the phase splitter V10B in order to obtain both negative and positive signals for the proper combinations at the matrix. The frequency characteristic of the Q channel is shown in Fig. 4B. The zero reference in this figure and in Fig. 4C should not be confused with that of Fig. 4A. In Fig. 4A the frequency spectrum is considered as having the video carrier for a zero reference, and the subcarrier frequency of approximately 3.6 mc is seen to fall at the center of the bandpass response. In Figs. 4B and 4C the detected chrominance signals are under consideration, and the response curves show the relative response of the Q and I channels to these signals.

Operation of the I channel is quite similar in many respects to that of the Q channel. A schematic of the I channel appears in Fig. 5. As mentioned earlier in the article, the No. 1 grids of both demodulators are directly connected to each other; hence, the same signal is applied to each channel. However, the 3.579545mc CW signal supplied to the I demodulator for synchronous detection is advanced 90 degrees in phase with respect to the Q-demodulator CW signal, with the result that the I signal is the one detected. The plate

circuit of V32 contains a low-pass filter and a delay circuit. The frequency characteristic of the I channel appears in Fig. 4C. The delay circuits in the I and Y channels are necessary in order to insure that signals from all three channels (I, Y, and Q) arrive at the color tube with the same time relationship they had when separated at the transmitter. The functioning of each channel is such that the Q signal suffers the greatest delay, the I signal the next greatest, and the Y signal is delayed the least. Therefore an additional small delay is added to the I channel, and a greater delay is added to the Y channel to bring the total in these channels to equal that of the Q channel.

The plate signal of the I amplifier V33A is of the correct polarity for application to the red section of the matrix, but this polarity must be reversed for application to the blue and green sections. This reversal is accomplished in the I phase-inverter stage.

The chroma control affects the amplitude of signal output from both I and Q channels. The ratio of I to Q signals is controlled by a potentiometer in the cathode circuit of the I demodulator tube. Both these controls affect the saturation of the colors finally appearing on the color tube; this is in agreement with a previous statement, that color saturation is dependent upon the amplitude of the chrominance signal and hue is dependent upon the phase of the subcarrier.

Luminance Channel and Matrix

The luminance or Y channel serves essentially the same purpose as the video stages in the monochrome receiver; that is, it amplifies the luminance signal to the proper amplitude for application to the matrix. Included in the luminance channel is a delay line for the purpose of delaying the luminance signal approximately 1.0 microsecond so that it will arrive at the matrix at the same time as the corresponding color or chrominance signal. The circuit diagram for the luminance channel is contained in Fig. 6. It includes that portion from the input of the first video amplifier to the input of the matrix.

The first video amplifier performs a number of functions. These functions are to provide the following signals:

1. Negative signal to the bandpass amplifier.

2. Deflection sync signals to the sync separators.

3. Color-burst signal to the burst amplifier.

4. Luminance signal to the second video amplifier.

The negative signal to the bandpass amplifier is taken off the contrast control in the cathode circuit of the first video amplifier. The deflection sync signals are taken directly from the plate. The color burst is obtained

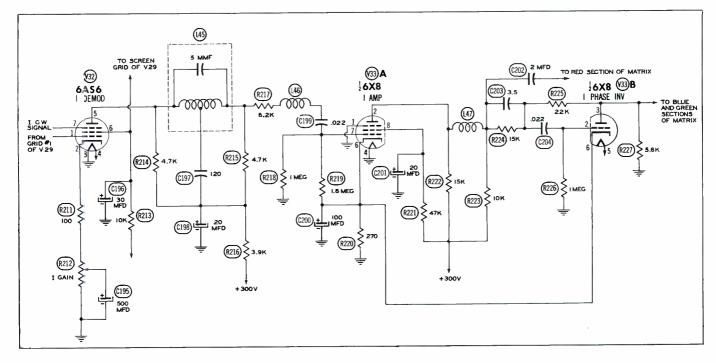


Fig. 5. The I Channel.

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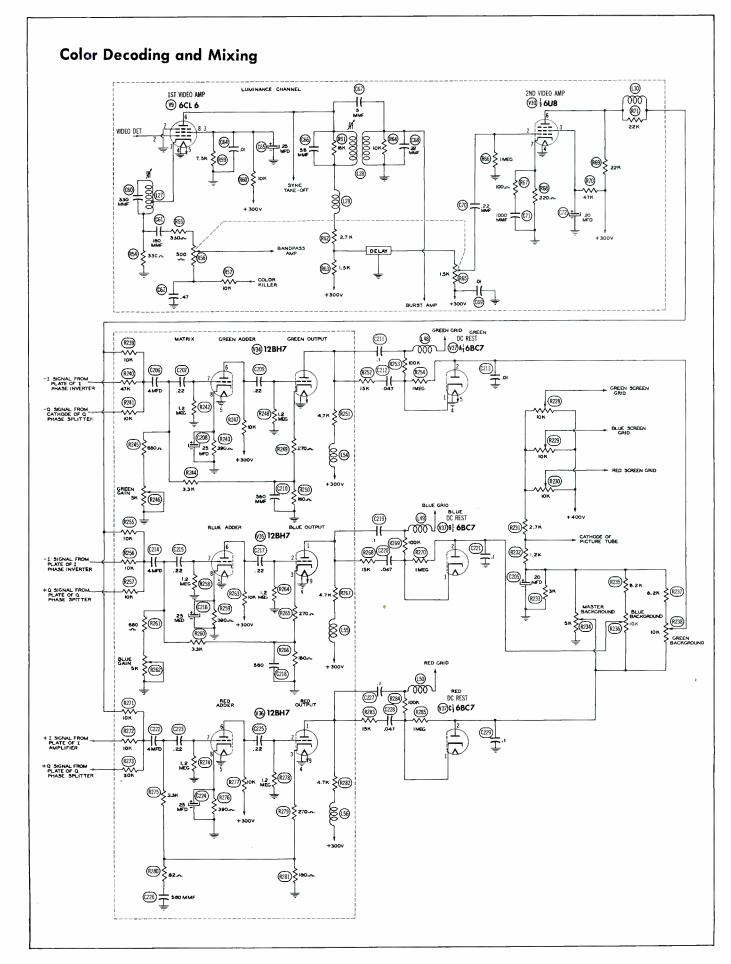


Fig. 6. Luminance Channel, Matrix, and DC Restorers.



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from the secondary of the plate-circuit transformer. The luminance signal passes through the primary of the tuned transformer and is then fed into the delay line, the output of which is applied to a potentiometer that comprises one section of a two-section contrast control. This contrast control was discussed previously. Further amplification is obtained in the second video amplifier to bring the signal to the proper level for application to the matrix.

The Y (luminance) signal is comprised of part of each primary color of the picture and is represented by the equation:

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

are further amplified by individual color amplifiers and then applied to the proper grids of the color tube.

Reference may be made to Fig.6 for the circuit diagram of the matrix unit. Pointed out on the schematic are the different signals that arrive at the matrix as well as the place where they were generated. For proper mixing, it is necessary to have present at the input of the matrix the following signals:

1. Luminance signal (Y).

2. A positive and negative Q signal.

3. A positive and negative I signal.

Y = .3R + .59G + .11B Q = .21R - .52G + .31B I = .59R - .28G - .32B ADDER ADDER ADDER ADDER

Fig. 7. Matrix Gain Settings.

в

B = .30 R + .59 G + .11 B + 1.72 (.21 R - .52 G + .31 B)-1.11 (.59 R - .28 G - .32 B) = .30 R + .59 G + .11 B + .36 R - .90 G + .53 B - .66R + .31 G + .36 B. G = .30 R + .59 G + .11 B - .64 (.21 R - .52 G + .31 B) - .28 (.59 R - .28 G - .32B) = .30 R + .59 G + .11 B - .13 R + .33 G - .20 B - .17 R + .08 G + .09 B. R = .30 R + .59 G + .11 B + .63 (.21 R - .52 G + .31 B) + .96 (.59 R - .28 G - .32 B) = .30 R + .59 G + .11 B + .13 R - .32 G + .2 B + .57 R - .27 G - .31 B.

The luminance signal is supplied from the output of the second video amplifier. The positive Q signal is obtained from the plate of the Q phase splitter, while the negative Q signal is taken from the cathode of this stage. The positive I signal is obtained at the plate of the I amplifier, while the negative I signal is taken from the plate of the I phase inverter.

As shown in Fig. 6, these signals are applied to the three fixed mixing resistors in the grid circuit of each adder stage. The green mixer receives +Y, -Q, and -I signals. Combining the three produces the green portion of the picture. Similarly, the blue mixer receives +Y, +Q, and -I to produce the blue; and the red mixer adds +Y, +Q, and +I to produce the red.

The Y, Q, and I signals are combined in each mixing section of the matrix in definite proportions. The gain settings of the matrix are shown in Fig. 7. Shown entering the matrix from the left are the three signals to be mixed. The numerical values shown in the squares represent the proportions in which they are combined to form the three primary colors in the output of the matrix. These colors are shown leaving the matrix unit at the bottom of the drawing.

By using the gain settings shown in Fig. 7, expressions can be obtained which represent the three color signals. These expressions are the following:

> B = Y + 1.72 Q - 1.11 I G = Y - .64 Q - .28 IR = Y + .63 Q + .96 I

Substituting the equations for Y, Q, and I (as shown in Fig. 7) in the foregoing equations we obtain:

thus showing what portion of each color is contained in the luminance signal. This signal is fed to each section of the matrix where it is combined with signals from the chrominance channel.

The purpose of the matrix is to take the color signals obtained from the Q and I channels and add them in the proper proportion to the luminance signal. The matrix is composed of three fixed resistive networks and their associated feedback type of amplifiers. After the mixing process has been performed, the resulting signals R

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These equations were worked out for the primary colors of blue, green, and red. The addition of the Y, I, and Q signals in proper amplitude and phase is accomplished by the use of three fixed resistive mixing type of feedback amplifiers. One section of a 12BH7 is employed with three fixed matrix resistors for each adder section. Further amplification for each signal is provided by an output stage which consists of the second half of a 12BH7.

As can be seen in Fig. 6, there are only two controls in the matrix. The reason for this is that the red signal required is approximately 100 volts, while the green and blue need only be approximately 50 to 70 volts to drive the picture tube. Therefore the red is used as a standard, and the amplitudes of the other colors are controlled to balance the resulting picture.

DC restoration is obtained by a triple diode type 6BC7 tube with plate circuits that comprise a bridge which is adjusted to maintain tracking of the bias for each gun at any setting of the master background control.

Following is a brief review of the main points covered in this article.

The luminance signal compares very closely to the normal video sig – nal in a monochrome receiver but contains in addition the color-synchronization bursts and a few higher frequencies from color detail too small for accurate discernment by the eye.

The chrominance signal contains the color information in the form of I and Q signals. The color hue is represented by the subcarrier modulation phase, and the color saturation is represented by the signal amplitude. The bandpass amplifier is designed to pass the color-subcarrier frequencies while attenuating the luminance signals. The demodulators utilize the phase difference to detect and separate the I and Q signals. Low-pass filters restrict each signal to the proper frequencies, and phase splitters and inverters supply the proper signal polarity for application of each signal to the matrix.

Since the I and Q signals each contain certain proportions of all three color signals, their combination with the luminance signal results in the separate red, green, and blue signals being available for the guns of the picture tube.

Henry A. Carter and Paul C. Smith

Checking Video Response

(Continued from page 27)

determined by the setting of the controls. The setting of the Center-Frequency control determines the frequency around which the signal deviation occurs. The Sweep-Width control is used to set the amount of deviation that is desired above and below the center frequency. For instance, a setting of 25 mc on the Center-Frequency dial and a 10-mc Sweep-Width setting provide a frequency-modulated signal between 20 and 30 mc. When used to align a tuned amplifier such as the video IF stages, the center frequency of the generator is adjusted to the center of the pass band of the amplifier and the limits of the sweep are adjusted to cover the upper and lower limits of the pass band. The output of the amplifier can then be displayed on an oscilloscope screen in the form of a curve. The synchronized-sweep voltage from the generator must be connected to the horizontal-input terminals of the oscilloscope. The complete horizontal trace then represents the frequency band covered by the sweep generator. Any point on



Fig. 5. Response Curve Produced by Open in Series Peaking Coil in 6AU6 Plate Circuit,

the horizontal trace can be considered to be representing a definite frequency, therefore the height of the curve at any given point represents the output of the amplifier at that frequency. Thus, a curve that is representative of the gain of the amplifier at all frequencies within the pass band can be displayed. This method can also be used for testing video amplifiers by adjusting the generator to sweep from zero cycles up to the maximum frequency to be checked. A description of this method follows.

There are many combinations of generator and oscilloscope that will provide a usable pattern, and there are others that will not. At this point, it is advisable to check the equipment on hand to be sure that the generator has enough output and the oscilloscope has a sufficiently wide response. The generator and oscilloscope are connected and the controls adjusted as if an amplifier were to be tested, except that the generator output is connected directly to the oscilloscope input.



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Fig. ð, Response Curve Produced by Open in Series Peaking Coil in 6AR5 Plate Circuit,

This gives a response check of both units and should produce a pattern similar to that of Fig. IA. This photo shows the response curve produced by the generator and oscilloscope which were used to procure all the included photographs. Fig. IB shows a curve obtained by using an oscilloscope having insufficient high-frequency response. If a check of the equipment on hand produces a pattern similar to this, the oscilloscope is not suitable for checking video-amplifier response in the manner illustrated in this article.

Connect the sweep generator to the input of the amplifier and adjust the controls to provide an output of a 4.5-mc center frequency with a sweep width of 9 mc. This setup was used to obtain the photographs accompanying this article. A wide-band oscilloscope is connected to the output of the amplifier and the synchronized-sweep output of the generator is connected to the horizontal-input terminals of the oscilloscope. The controls of the oscilloscope are adjusted so that the sweep voltage from the generator provides the horizontal trace. With this setup, the oscilloscope screen presents a response curve of the amplifier at all frequencies from zero to approximately 9 mc, and any deficiency in the frequency response of the amplifier will be apparent as a droop or sag in the curve. If it is desired, a separate marker generator can be coupled to the amplifier input and the marker pip will then identify the frequency at which the loss of amplification begins or ends.

The diode detector normally used for video detection is a lowimpedance device, and its load impedance is of a very low value. To prevent this low impedance from loading the generator output, it is necessary that the detector load be

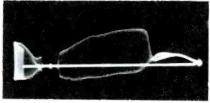


Fig. 7. Response Curve With Cathode By-Pass Capacitor Shorted.

removed from the video-amplifier input and a substitute high-impedance circuit be added. A 470-K Ω resistor and a 1.5-volt battery are connected in series from the videoamplifier grid to ground. The coupling capacitor should be as large a value as possible 1 to 1.0 mfd). In those circuits wherein fixed bias is applied to the video-amplifier grid and capacitive coupling is used, it is only necessary to disconnect the detector-load circuit.

The video amplifier shown schematically in Fig. 2 is representative of most video amplifiers in that it is compensated to have a fairly flat response up to 4.5 mc and actually has a small amount of gain up to 6 mc. Fig. 3 is a photograph of the normal response curve of this amplifier and shows the extreme dip at 4.5 mc due to the trap formed by Ll and C2. (Note: The collapse of the curve at the extreme left does nct result from a defect in the video amplifier. The sweep generator used in making these photo-

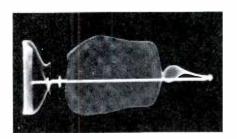


Fig. 8. Response Curve Showing Effect of Added Capac ty,

graphs was of the beat-frequency type, and the output diminished to zero whenever the swept oscillator locked in with the fixed oscillator.) The amplifier has some gain above 4.5 mc, but this is of no consequence since only the frequencies below 4 mc are used to modulate the picture tube. A high-impedance probe was used on the input lead of the oscilloscope for all photographs except that of Fig. 4. This shows the distortion of the response curve due to the input capacity of the oscilloscope.

One of the troubles often found in a video amplifier is an open peaking coil. When the coil does not have a shunt resistor, such as L4 and L6 in Fig. 2, the result of an open is definite. The plate voltage is removed from the tube, and the amplification ceases. The result of an open in L3 or L5 in Fig. 2 is less definite. The shunt resistor is still in the plate circuit; the tube retains plate voltage, although at a low value; and some amplification remains. Fig. 5 shows the result of an open in L3, and Fig. 6 shows the

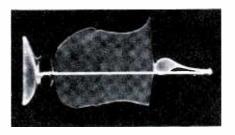


Fig. 9. Effect of Stray Capacity on High-Frequency Response.

result of one in L5. The capacitor C6 in the cathode circuit of the 6AR5 video-output stage was included in the design of the amplifier to improve the high-frequency response. If an open should occur in this capacitor, the oscilloscope pattern would be similar to that of Fig. 2 but would have a lower amplitude. If, however, this capacitor were to develop an internal short, it would

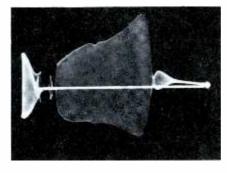


Fig. 10. Excessive Peaking of High Frequencies by Added Stray Capacity.

remove the normal bias from the 6AR5 in addition to lowering the response. Fig. 7 illustrates the result of this condition and shows the distortion resulting from the operation of the 6AR5 at approximately zero bias.

During the servicing of a receiver, it is often necessary to move leads and components from their original location. While doing this, it is possible that a lead or component could be moved close enough to the circuits of the video amplifier that an appreciable capacity to ground would be introduc-

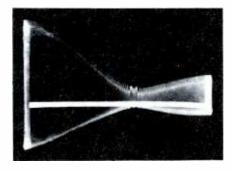
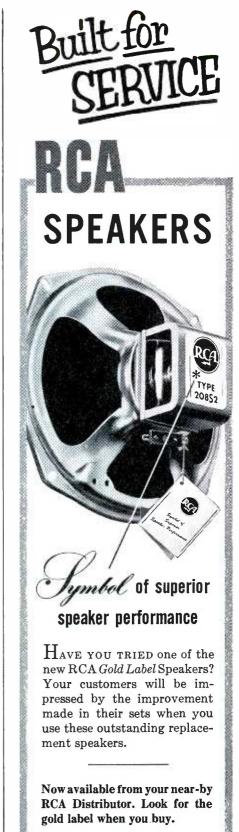


Fig. 11, Response Curve Obtained With Correct Adjustment of 4.5-Megacycle Trap.





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ed into the circuit. The plate circuits of the video amplifier would be the most affected by this added stray capacity. To simulate this con-dition, a 5-mmf capacitor was shunted to ground from each of several points in the video amplifier, and the resulting waveforms appear in Figs. 8, 9, and 10. Fig. 8 was obtained with the capacitor connected to the plate (pin 5) of the 6AU6, in Fig. 9 the capacitor was connected to the junction of Ll and L3, and in Fig. 10 the capacitor was connected to the plate (pin 5) of the 6AR5. It can be seen that the added capacity has a very distinct effect on the high-frequency response of the amplifier. A condition of this sort could have been injected into a receiver during a previous repair by a service technician who had thoughtlessly moved a lead or component.

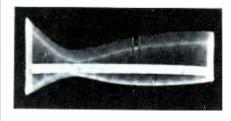
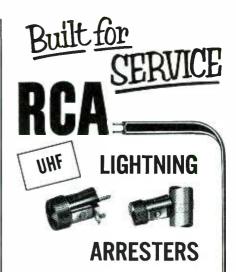


Fig. 12. Response Curve Showing Misadjustment of 4.5-Megacycle Trap.

This method of checking video response also provides a fast and very accurate way of adjusting or checking the adjustment of the 4.5mc trap during the response check. To achieve this, it is necessary to reduce the Sweep-Width-control setting to approximately 1 mc; adjust the Center-Frequency control to center the response curve on the oscilloscope screen; and inject a calibrated 4.5-mc signal into the input of the video amplifier. Fig. 11 shows the pattern obtained when the trap is correctly adjusted, and Fig. 12 shows an incorrect adjustment.

This procedure may seem complicated during the first several trials, but with repeated usage the complications should disappear. It will be easier to set up the equipment and obtain an over-all indication of amplifier performance at once than to make numerous readings with an ohmmeter or voltmeter. For the service technician who demands the best possible performance from the receivers he has serviced, this method should prove valuable.





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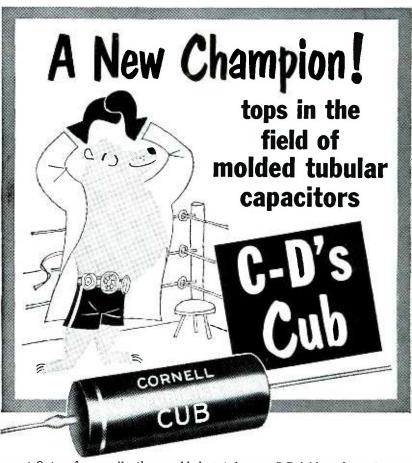
(Continued from page 11)

each stage performs its designated role, it is now necessary to investigate the schematic diagram of Fig. 5. This schematic diagram represents the color-sync system shown previously in the block diagram.

A pentode tube is employed as the burst amplifier. The grid of this tube is driven by the burst signal inductively coupled from the plate of the first video amplifier. It was mentioned previously that this stage

was cut off during the video portion of the signal. This cutoff is accomplished by application of a plus voltage to the cathode. The tube is permitted to conduct during retrace by applying a negative pulse to the cathode. This pulse is taken from a winding on the horizontal-output transformer.

The plate load for the burst amplifier consists of a high-impedance transformer with a bifilar winding on the secondary. A signal of approximately 60 volts is developed across each half of the secondary



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winding. This signal is then coupled to the phase detector which consists of two triodes connected as gridcathode diodes. The plates of these triodes act as shields for their respective section. A 3.579-mc signal from the color-phase amplifier also appears at the phase detector. This signal is representative of the locally generated signal. The phase detector compares these two 3.579-mc signals, and any difference appears as a DC error voltage at the arm of the AFC balance control. This DC error voltage is therefore present at the grid of the reactance tube. With no error voltage present, the grid of this tube is at approximately zero volts with respect to ground. Bias for the reactance tube is partially from self-bias and partially from a plus voltage introduced on the cathode. As mentioned previously, the reactance-tube stage acts as a capacitor. The amount of capacitive reactance introduced into the oscillator depends upon the conduction of the reactance tube. This conduction is controlled by the amount of DC error voltage applied to the grid.

It may be seen from the schematic diagram that the 3.579-mc oscillator is crystal controlled and is connected as a cathode follower. A transformer in the cathode of the oscillator couples a signal directly to the I demodulator. A 3.579-mc

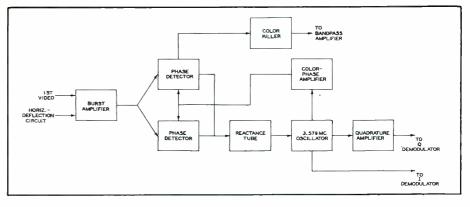


Fig. 4. Block Diagram of the Color-Sync System.

signal also drives the grid of the quadrature amplifier. This amplifier has a transformer in the plate circuit which couples the resultant signal to the Q demodulator. The quadrature-amplifier circuit introduces a 90-degree phase shift in the CW (continuous-wave) signal going to the Q demodulator.

The grid of the color-phase amplifier is also driven by a CW signal from the 3.579-mc oscillator. This stage is self-biased. The amplified signal is developed across the primary winding of the transformer in the plate circuit of the color-phase amplifier. The secondary of this transformer couples the signal to the phase detector. This circuit also contains the phase control. This adjustment controls the phase of the locally generated CW signal used as a reference in the phase detector. This, in turn, will determine to a certain extent the phase of the signals to the I and the Q demodulators. The phase control is adjusted for proper color rendition.

The over-all purpose of the color-synchronization system is to control the CW signals supplied to the color demodulators. Improper operation of this system will usually result in false color information being extracted from the transmitted signal.

Don R. Howe

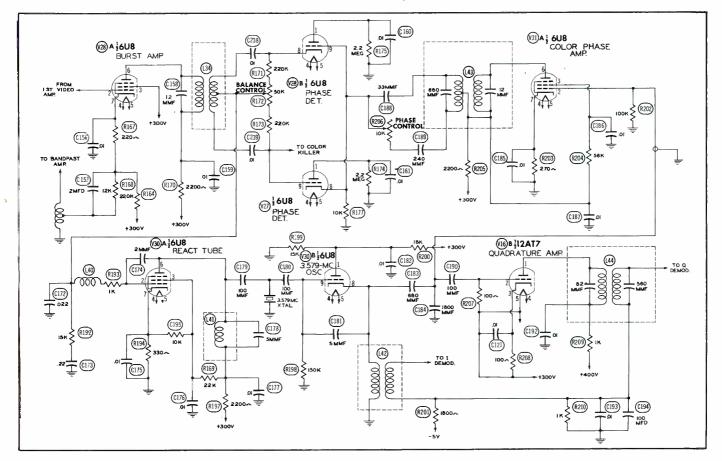
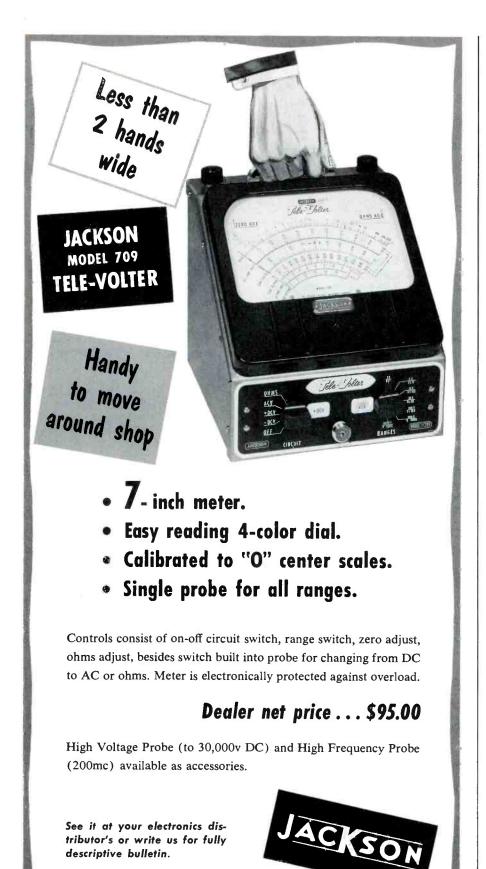


Fig. 5. Schematic Representation of the Color-Sync System.



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Shop Talk

(Continued from page 9)

frequency amplifier system have been changed.

If tube substitution in the video detector and video-frequency amplifier stages does not increase the height of the wave on the scope screen, return the original tubes to their sockets. In the video IF system, realignment is advisable after changing tubes. This is particularly important when a 40-mc IF is employed. Sometimes, replacement of tubes without realignment will show no change; but after realignment, a considerable increase in sensitivity will be realized. This same precaution applies to the RF section as well.

3. Many receivers employ germanium crystals as video detectors. Substitutions should also be made for such crystals, because there appears to be wide variations between different crystals.

4. For the sound system, an aural test is usually satisfactory. If the receiver is a nonintercarrier type, set the AM generator to the soundcarrier frequency of the channel to which the set is tuned. Turn up the generator output until the audio note is just heard in the loudspeaker. Then substitute new tubes for those in the sound system of the receiver, noting whether there is any noticeable increase in sound level. If the receiver is an intercarrier type, the AM generator must be set to 4.5 mc and coupled across the video-detector load for this test.

5. For the sync separator, sweep systems, and damper tube, a suitable check can be carried out using a tube tester, perferably one that indicates mutual conductance. Test each tube first to determine whether it is up to the specifications established for it, as indicated on the meter. Then without changing any of the settings, try several new tubes to see whether a greater reading can be obtained. Use the tube that gives the best indication. Follow this same procedure for every tube in the sections mentioned.

Note that by this latter test we are not only comparing each tube against the established standard for that tube, but we are also checking each tube against new ones.

6. The high-voltage rectifier tube is best checked by substitution, measuring the high voltage after each change.

When the foregoing tests have been completed remove the instru-

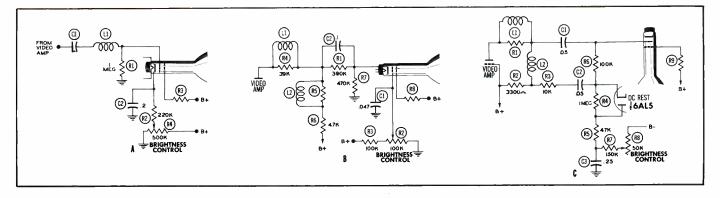


Fig. 1. Three Different Arrangements for Brightness Control.

ments and the inserted bias voltage, and air check the receiver. If after that the changes recommended by the manufacturer are still deemed necessary, they may be made with the full knowledge that the receiver is operating at peak efficiency.

REVIEW

Cyrus Glickstein, "Loss of Control Over Brightness," Radio-Electtronics, April 1952, Gernsback Publications, Inc., (formerly Radcraft Publications, Inc.), Erie Ave., F to G Sts., Phila. 32, Pa., published monthly, \$3.50 per year in United States, its possessions, and Canada.

Our review this month concerns the brightness control in a television receiver. Because of the simplicity of most brightness-control circuits, one would not expect to encounter much difficulty in correcting any troubles that develop in them. Ordinarily this is true, but there are enough instances when the defect is not readily uncovered to warrant an examination of some of the causes of loss of control over brightness. This is done in Mr. Glickstein's article.

The brightness control in a television receiver consists of a potentiometer which, by its setting, varies the bias applied to the picture tube. Varying the bias, determines the average number of electrons passing the control grid and striking the fluorescent screen. In consequence, the intensity or brightness of the image is changed.

When control over brightness is lost, the trouble is not caused by any defect in the high-voltage system or inability of the signal to reach the picture tube. It arises because the brightness potentiometer cannot vary the bias between the picture-tube control grid and cathode.

Several typical arrangements of brightness-control circuits are shown in Fig. 1. In Fig. 1A, the video signal is fed to the grid of the picture tube. The DC voltage of the grid with respect to ground is zero, since the grid connects to the chassis through a 1-megohm resistor. The brightness potentiometer is in the cathode leg of the tube. One end of this control connects to the chassis, while the other end receives a B+ voltage. Making the cathode positive is equivalent to making the grid negative by an equal amount.

For most types of cathode-ray tubes, a bias of approximately -50 volts cuts off electron flow and as a result extinguishes the raster. The normal range of the brightness control is from zero volts, or a few volts negative, to more than -50 volts.

Another bias arrangement is shown in Fig. 1B. In this arrangement the cathode receives the video signal, and so the brightness control is placed in the control-grid circuit A small positive voltage is made available to the grid in order to offset partially (but not totally) the positive voltage on the cathode. The net result is a negative grid bias with respect to the cathode.

In Fig. 1C, the cathode is grounded, and a variable negative voltage is fed from the brightness control through the DC restorer network to the control grid of the cathode-ray tube.

Loss of bias control will result in loss of brightness control. There are three common defects which can affect the bias of a picture tube:

1. A defective picture tube.

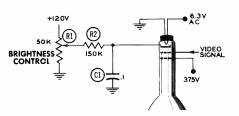


Fig. 2. A Brightness Control in the Cathode Leg of a Picture Tube.

2. A defect in the immediate bias circuit.

3. A defect which is in some other portion of the receiver and which is somehow affecting the bias of the picture tube.

A defective cathode-ray tube can cause loss of control if either of two conditions is present: (1) a short or partial short from cathode to grid or heater, or (2) a gassy tube. In the first instance, loss of control will occur if the brightness control is situated in the cathode leg of the picture tube. See Fig. 2. One side of the heater is usually grounded. Hence, when a cathode-to-heater short circuit develops, the cathode is placed at ground potential and no variation of the brightness control will alter this. Whether or not a picture is observable under these conditions depends upon the average potential of the grid. Generally, if a picture is obtained, it will be quite bright.

A gassy picture tube may cause loss of control over brightness because ionization takes place inside the tube. This causes the grid to become more positive than normal. When a picture tube is gassy, a picture may still be visable on the screen. The picture usually turns negative (white areas black and black areas white) at high levels of contrast and brilliance.

In the second category leading to loss of control over brightness are defects in the immediate bias circuit. These can include a variety of items. For example, if capacitor C2 in Fig. 1A should short out, then the cathode of the picture tube would be at a fixed ground potential. With bias thus removed, brilliance is maximum and the brightness control has no effect.

An open 100,000-ohm resistor, R3 in Fig. 1B, would effectively ground



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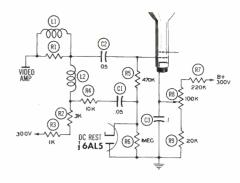


Fig. 3. Leakage Causes Control Loss.

the grid of the cathode-ray tube. The positive voltage on the cathode would then blank out the picture entirely or make it quite dark. Along the same lines would be a large increase in the resistance of R_3 or an open lug at the B+ end of the brightness control.

It is interesting to note that an open lug at the ground end of the control would lead to an overly bright picture or screen. With the ground connection broken, the full B+ is applied to the control grid. The flow of current to the grid and through R2 and R3 would reduce the actual positive grid potential, but the grid would still be positive enough to make the screen very bright. As a matter of fact, the excessive tube current flow could readily lead to picture blooming (or even raster extinction) if the highvoltage supply has poor regulation.

Leaky coupling capacitors at the grid of the picture tube, C_1 and C_2 in Fig. 3, can place a positive voltage on the picture-tube control grid. This positive voltage may exceed the positive voltage present at the cathode. Under these conditions, the picture cannot be extinguished by brightnesscontrol rotation. The picture detail may be almost normal. Depending on the amount of leakage, the control may either be unable to reduce the brightness at all or just cut it down a little.

When direct coupling exists between the final video amplifier and the picture tube (grid in Fig. 4), then the positive voltage present at the control grid is dependent upon the proper functioning of the video-amplifier tube. Under normal conditions in Fig. 4, the picture-tube control grid receives a positive potential of +150 volts; and this is offset by sufficient positive cathode voltage to establish a negative bias for the tube.

If something should cause the plate current of the video-amplifier tube to decrease appreciably or cease

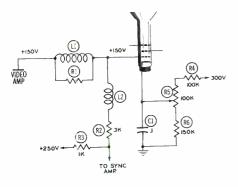


Fig. 4. Effects of Defective Video Tube. (See Text.)

altogether, then the plate voltage of the tube will rise, bringing the picture – tube grid voltage up with it. No setting of the brightness control will cut off the electron flow in the picture tube.

Perhaps the most difficult troubles to find are those which originate in some seemingly remote section of the receiver (remote with respect to the brightness-control circuit). An example of this occurred in an RCA Model 6T74 receiver. There was no control over brightness; the picture was fair, but the sync was very poor. Sound was very low and distorted. The trouble was traced to a defective 6K6 audio-output tube. This tube (Fig.5) receives +375 volts in its plate circuit and ties its cathode into the +120-volt line. When a partial short developed between cathode and filament, the +120volts were brought close to ground potential. This caused a redistribution of the voltages across the lowvoltage power supply; and the cathode of the picture tube, which operates off the +120-volt point, was drastically

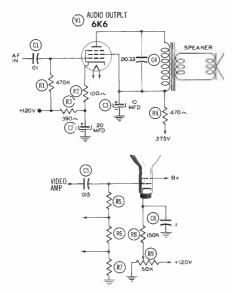


Fig. 5. A Partial Short Between Cathode and Heater of the 6K6 Resulted in Loss of Control Over Brightness at the Picture Tube. affected. The trouble also disturbed the operation of the sound IF stages and the sync amplifier, which also connected to the +120-volt powersupply terminal.

Now that we have seen the most common causes of loss of control over brightness, let us see how the trouble can be tracked down as quickly as possible. As a first step, check to see if there are any other apparent defects. It might also pay to check the action of the other controls. If side effects are noted, such as distorted sound or no sound at all, then the trouble is likely one of low B+ somewhere in the set, and the loss of control over brightness probably stems from this. If the schematic diagram is handy, check to see whether an arrangement such as that shown in Fig. 5 is employed; and if so, then the audio output tube should be tested.

When impairment of the brightness control action is the only apparent difficulty, then the following procedure will help to localize the trouble.

Remove the base socket of the picture tube; and, with the set on, measure the voltage between the grid and cathode terminals of the socket. To be normal, the grid should be negative with respect to the cathode, and rotation of the brightness control should cause the bias to vary. Any abnormal readings will indicate that the fault is in the bias circuit. On the other hand, normal readings will localize the trouble in the tube.

In some receivers the filaments are in series parallel, and removing the tube socket will open up the filament circuit of the receiver. A jumper in the form of a piece of solder inserted in the filament holes of the tube socket will restore filament continuity.

If it is found that the trouble lies in the bias circuit, then the service technician should next determine whether it is in the grid or the cathode circuit. First measure the voltage between grid and chassis, and note whether this is what it should be (as indicated by the schematic). If the brightness control is in the grid circuit, vary its setting and see if this varies the grid potential over the proper range. Make a similar check between cathode and ground. Once the trouble is pinned down to a specific circuit, component checking is in order

Milton S. Kiver



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Cascode Tuner Installation

(Continued from page 17)

across R33. This voltage is applied through the filter network, R32 and C27, to the grid circuit of the video IF and RF amplifiers. The portion of the contrast control marked C is included in the rectifier circuit and is also a part of a divider network together with R34. This network is connected to +120 volts. Thus a small fraction of +120 volts is applied to the cathode, pin 5 of V6, and acts as a delay bias which must be overcome by the video signal before rectification can take place.

For example, when portion C of the contrast control is 200 ohms, the voltage applied to pin 5 of V6 is 2/392 of 120 volts or approximately +.6 volt. As the contrast control is advanced for greater conteast with weak signals, the value of C increases and a larger portion of 120 volts is applied to pin 5 of V6. Conversely, as the contrast is reduced when receiving strong signals, less voltage is applied to pin 5 and the smaller delay voltage allows a greater AGC voltage to be applied to the RF and video IF stages.

With models employing the switch M5, the action is as described in the foregoing with the switch in "Normal Area" position; but when the switch is in the "Noisy Area" position, the AGC voltage is taken directly from the video-detectorload resistor R35. No delay voltage is present in this case; so the full AGC voltage is applied, and the sensitivity of the RF and video IF stages is reduced correspondingly to offset the high noise level. In receivers where the AGC voltage is taken from the video detector and applied to RF and video IF stages alike, with no provision for delay, it may be found that the AGC voltage is sufficient to reduce the sensitivity of the RF stage by an undesirable amount, even with weak input signals. A "Local-Fringe" switch can be added, as in Fig. 2, in order to allow the RF grid to be returned to ground thus reducing the RF grid bias to the small amount developed as contact potential bias.

An example of the second type, or nonadjustable delay circuit, appears in Fig. 3. This type may easily be made adjustable by the addition of a control, as indicated by the dotted lines. Here the AGC voltage is developed by a keying tube which has several attendant advantages: (1) a greater value of AGC voltage is developed; (2) this voltage is governed by the level of the synchronization pulse tips and so is not subject to effects caused by large variations of picture information level; and (3) random noise peaks in the signal have little effect on the AGC voltage, since the keying tube conducts only during the period of the horizontal synchronization pulse.

The voltage developed at the plate of the keying tube V9 is applied to the filter section composed of R48 and C7. The resultant voltage at point A is larger than that normally applied to RF- and video IF-ampli-fier grids; and consequently, to obtain the correct values, this voltage is impressed on the dividing networks shown. With the values of R33 and R34 as indicated, approximately 1/4 of the voltage at point A will be applied as bias to the video IF-amplifier stages. R49 and R29 are connected in series to a +115-volt source, and the diode plates of a clamper tube (V10) are connected to their junction. The RF bias voltage is available at this junction. When voltages at point A are below a certain value, V10 will conduct, maintaining point B at approximately zero volts DC. As the voltage at point A rises in negative value, eventually a point will be reached where V10 ceases to conduct; and the voltage at point B will also start to rise in negative value, this voltage being applied as bias to the RF stage. In this manner the bias voltage to the RF stage is delayed, being approximately zero for small input signals and rising in value only after a certain signal level is reached.

Since approximately 1/4 of the voltage at point A is applied to the video IF grids while nearly 8/9 of the voltage increase at A appears at point B after the voltage at B starts to rise, eventually the voltage at B will overtake and surpass the bias on the video IF grids. This action is diagrammed in Fig. 4 where the

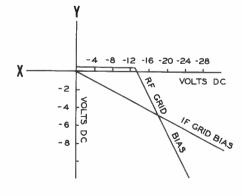


Fig. 4. Diagram of Delay Action Obtained From Circuit of Fig. 3.

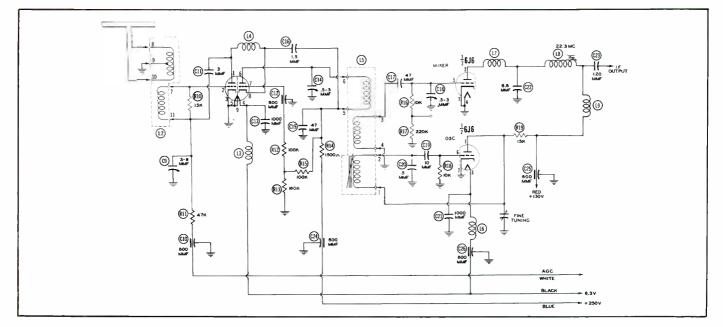


Fig. 5. Complete Schematic of a Standard Coil Cascode Tuner.

X-axis represents a linear rise of voltage at point A, while the Y-axis represents the resultant RF and IF bias voltages. This is not an exact representation of the action occurring during actual receiver operation inasmuch as the voltage at point A is assumed to increase linearly with increasing input to the receiver. However, it does serve to show that the RF grid bias is delayed, remaining at a near zero value until the voltage at point A reaches approximately -13.5 volts, then increasing at a more rapid rate than the IF grid-bias voltage. The RF grid bias is shown to start at a small positive value rather than zero; for although the resistance of the AGC clamper tube V10 is quite low during conduction, it does not reach zero which would be the necessary condition in order to obtain zero volts at point B.

The delay value should not be so great that the RF or video IF stages are allowed to overload before bias is applied to the RF stage, nor should the value be so small that sensitivity of the RF stage is reduced for comparatively weak signals.

For a given value of B+ voltage (+115 volts in this case), the ratio of R29 to R49 and the voltages at point A are the factors controlling the delay value. When installing the cascode tuner in a receiver of this type, the service technician may determine the optimum ratio by experimentation. In the example shown, R9 is dotted in, which indicates that it is used in some models. By adjusting this control the operator can select the delay voltage which works best for his particular case. For receivers not equipped in this manner, $R9\ could\ be\ connected\ temporarily$

while determining the best operating point; and a fixed resistor having a value of R9 + R29 could then be substituted for R29. To adjust R9 the receiver is tuned to the strongest available TV signal, R9 is then rotated until the picture overloads, then it is turned in the opposite direction enough to eliminate the overload.

A complete schematic of the Model TV-2232 Standard Coil tuner considered in this article is shown in Fig. 5. Six electrical connections are required between tuner and receiver: (1) 250-volt B+ line for RF amplifier plate, (2) 130-volt B+ for mixer plates, (3) 6.3 volts for heaters, (4) AGC line to RF stage. (5) IF output, and (6) ground connection for the entire tuner. Voltages 1 and 2 can usually be obtained at some point in most receivers. Current requirement of the tuner is low and should not differ materially from that of the original tuner. Slight variations from these values will have no noticeable effect on the tuner operation. These voltage points should be well filtered. If oscilla-

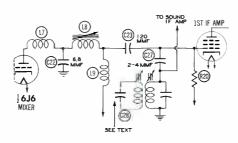


Fig. 6. Method for Adapting the Cascode Tuner to a Non-intercarrier Receiver.

tions are encountered, additional filtering or decoupling of these voltages sources may be necessary. All connections between tuner and receiver should be no longer than necessary. Some manufacturers rely upon the metal mounting screws to furnish the ground connection between tuner and receiver, but a safe practice to follow is the use of a short length of braid soldered between the tuner and the receiver chassis.

Certain receiver types may not prove readily adaptable to conversion, among these being: the ones employing a series-filament string, with the accompanying problem of proper filament-current drain, and those using link coupling or special bandpass coupling circuits between the tuner and the first video IF stage.

In those receivers having a shunt-tuned coil in the grid return of the first video IF stage, the coil can be replaced by a resistor of proper value (5K to 10K ohms) and the output capacitor of the new tuner can be connected directly to the grid of the first video IF-amplifier tube. If the shunt coil is mounted on the original tuner, it naturally presents no problem because it is removed with the original tuner.

Although this particular model of Standard Coil tuner was not designed for use in nonintercarrier receivers, it may be employed in that manner, depending upon the receiver involved and the ingenuity of the service technician. If the sound take-off point is in the plate circuit of the first or second video IF stage, the conversion will be the same as



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for an intercarrier receiver. If the sound take-off is accomplished in the plate circuit of the mixer tube, it is usually in the form of a trap winding on the mixer plate coil. Should the coil-and-trap assembly employed on the original tuner be small enough, it may be mounted directly on the replacement tuner; but that is not an absolute requirement. The coil may be mounted on the receiver chassis allowing the trap winding to be connected to the tuner IF-output line, as shown in Fig. 6. The plate winding can be left open or shunted with a small capacitor. The need for this capacitor, and its value, can be determined during alignment by shunting the plate winding with various capacitors of values around 15 mmf and noting whether the video IFresponse curve is changed appreciably. Should the addition of this capacitor result in a change of the response curve, the final value of C28 should be such that the tuned circuit resonates at a frequency below the sound IF.

The tuner has been properly aligned at the factory, but some adjustment of the mixer plate coil (L8, Figs. 5 and 6) may be necessary in order that the over-all video IF response will correspond as nearly as possible to the recommended response for the receiver.

The mixer-tube shield should be lifted slightly to remove it from ground, and the output of a sweep generator should be connected to the ungrounded shield. The sweep generator is set to cover the receiver video IF range, and the response is viewed with a scope at the video detector. Some receivers may require only a slight readjustment of the mixer plate coil. If that adjustment is not sufficient, the remainder of the video IF strip should be checked for correct alignment and realigned, if necessary. The oscillator setting should also be checked on all available channels and adjusted as required.

In summary, the following points might be mentioned as the main ones to consider when making the installation of the cascode tuner:

1. Space requirements for the cascode tuner and mounting considerations.

2. Proper B+ voltages for tuner operation.

3. Adaptability of the video IF-input circuit.

4. Application of AGC voltage to the tuner.

5. Alignment of the receiver for proper video IF response.

Paul C. Smith

Stocking the Tube Kit

(Continued from page 21)

of 79 different types which cover most of the types employed in television receivers for the 1946-to -1953 period. Included are many items which are found desirable but not absolutely essential to home servicing. A complete listing of the contents is shown in Chart 1. A possible saving of time is an attractive feature of this kit over the ''Standard Kit'' to be described.

Fig. 2 shows the "Standard Kit" which permits a high percentage of home repairs with a minimum number of items. The tube complement has been reduced to include 74 tubes covering 65 types. The use of combination tools further reduces the number of items in this kit which is particularly convenient where limited areas are covered not far removed from the shop location. Refer to Chart 2 for a list of items in this kit.

A feature common to both kits is a chart which tells the quantity and type of tubes found in the kit. This chart is covered with a transparent sheet of plastic. A grease pencil is provided by which a mark is made next to the tube type whenever one is used on a service call. When the service technician returns to the shop, it is only necessary to consult this chart for a rapid inven tory so that tubes may be replaced in the kit. The grease-pencil mark ings are readily removed by merely wiping them off with a cloth. This



Fig. 2 The Standard Tube Kit

system eliminates a tiresome tube by-tube count upon returning to the shop.

No provisions have been made in this kit for resistor and capacitor replacement since this usually requires taking the set to the shop. However, should this type of service be desired, it is only necessary to include a supply of resistors and capacitors, since the tools necessary to replace these components are already provided.

The included tube list is derived from the number of tubes in service and the types of tubes having the highest replacement rate. Two tube lists for each kit are included. One list is to be used in areas where television reception has been provided prior to 1948 or 1949. By stocking the tubes shown in this list, the technician will be able to make tube replacements in the earlier receivers which might still be operating. The other list is to be used in areas where telecasting has started in 1952 or 1953. Practically all receivers in these areas will be new models, making it unnecessary to stock tubes for older model sets.

The model number of the set should be obtained when the cus tomer calls, if at all possible. With this known, the service technician may consult his "Television Tube Location Guide" to determine if any tubes are employed which are not ordinarily stocked in his service kit. If any such tubes are found; they may be taken from stock in the shop and placed in the service kit.

* * *

CHART II

CONTENTS OF THE STANDARD KIT

TUBE TYPES	TV MODE I 52-53 46-5 (quant.)		52-53	ODELS 46-53 ant.)		TV MC 52-53 (qua	46-53	TUBE TYPES	52-53	ODELS 46-53 ant.)	TUBE TYPES	52-53	ODELS 46-53 uant.)
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January, 1954 - PF INDEX



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Audio Facts

(Continued from page 31)

the term, we refer to high quality true-to-life reproduction.

Basic Forms

Having gone into some of the background of audio in general and some of the reasons why we have high-fidelity systems and what to expect from them, the system itself is due for some discussion. We will first consider the basic things needed to make up a system capable of highfidelity output and then discuss each section in more detail in later paragraphs.

We speak of systems, for that is what they are. Whether large or a phonograph pickup as the source of signal. This can well be any of the turntables or record changers designed for playing all or any of the 33 1/3, 45, or 78 rpm records. The signal picked up by the phono cartridge is fed into the next section which, in such a system, will include a combination of voltage amplification and tone compensation or control circuits. To qualify as a high quality system it is practically essential to have treble and bass controls as a means of balancing the sound output. The power-output stage is required to drive the loudspeaker.

A system such as this may be one of the small high quality, tablemodel phonographs which are now being manufactured and which are capable of producing higher quality of sound than many people have ever heard before. Of course, on the other hand, any or all of the equipment making up the separate sections may be of the most expensive and select variety, since the most important qualification required of this equipment is its ability to produce high quality sound.

In Fig. 2 we have a more elabo rate system, which is evident in the diagram as the preamplifier and compensation section following the pickup. The preamplifier section is required when a magnetic type of pickup cartridge is employed, as is usually the small, simple or elaborate (depending upon the desires and needs of the owner) they all follow a basic pattern of functions necessary to produce the desired high quality of reproduction. Each section or piece of equipment must function properly or otherwise it can nullify the correct operation of all the others in the system.

The block diagram shown in Fig. 1 shows the layout of a simple basic audio system. Since most sound



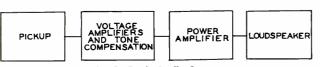


Fig. 1. Basic Audio System.

systems in the home are used mainly for the reproduction of music from records, the first block represents case in the majority of high quality systems. Equalization is also required with these pickups as well as for the various types of records played. Tone-control circuits and voltage amplifiers are required in addition to a power-amplifier section to drive the loudspeaker. This is probably the most-used layout and can be a, powerful outfit with a complete loudspeaker system. In fact, it may border very closely upon the system shown in Fig. 3.

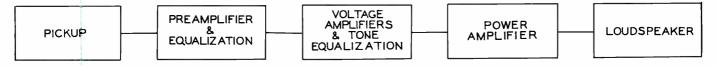
system that is usually used with an outfit such as this. We may even have a disc recorder connected to the output of the power amplifier. In fact, most anything in the audio line may be connected into this type of system, depending upon the whim and resourcefulness of the owner. But this does give the basic form of our largest systems.

Cartridges

The phonograph cartridge is an important item, for the final results depend upon how well it can do its

the crystal cartridge to high temperature and humidity and its more or less restricted frequency response have limited its use in most highfidelity work. The ceramic cartridge is not affected by high temperature and humidity, and some recent ones are proving quite satisfactory in certain applications.

The magnetic cartridges have been used in most of the sound systems of better quality because of the excellent reproduction they afford, but they do have the disadvantage of low output and require the added gain of a preamplifier. Another disadvantage of the magnetic cartridge is that equalization is needed to bring up the bass response which is inherently low in this type. Despite these disadvantages, their fine performance



The circuit in Fig. 3 can become very elaborate and complicated. As shown, it can have signal input from a phono pickup, an AM and FM radio tuner, playback from a tape or wire recorder or from the sound sec tion of a TV receiver. Besides the preamplifier and equalization section we must include some means of switching the wanted input into the circuit and with the desired equalization as required. Tone control, voltage amplification, and power output must be used as always. We also have an added section, the divider network, to distribute the signal to the individual units of the loudspeaker

Fig. 2. A More Complex Audio System.

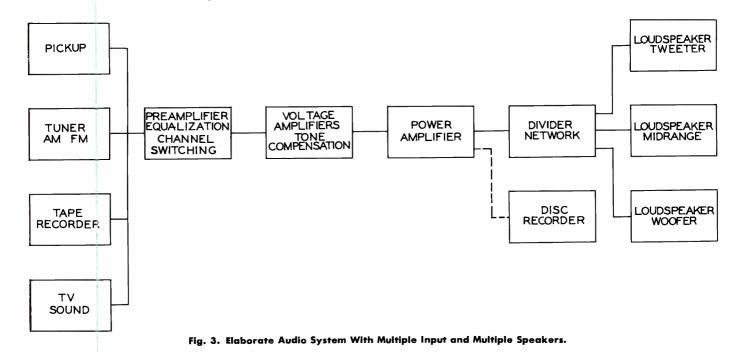
part in picking up the modulation impressed upon the record and feeding it into the rest of the system. The most popular types are the crystal, ceramic, and magnetic. Some special types, such as the lightweight FM pickup, are capable of providing excellent reproduction but have been put into only limited use to date.

The crystal and ceramic cartridges have been by far the most popular type ingeneral use. The high output, as much as two or three volts with some crystals, and the need of very little equalization are their big advantages. The susceptibility of noted for wide frequency response and low distortion has resulted in their nearly universal use in the best systems.

Pickup Stylus

Any discussion of pickups must also include mention of the stylus (needle), since it is such an important link in the playback network. It makes the direct contact with the record groove and transmits the modulation found there to the pickup in order to generate the signal fed to the system.

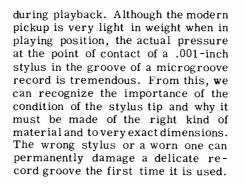
A stylus for microgroove records (33 1/3 rpm long-playing and



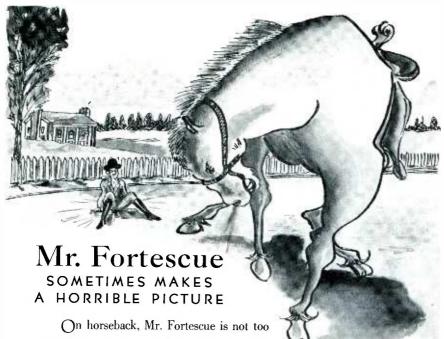
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45 rpm) must have a tip that is .001 ·inch (1 mil) in diameter. A .003-inch (3-mil) stylus is used with the usual 78-rpm recordings. The .0025- and .0027-inch sizes are specified and supplied for certain types of commercialtranscriptions. For home use we need two cartridges, one with a 1-mil stylus and the other with a 3-mil tip; or we need a cartridge equipped with two needles, one of each dimension, if we are to be prepared to play all three types of records.

It must fit the groove correctly if it is to give satisfactory results and not damage the record or itself



Diamond and sapphire are just about the only materials used in manufacturing needles intended for



adept. But that's the only place where he's apt to make a poor picture. When it comes to TV, he knows his business. He

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- VHF amplifier and TV receiver can be used on channels 3, 4, 5 or 6 to eliminate receiver oscillator harmonic or local VHF station.



high-fidelity use, since they withstand wear better than others. Even though the first cost of the diamond stylus is higher, it is less expensive in the long run; because it will outwear several made of sapphire. In any case, a stylus should be changed before the wear it has received starts to damage the grooves of valuable records.

Turntable, Arm, and Motor

In order to play records, we must have a turntable on which to spin them and a pickup arm to hold the cartridge in position. To play all of the usual types, the turntable must revolve at a constant speed of 33-1/3, 45, or 78 rpm with no unsteadiness or vibration. Unsteadiness would be heard as wow in the reproduced sound, and vibration would register as rumble.

The high quality three-speed record changers now available were designed for this purpose. They feature smooth-running turntables driven by suitable motors and have provisions made to mount most any of the more popular pickup cartridges.

Many of the record changers in general use are equipped with twopole motors which, although they do give good performance, do have a fairly strong hum field. Since most magnetic cartridges are sensitive to hum pickup, those changers intended for high-fidelity applications are supplied with four-pole motors which do not have a heavy hum field. In this way, the undesirable effect is avoided.

Many serious enthusiasts do not use a record changer, but instead they use a turntable of the transcription type. These precision-built units, which are usually equipped with accurately machined and dynamically balanced 12- or 16-inch cast aluminum turntables driven by powerful motors, provide exceptionally smooth and quiet operation. One of the many suitable pickup arms must be selected and mounted to accommodate the desired pickup when the transcription type of turntable is employed.

One thing seldom mentioned is the fact that some magnetic cartridges cannot be used with iron or steel turntables, because of their strong magnetic pull, unless certain precautions are taken. When this type of cartridge is in playing position on a record on a steel turntable, its weight can be increased by more than an ounce on account of this pull. If a piece of felt or some such nonmagnetic material 1/8 inch or more in thickness is placed on the turntable under the record, the increase in spacing will reduce the pull to where it has no noticeable effect and will allow normal operation.

Preamplifiers, Equalization, Compensation, and Control

Preamplifiers and control units furnishing needed amplification, equalization, and tone compensation have been mentioned in conjunction with the phono cartridges. Some detailed discussion concerning them was also given in "Audio Facts" published in PF INDEX and Technical Digest, issues March-April 1952, May-June 1952, and July-August 1952. Even though some points will be repeated, the preamplifier control unit has become such a standard feature of high-fidelity installations that the reasons for its wide use and popularity cannot be ignored here.

The added gain needed to amplify the low output of a magnetic cartridge to a level high enough for normal operation of the sound system is provided by the preamplifier. Equalization is accomplished at the same time by amplifying the low frequencies an added amount to boost them up to a normal level and thus overcome the deficiency in bass response which is characteristic in magnetic cartridges.

Small units, suitable for adapting magnetic cartridges to systems not so equipped, have been available for some time. They are easily installed and serve the purpose very well. Usually the preamplifier is somewhat more elaborate and is included with other circuits to make up a more complete control unit.

Recordings are made on various curves based on widely varying crossover frequencies and amounts of high-frequency roll-off. Therefore some form of adjustable equalization is required for correctly matching the characteristics of different records to the system in order to obtain a balanced response. These are the controls usually marked ROLL-OFF and CROSSOVER, and in most cases they are located on the preamplifier control unit.

Tone-control circuits compensate for the deficiencies that might occur in the program material and provide a means of achieving a balanced response when required, because of characteristics of the loudspeaker or the effects of the acoustics of the room in which the listening is done.

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All of these circuits and controls, including the necessary channel switching if tuners and recorders are also employed, may be made up in a unit complete with its own power sup ply. Other similar units may draw their power from the supply in the power amplifier. These types lend themselves to remote-control operation of the complete sound system. In some cases, the unit may be built in as a permanent part of the poweramplifier chassis or the tuner used. Since many of these units are available and in such variety, it is not difficult to select one suitable for most any situation.

Power Amplifiers

Power amplifiers have also been the subject of detailed discussions in previous "Audio Facts." These appeared in PF INDEX and Technical Digest issues for January-February 1952, May-June 1952, and July-August 1953. But many things concerning power amplifiers can stand repetition and added comment because of their important function of supplying the power to drive the loudspeaker.

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and the application of negative feedback have been great factors in the remarkable improvements made in the modern audio power amplifier. Power-output capabilities have been increased and distortion reduced to extremely low percentages. In fact, quality of operation is so consistently high in these power amplifiers that the power-output rating is probably the main thing to consider when selecting one for a certain application.

Finding a power amplifier suitable for use in most any sound system is certainly no problem, not with the great number of excellent ones available in such a variety of shape, size, power output, and price. The usual power-amplifier chassis contains at least one or two stages of voltage amplification, while some also include the tone and equalization circuits. Several are designed for use with a certain series of matched units; but since complete specifications and ratings are supplied with all amplifiers, selecting the proper one should present no difficulties.

As mentioned, the power output required for satisfactory operation of the sound system involved is an important consideration. A small amplifier that will deliver a maximum of two or three watts of good clean output may be very satisfactory for use in a small quiet room, but it could not come close to handling the requirements of a larger and probably noisier room.

There is quite a difference in the amplifier used in the small high quality table-model phonograph and the one used in a large custom installation which includes an elaborate loudspeaker system. The quality of operation of the small amplifier can be just as high as that of the larger one, the big difference being in the amount of power output required.

We do not want to leave the impression that power output is the only thing to think of, for that is not true. We have wanted to stress the fact that of all the excellent available amplifiers which do fulfill the important requirements, the one capable of handling the work to be done must be chosen.

Loudspeakers, Enclosures, and Divider Networks

A discussion on loudspeakers, in common with the other items mentioned, could be carried on and on. This makes it difficult to cover adequately in a few paragraphs the important things concerning their selection and use. Some of the phases were dealt with in "Audio Facts" on loudspeaker enclosures and divider networks in PF INDEX and Technical Digest issues for March-April 1953 and May-June 1953.

Although basically unchanged very little over the years, loudspeakers have been the subject of much research and experimentation. This activity also includes the enclosures necessary for their proper performance. All of this has had the result of making it possible to select a single unit or a complete system which will fit most any application.

Size, power-handling ability, and price are the usual things considered when selecting these units which perform the critical function of converting the electrical signal into acoustical power. Selecting the best one possible under the circumstances is always the best policy; for whether large or small, simple or elaborate, quality in the loudspeaker will pay off in quality reproduction.

To achieve a smooth widerange response with low distortion, most high-fidelity systems (including the small high quality table-model phonograph) employ two or more loudspeakers. These may be separate individual units or one of the coaxial type, which is actually a highfrequency "tweeter" and a low-frequency "twoofer" mounted coaxially as a unit.

Where "woofers" and "tweeters" are employed, a divider network must be used to separate the high and low frequencies and to channel them to the appropriate unit.

Cabinets

Since so many high-fidelity systems are custom built, the subject of suitable cabinets to house the equipment could stand quite a lot of discussion. All manner of built-in installations have been made, book shelves have been appropriated, and cabinets have been converted to accommodate various pieces of audio equipment.

This has been true because a high-fidelity system could not be purchased as a complete unit but had to be assembled. Most of the finest pieces of equipment are large and do not lend themselves to mass production in units of a reasonable size.

A number of the large manufacturers are now marketing complete high quality sound systems housed in suitable cabinets. These afford very good reproduction excelled only by the better custom installations.

Robert B. Dunham

Guying Chart

100

Pt. No. 2

Pt. No. 3

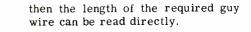
IOWER HEIGHT (FEET)

80

(Continued from page 35)

30° MINIMUM

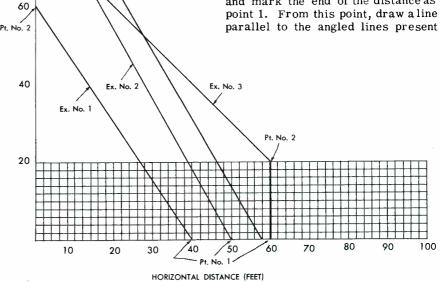
ANGLE



EXAMPLE No. 2

Calculating the Maximum Height of Tower Which Can Be Erected When the Distance From the Tower Base to Any or All Guy-Wire-Anchor Locations is Limited.

Measure the distance on the ground between the desired tower location and the nearest anchor location. Enter this distance on the HORIZONTAL-DISTANCE scale of the chart (starting from the left), and mark the end of the distance as point 1. From this point, draw a line parallel to the angled lines present





be erected can be determined by using the chart in Fig. 1 when the distance from the tower base to guywire-anchor location points is known.

Three examples of the use of this chart are illustrated in Fig. 2.

EXAMPLE No. 1

Determining the Length of Guy Wire Needed for a Given Tower Height and Anchor Location.

Measure the distance on the ground between the tower location and the guy-wire-anchor location. Enter this dimension on the chart scale marked "HORIZONTAL DIS-TANCE," starting from the left. Mark the end of this distance as point 1. Measure the distance on the tower between the base and the guy-. wire anchor. Enter this dimension on the chart scale marked "TOWER HEIGHT," starting from the bottom. Mark the end of this distance as point 2. Connect points 1 and 2 with a straightedge, and note the distance between them. The straightedge can consist of a piece of paper, and the points can be indicated by pencil marks. Align the edge of the paper with the horizontal scale of the chart,

on the chart. The point at which this line crosses the TOWER-HEIGHT scale gives the maximum height of tower which can be erected.

EXAMPLE No. 3

Determining the Length of Guy Wire Required When One or More of the Guy-Wire-Anchor Locations Cannot Be Placed at Ground Level.

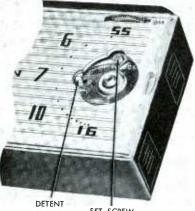
Measure the distance between the tower location and a point direct ly beneath the anchor location. Enter this distance on the HORIZONTAL-DISTANCE scale of the chart (starting from the left), and mark the end of the distance as point 1. Measure the vertical distance from ground level to the anchor location. Enter this distance on the chart on a vertical line above point 1, and mark the end as point 2. Measure the distance on the tower between the base and the guy-wire anchor. Enter this dimension on the chart as point 3. The distance between points 2 and 3 gives the required guy-wire length.

Design Features

(Continued from page 29)

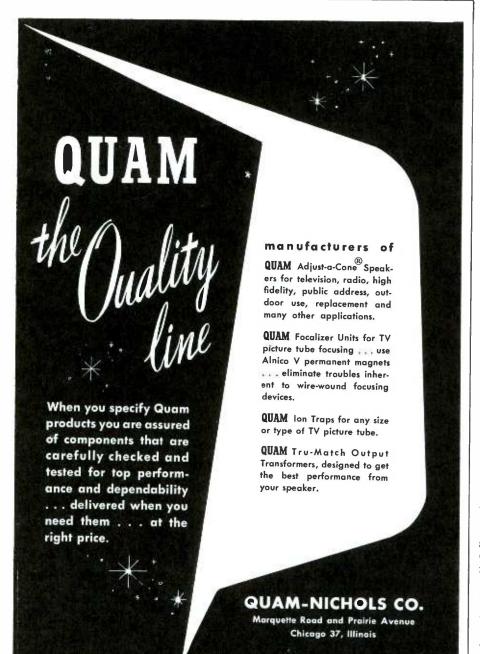
which event certain low-frequency commercial AM radio broadcasting stations will shift their operating frequencies to 640 kc and the highfrequency stations will shift theirs to 1240 kc. Each station in a given group will transmit for a predetermined number of seconds after which another station in the same group will transmit for a certain time. Such a system makes it difficult for a potential enemy to use the transmission of a broadcasting station as a navigational aid or as a homing signal.

There is a detent spring provided on the set for the purpose of



SET SCREW SPRING

Fig. 5. View of Detent Spring for Quick Selection of Civilian-Defense Broadcasts.



tuning the set to these frequencies in total darkness. This spring can be seen in Fig. 5. To place the spring into operation, it is only necessary to remove the tuning-control knob, loosen the set screw, slide the detent spring in a clockwise direction, tighten the screw, and then replace the knob. The knob has two notches on the underside. The spring snaps into these when the knob is properly tuned to receive the signals.

To prevent damage to the closely spaced components, the use of a large soldering iron should be avoided when working on this set.

RCA Victor Portable Radio Model 3-BX-671

One of the several interesting features of the RCA Victor Model 3-BX-671 portable radio is the inclusion of seven tuning bands. Table I gives the frequency ranges of each of the bands

TABLE 1

Frequency Ranges for Each Band of the RCA Victor Model 3-BX-671 **Multiband Portable Radio**

''A'' Band (Broadcast)540-1600 kc
"'B'' Band 2.0-4.0 mc
"C" Band 4.0-8.0 mc
31-Meter Spread Band 9.45-9.85 mc
25-Meter Spread Band 11.55-12.05 mc
19-Meter Spread Band 14.90-15.55 mc
16-Meter Spread Band 17.50-18.20 mc

The RF and oscillator coils are mounted on the band switch. Holes are provided in the shields and cover to facilitate alignment. However, there are a couple of alignment points that require the use of a very limber tuning tool. Both of these are oscillator adjustments.

Also featured are three antenna systems which are shown in Fig. 6. One is a flat-loop type of antenna mounted inside the front lid of the case. This loop is intended for use on the standard broadcast band only. Another type of antenna intended for standard broadcast is also included. This type is a Ferrite rod antenna which is provided with suction cups and a long cable to permit attachment to the pane of an outside window. This setup

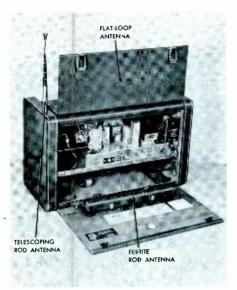


Fig. 6. Rear View of RCA Victor Receiver Model 3-BX-671 Showing Three Antennas.

usually provides better reception in such places as trains and inside buildings where steel construction may cause weak reception. For the shortwave bands, a telescoping-rod type of antenna concealed in the right side of the case is supplied. It can be placed into use by depressing the release button on the lower right side of the case and pulling up on the antenna tip which appears at its opening. The antenna should be raised until a definite click is noted. This indicates that the lower section is extended. Its complete extension is mandatory for short-wave reception.

This chassis has provisions for installing an RCA RK-186 converter for operation on 230 volts DC or on 25 to 60 cycles AC, in addition to operating on the regular 117 volts AC power or on self-contained batteries. The schematic for the converter may be seen in Fig. 7. Fig. 6 shown a photograph of the chassis inside the case. Fig. 8 shows a close-up of the converter RK-186.

Variable Definition Control

The RCA Victor Model 27-D-384 TV receiver employs an interesting new feature which is designed to aid in reproducing the best possible picture under various conditions of re-

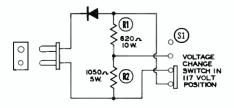


Fig. 7. Schematic Diagram of RCA Converter RK-186.

ception. Four modes of operation are provided through the operation of a single switch which is called a "Definition Switch." A schematic of this switch and associated circuitry is shown in Fig. 9. In position No. 1 (for snow suppression), the high noise frequencies are by-passed to B+ through C2. In position No. 2 (for normal operation), V2 and V3 (the peaking amplifier and the agitation compressor) are both out of the circuit and thereby have no effect. When the switch is in position No. 3 (for high peaking), the high frequencies are coupled from the plate circuit of the video-output tube and are developed across L2 and L3. In position No. 4 (for maximum high peaking), there is more signal developed across L2, L3, and L4. This signal is then applied to V2, which is the peaking amplifier. The high frequencies, after being amplified by the peaking amplifier, are then applied to the grid of the picture tube. At the same time the video signal is also being applied to the cathode.

On live pickup programs, best operation is usually obtained in the normal position. When the program is originating from film, operation on the high-peaking or on the maximumhigh-peaking positions will usually result in a sharper or "crisper" picture. There may be times, particularly under strong signal conditions, when trailing whites will be produced when the switch is in the maximum-highpeaking position. If such is the case, switching back to position No. 3 will usually eliminate or reduce this effect.



VOLTAGE-CHANGE SWITCH IN 117-VOLT POSITION

Fig. 8. Close-up of RCA Converter RK-186 Showing Power-Selector Switch.

Vocatron Intercom Models CC-20(D) and CC-45

The Vocatron Intercom Models CC-20(D) and CC-45 loudspeaking intercommunication systems employ the carrier-current system which thereby eliminates the need for connecting the units together with separate lines. The Vocatron CC-45 is shown in Fig. 10. The carrier-current system of transmission uses the power lines as its transmission medium. It is a low-cost system which is efficient. The Vocatron has incorporated in its circuit a special patented silencing

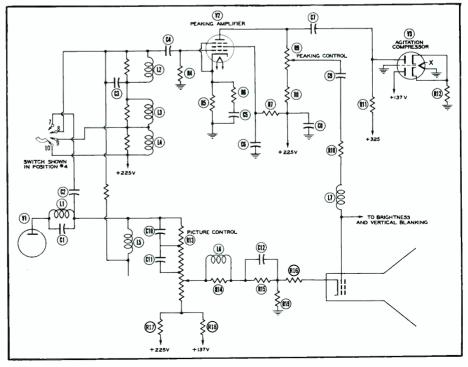


Fig. 9. Schematic Diagram of High-Peaking and Agitation-Compressor Circuit in the RCA Victor Model 27-D-384.

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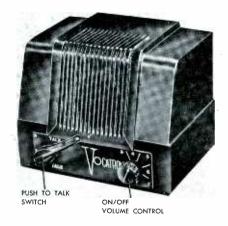


Fig. 10. Cabinet View of Vocatron Intercom Model CC-45.

circuit to keep the receiver section completely dead until keyed on by the signal from another Vocatron unit. This special silencing circuit eliminates any line noise caused by motors and machinery when the unit is not being used. There are plug-in type of filters available to reduce any such noise during communication between units.

These units can be installed quite easily because no interconnecting wires are required between units. They can very easily be moved from one room to another by simply unplugging the line cord, moving the unit to another room, and plugging in again. All units of one system must be on the same power-line transformer, since excessive losses are experienced

RADIO CHASSIS

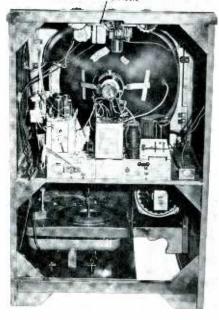


Fig. 11. Rear View of Zenith TV-Radio Combination Model L2281 RU Showing Mounting Method of Radio Chassis.



Fig. 12. Front View of Zenith Model L2281 RU Showing Radio Tuning Knobs.

when the carrier signal is coupled from one transformer winding to the other.

The CC-45 is a deluxe model that is designed for especially difficult installations when long-distance operation and excessive line noises are involved.

Radio Chassis 4L03 Used in Zenith TV-Radio Combination Model L2281 RU

The radio chassis in the Zenith L2281 RU combination is mounted in a very unique manner. As may be seen in Fig. 11, it is mounted on the under side of the cabinet top with the top edge of the control knobs protruding through slots in the top of the cabinet. See Fig. 12.

This manner of mounting the radio permits use of a narrow cabinet without putting the radio below the TV chassis. This eliminates the necessity of stooping to operate it.

The radio chassis employs four tubes with series filaments. The radio has its own power supply so that it need not depend on the TV chassis for power. This is a good feature, for it permits operation of the radio without using any portion of the TV chassis except the speaker.

In the Interest of Quicker Servicing

(Continued from page $\mathbf{23}$)

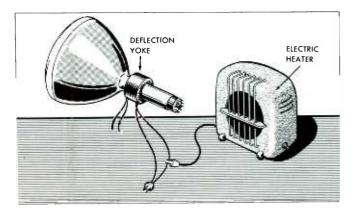


Fig. 2. Series Connection of the Deflection Yoke and 1200.Watt Heater.

RUBBER SUCTION CUP

Fig. 3. A Device Used for Removing Safety Glass.

moval of this glass is desirable when cleaning the face of the picture tube; however, after removal of the items holding the glass in its frame, a close fit may prevent the glass from being easily removed. It is usually impossible to reach through the rear of the cabinet and push the glass out while still holding it from the front. A simple solution to this problem is afforded by the following device.

This device consists of two suction cups attached to a wooden handle. This is shown in Fig. 3. Placing the suction cups against the safety glass and applying a slight pressure will cause the cups to adhere to the glass. The handle is then pulled outward and the glass removed. This handle is also very convenient when replacing the safety glass.

The foregoing suggestion was submitted by Mr. Chester Merizak, 1311 West Haddon Avenue, Chicago, Illinois.

Ion Traps

There are frequently a number of television receivers in the shop awaiting replacement of picture tubes. When the picture tube arrives and replacement in the set begins, time out is sometimes necessary to look for a missing ion trap. When one is found, it may not be the original. Ion traps may also be misplaced during bench servicing, if they have been removed for some reason. This situation may be remedied in a very simple way. Take a look at the rectifier tube. If it is of the 5U4G type, an ion trap will fit very nicely over the top of this tube. Placement of the ion trap on this tube will eliminate a possible search and in addition will prevent replacement with an ion trap of an unsuitable type. This is simple but very effective.

While considering the subject of ion traps, another hint is suggested which could save time and possibly prevent damage to a picture tube. When removal of an ion trap is contemplated, a pencil mark in the form of an arrow should be placed on the trap. This arrow could be placed at a point in line with the top center of the picture tube and pointing toward the front of the tube. The ion trap then may be replaced in approximately the same position from which it was removed. This will shorten the hunting process normally required to determine correct ion-trap positioning.

Checking Horizontal-Deflection Coils

A keystone picture was observed on a 16-inch television receiver.

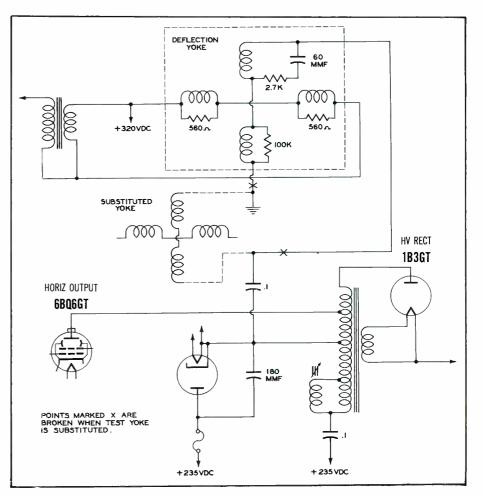


Fig. 4. Schematic Diagram of a Deflection System Showing Test Connections.

This condition ordinarily is indicative of a defective deflection yoke. The nature of this keystone pattern further indicated that the horizontal-deflection coils were at fault. Very bad blooming was also noted. A resistance measurement of these coils yielded the correct measurements and therefore seemed to indicate that the coils were good.

Three possible troubles could exist in a deflection yoke: (1) the vertical-deflection coils could short to the horizontal-deflection coils, (2) one of the coils could be open, (3) the deflection coils could have shorted turns.

The deflection system employed in this receiver, as represented in Fig. 4, indicates the presence of a DC potential on the vertical-deflection coils. If the condition of a short between the two sets of coils had existed, the DC voltage would have beenshorted to ground through one of the horizontal coils. This was not the case; therefore, the first condition was eliminated. A resistance measurement eliminated the possibility of an open coil during static conditions. If several turns of a coil had been shorted, this measurement would not have been of the specified value.

The results of these measurements left considerable doubt as to the actual condition of the deflection yoke. Obviously, the yoke could be removed and a new yoke installed. This operation requires considerable time; and if the original yoke should not be defective, the time required for this replacement would be lost. Therefore, it would be a distinct advantage if some method could be employed whereby the condition of the original yoke could be positively determined. Such a method would prove particularly advantageous in this case, since examination of the yoke revealed that it had become adhered to the neck of the picture tube. It was very likely that damage might result to the yoke during the process of removal. The following procedure was employed to test the yoke without removal from the chassis.

The high voltage was measured with the brightness control turned down and was found to be 5,600 volts, which is far below normal. No picture need be visible for the following test, so the brightness control may be left in this position. In order to

determine if this low voltage was caused by the horizontal-deflection coils, a new deflection yoke with the same horizontal-coil inductance was selected. The leads to the original horizontal coils were disconnected from the receiver; and the leads from the new coils were substituted temporarily, as indicated in Fig. 4. Another high-voltage reading was taken. This measurement showed a reading of 11,000 volts, which was more normal. This confirmed our suspicion of a defective deflection yoke. Upon replacement of the original yoke, the receiver returned to normal operation.

As indicated in the foregoing example, resistance measurements do not always reveal the true condition of a component. The check made by substituting a new set of horizontaldeflection coils and by comparing high-voltage readings was certainly warranted in this case. The test definitely established that the deflection yoke was defective. If the deflection yoke had not been defective, the test would have prevented possible damage to a good yoke.

Don R. Howe





OLOR

C (

<u>Aperture Mask</u> - A thin, perforated plate placed between the electron guns and the phosphor-dot screen in a color picture tube.

Balance - See Color Balance.

- <u>Brightness</u> That attribute which makes an area appear to emit more or less light.
- <u>Chroma</u> That quality that embraces hue and saturation together; white, black, and values of gray have no chroma.
- <u>Chrominance</u> That attribute of light which produces a sensation of color apart from luminance or difference in brightness.
- <u>Chrominance Channel</u>—In a color television receiver, the path which is intended to recover the colordifference signals from the color subcarrier and its sidebands.
- Color Balance The adjustment of electron-gun emissions to compensate for the difference in the light-emitting efficiencies of the three phosphors on the screen of the color picture tube.
- <u>Color Burst</u> Approximately nine cycles of color-subcarrier frequency. These cycles are added to the horizontal pedestal of the composite color signal for synchronizing the reference oscillator in the receiver with the color carrier from the transmitter.
- $\frac{\text{Color Dilution} A \text{ condition brought}}{\text{about by mixture with white light; desaturation.}}$
- <u>Colorimetry</u> The science of color measurement and specification.
- <u>Color Primaries</u> In the color receiver, the saturated colors of definite hue and variable luminance produced by the receiver. These color primaries, when mixed in proper proportions, form other colors.
- <u>Color Purity</u> Freedom from mixture with white or freedom from mixture with the other color primary or primaries not already present in the desired color.

- <u>Color Saturation</u> The degree to which white light is absent in a particular color.
- <u>Color Subcarrier</u> The modulation sidebands of this carrier are added to the monochrome signal. to convey color information.
- <u>Composite Color Signal</u> The color picture signal plus blanking signals and all synchronizing signals.
- <u>Convergence</u> The meeting or crossing of three electron beams at a common point. See Dynamic Convergence and Static Convergence.
- <u>Decoding</u> In color receivers, the process whereby the colordifference signals are recovered from the color picture signal.
- Dilution See Color Dilution.
- Dominant Wavelength Of A Color -The single wavelength of light which predominates in any particular color.
- <u>Dynamic Convergence</u> The convergence attained under operating conditions (during scanning).
- Dynamic Focus The focus attained under operating conditions (during scanning).
- \underline{Focus} See Dynamic Focus and Static Focus.
- <u>Hue</u> The name of a color. Neither black nor white nor any of the values of gray are considered hues.
- Luminance Amount of radiant energy emitted from a source and evaluated with reference to its ability to evoke brightness; determined in the case of color TV by the amount of beam current striking the phosphor screen.
- Luminance Channel In a color television receiver, the path which is intended to carry the luminance or black-and-white portion of the color picture signal.
- <u>Matrix</u> —The section of the color receiver where the three primary color signals (representing red, green, and blue) are recovered

for application to the picture tube.

CV TERMS

- <u>Misregistration</u> The production of wrong color or colors due to faults in the color picture tube, in components directly associated with the tube, or in adjustments.
- <u>Moire</u> In television the spurious watery pattern in the reproduced picture resulting from interference beats between two sets of periodic structures in the image.
- <u>Monochrome</u> —By strict definition, a picture having a single hue; but in practical television parlance, a picture in black and white.
- <u>Monchrome Signal</u> A signal or portion of a signal which contains only the brightness or luminosity values of a televised image and produces a black-and-white picture.
- <u>Planar Mask</u> A shadow or aperture mask which has no curvature; one which is perfectly flat.

Primaries - See Color Primaries.

Purity - See Color Purity.

<u>Quadrature</u> — The 90-degree phase displacement of one alternating current or voltage from another.

Saturation - See Color Saturation.

Shadow Mask - See Aperture Mask.

- <u>Static Convergence</u> The convergence attained when the electron beams in the color picture tube are at rest or at the position which they would occupy on the screen if scanning were not applied.
- <u>Static Focus</u> The focus attained when the electron beam is theoretically at rest or is at the position it would occupy if scanning energy were not applied.
- System Of Beams The three electron beams emitted by the triple electron-gun assembly. They occupy positions equidistant from a common axis and are spaced 120 degrees apart around the axis.

Record Changer Servicing

(Continued from page 13)

B. If the tone-arm set-down point is erratic in operation, the following method to determine the trouble is suggested:

1. Check the cartridge lead wires to see that they are long enough to permit free movement of the tone arm.

2. Check the tone-arm control lever to see if it is binding.

3. Check all springs that help to actuate the tone arm in order to see if they are properly connected.

4. Check the tone-arm hub (2) in order to see if it has worked loose on the tone-arm control lever. If such is the case, make the following adjustments:

a. Tighten the set screw (3) enough so that the tone arm will be actuated by the tone-arm control lever during the change cycle.

b. Place a 10-inch record on the turntable.

c. With the power plug out, press down on the REJECT knob; then

rotate the turntable clockwise by hand until the tone arm just barely starts to lower to the turntable. At this point, the horizontal movement of the tone arm is fairly stable.

d. Loosen the set screw (3) and move the tone arm so that the needle is approximately over the starting grooves of the record.

e. See that the hub (2) is fairly well seated on the retaining ring (4); then tighten the set screw (3).

f. After this adjustment has been made; put the changer through a complete change cycle and observe the landing of the tone arm.

g. If a finer adjustment is necessary, it may be made as described in step 5 of part A.

h. Check the needle in the car tridge to see if it is tight.

The description of the procedure for adjusting the set-down point applies to all the models of Admiral record changers previously designated. It is obvious that some parts in the various models may be of a different design; nevertheless, the service technician should be able to recognize these differences and make any alteration

necessary. It is felt that an explanation of the set-down point will be an aid in understanding the service adjustment on the other Admiral models mentioned, although the illustration used is of the Admiral RC212.

Milwaukee

11200, 11600

These Milwaukee models differ some from each other in design and operation, but the set-down adjustment which follows is precisely the same for all.

1. Place the changer on a rack in order to observe the operation of the mechanism and to make the adjustment.

2. Set the mechanism to play 10inch records.

3. Place a 10-inch record on the turntable.

4. With the power removed, reject the mechanism; then rotate the turntable by hand in a clockwise direction until the tone arm moves inward and just starts to lower to the turntable.

5. Using the photograph of the bottom view of the Milwaukee Model 11200 (Fig. 2) as a guide to locate the parts, loosen the clamp screw (1).



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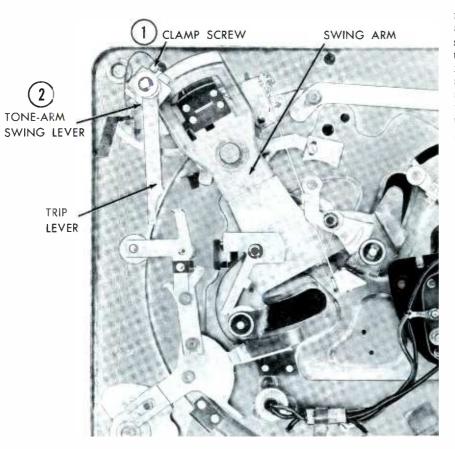


Fig. 2. Milwaukee Changer, Bottom View.

6. With the tone arm in the position mentioned in step 4, hold the tone-arm lever (2) in engagement with the set-down lever.

7. While holding these parts in engagement, move the tone arm over the starting groove of the record and then tighten the clamp screw (1).

8. Place a stack of records on the changer, and plug the changer into a convenient power receptacle of proper rating.

9. Reject the entire stack of records one at a time observing the landing point of the needle on each record. Make the above adjustment if necessary until the set down is correct.

The foregoing adjustment procedure is a definite method in which the proper set-down position of the tone arm is adjusted in these Milwaukee models. If the set-down point of the tone arm is erratic in operation, the service technician may locate and correct this erratic operation by rejecting several records and observing the actual parts that actuate the tone arm. The service technician should observe the mechanism for binding or bent parts and for missing springs.

V-M 400 Series

400D, 402-D, 404, 405, 406, 407

The various models of the V-M 400 Series of changers differ some in design and operation, such as in duospeed or three-speed operation; however, in each case, the actual set-down adjustment is the same.

The V-M automatic record changer will be found in many different radio and television sets. Some of the differences to be noted in these changers may be in the color of the changers or in the type of tone arms used.

The set-down adjustment procedure is as follows:

1. Place a 10-inch record on the turntable.

2. Set the control knob so that the mechanism will function for 10-inch set down.

3. With the power removed from the mechanism, turn the reject knob to REJ position.

4. Rotate the turntable by hand in a clockwise direction until the tone arm moves in over the record and starts to lower to the turntable. 5. The set-down position of the needle is adjusted by means of the two adjusting screws (1A) and (1B), as shown in Fig. 3. If the needle is setting down too near the edge of the record, loosen the back screw (1A) about 1/4 turn and tighten the front screw (1B) to lock the adjustment in place. If the needle is setting down too near the center of the record, loosen the front screw (1B) and tighten the back screw (1A). When correct set down is obtained for the 10-inch position, the 12-inch and 7-inch needle set-down points will also be correct.

This adjustment can be made without removing the changer from the radio or TV cabinet. The adjustment tone screws are made accessible by raising the tone arm to a vertical position. After making the set-down adjustment and after playing a few records, if it is found that the tonearm set-down point varies, check the following:

1. Check the cartridge lead wires to see if there is enough slack to allow the tone arm to move freely.

2. Check the catch (2), index cam (3), and index lever (4) to see that these parts are not binding. If they are binding during the automatic oper-

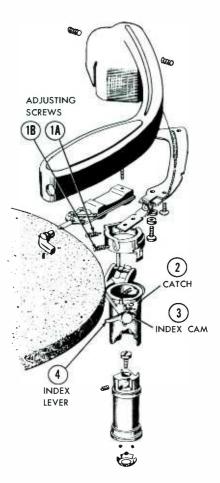


Fig. 3. Tone-Arm Assembly of the V-M 400 Series Changer.

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ation of the changer, erratic tone-arm set down will result.

3. Move the tone arm back and forth over the record to see if it binds in any position. This is done by hand with the mechanism out of cycle.

If the set down is still erratic after these steps have been checked, then a careful study of the set-down mechanism and its operation should be of great help in locating the trouble.

V-M 950 Series

All automatic record changers bearing resemblance to the automatic record changer shown in Fig. 4 belong to the V-M 950 Series. The set-down adjustment may be made with the changer remaining in the cabinet.

The set-down position of the needle is adjusted by means of the setdown adjustment screw (1), as shown in Fig. 5. This screw is mounted on

the tone-arm, hinge-arm assembly. Turn this adjustment screw (1) to the left or right until the needle lands in the starting groove of a 10-inch record. When the correct set-down position is obtained for 10-inch records, the 12-inch and 7-inch record set-down points will also be correct.

It is suggested that in the event the set-down adjustment of any automatic record changer does not position the tone-arm set down properly, the

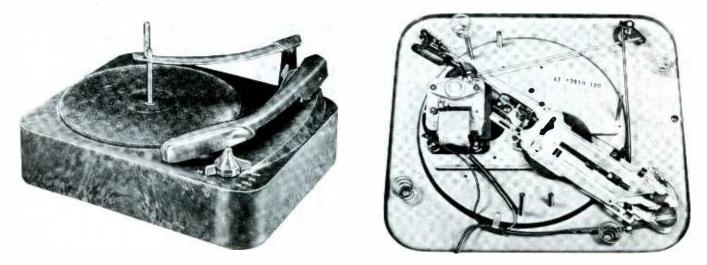


Fig. 4. V-M 950 Series.





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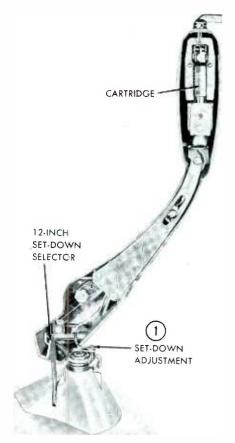


Fig. 5. Tone Arm of the V-M 950 Series.

service technician should study the movement of the tone arm in order to detect its faulty movement.

The tone arm and its connecting parts should always be checked to see that they are securely mounted and that they are all working freely. The lack of lubrication or excessive lubrication of the moving parts of the tonearm bearings and connecting parts may also prevent the tone arm from operating properly.

Webster-Chicago

246, 256, 346, 356

Normally the set-down point is adjusted by turning the eccentric screw (1) in the hinge assembly. See Fig. 6. This adjusting screw is accessible through the top of the tone arm. Turn this screw clockwise to index the needle in toward the spindle and counterclockwise to index it away from the spindle.

Should further adjustment be necessary, proceed as follows:

1. Turn the eccentric screw (1) to a neutral position.

2. Set the record shelf to the 10-inch position.

3. Place a 10-inch record on the turntable.

4. Operate the mechanism by revolving the turntable manually in a clockwise direction until the needle drops to within 1/8 inch of the record.

5. Be sure the notch in the pickuparm raising disc (1) shown in Fig. 7 engages the pickup raising lever (2) of Fig. 7, which is a partial drawing of some of the parts beneath the base plate.

6. The tone arm may now be regulated by adjusting the two set screws in the raising disc (1). The screws

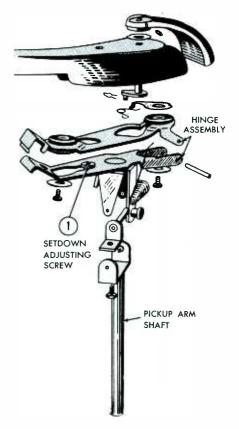


Fig. 6. Tone Arm and Hinge Assembly of the Webster-Chicago 356.

have pointed ends which fit into the off-center holes in the pickup-arm shaft (2) shown in Fig. 6. Alternately loosen one screw and tighten the other until the needle rests above the record lead-in groove at the desired point. Be sure that both set screws are tight when this adjustment is completed.

7. Complete the change cycle, and place the tone arm on the arm rest. If necessary, bend the tongue of the tone-arm raising disc (1) of Fig. 7 closer to or away from the base-plate post until the tone arm is correctly seated on the rest button when the tongue is touching the base-plate post.

CAUTION: All adjusting bends should be slight but firm.

8. Check the adjustment by placing a stack of records on the spindle, by running the changer through several change cycles, and by observing the landing of the needle. Any minor adjustments may be made by the eccentric adjusting screw (1) of Fig. 6.

9. Turn the record shelf to 12 inches and check the needle drop on a 12-inch record. If any adjustment is necessary, make it with the eccentric screw (1) of Fig. 6.

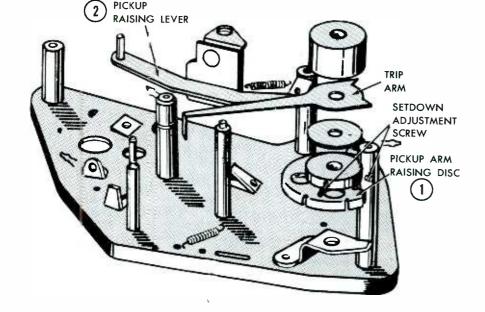
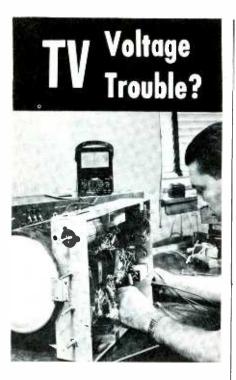
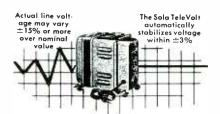


Fig. 7. Subframe of the Webster-Chicago 356.



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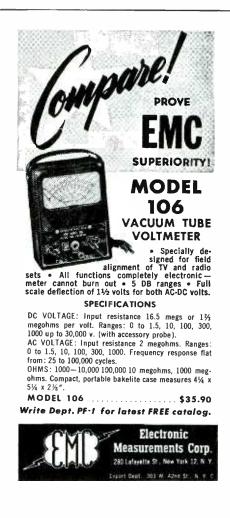


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Record Changer Servicing

10. The 7-inch set-down adjustment for Webster-Chicago Model 346 is made by bending the bracket of the pickup-arm rest as follows: (a) move the tone arm to the center of the turntable; (b) trip the mechanism; (c) rotate the turntable in a clockwise direction until the tone arm reaches the approximate mid-point of its outward swing; (d) stop the rotation of the turntable and move the pickup arm toward the center post until the outside or 7-inch notch of the pickuparm raising disc (1) engages the pickup-arm raising lever (2), see Fig. 7; (e) rotate turntable until the pickup arm reaches the end of its outward movement; and (f) raise the 7-inch pickup-arm-rest bracket located on the base plate near the control knob and bend it in or out until it just touches the side of the tone arm. This adjusts the set-down point of the nedle for the 7-inch record.

Lester W. Caudell



Monochrome Reception

(Continued from page 19)

information contained in the transmitted signal passes normally through the luminance channel.

The video signal from the second video amplifier is applied simultaneously and in equal proportions to each section of the matrix. Since no signals are applied to the Q and I channels, no color information will be fed to the matrix from these channels. For proper operation of the color receiver, the background controls and the gains of the adder circuits must be adjusted so that each gun conducts sufficiently to contribute to the production of a black-and-white picture when signals of equal amplitude are applied to the input of the matrix. When receiving a monochrome signal, all voltages at the input of the matrix are equal, resulting in a black-and-white picture.

The deflection synchronization circuits of the color receiver operate in the same manner during reception of a monochrome signal as they do during color reception; however, the horizontal line and field frequencies employed for the two systems are slightly different. During the process of selecting the color subcarrier, it was found necessary to employ a horizontal-line frequency of 15,734.26 cycles per second with a tolerance of ± 0.047 cycles per second. The standard established for monochrome transmissions is 15,750 cycles per second with a tolerance of 1 per cent. Upon comparison of the two frequencies, a difference of only 0.1 per cent is noted. This difference is well within the 1-per-cent tolerance established for the monochrome signal.

A system of 525 lines per frame was maintained for color transmissions; therefore, the new horizontalline frequency of 15,734.26 cycles per second resulted in a new field frequency. This new field frequency is 59.94 cycles per second, as compared to the monochrome frequency of 60 cycles per second. It was stated that the difference in frequencies is only 0.1 per cent. A variation of this amount will not be perceptible in the viewed picture.

The flexibility of the color receiver has been demonstrated by its ability to respond equally well to either a monochrome or a color transmission. The viewer is therefore not confined to the reception of color transmissions in areas where both types of signals are provided or where color programs constitute only a portion of the station's program.

Don R. Howe

Dollar and Sense Servicing

(Continued from page 37)

MAINTENANCE. When a customer complains about the high yearly cost of keeping a TV set running, try pointing out this fact: The total cost of maintaining present military electronic equipment over its useful life ranges from 10 to 100 times the initial cost of the basic equipment. The more correct average figure here is closer to the larger, or say 50 times initial cost. For a \$200 TV set, then, the military would be plunking out \$10,000 extra to keep it running 8 years.



ITV DETECTIVE. Industrial television gave police an eye-witness view of thieves at work in the stockroom of an RCA television service branch in Hollywood recently. Inventories revealed that some \$38,000 worth of television equipment had been stolen, with all indications pointing to an inside job. With cooperation of police, an ITV camera was concealed up among the rafters of the stockroom, with the lens focused on the loading platform and with the receiver in a second-floor room some distance away.

Police stood by at the receiver for two weeks, watching closely a particular clerk who casually placed boxes of TV tubes on the loading platform during the lunch hour on Tuesdays and Thursdays when few people were around. Soon a pickup truck would back into the driveway, the clerk would help load up, and away would go the loot. When this method of operation had been detected, the trap was set. As the truck moved off with the next load, the clerk was arrested. A police car trailed the truck to its destination and there seized the driver and two alleged confederates.



CRYSTAL SETS. Still with us and selling at the rate of around 150,000 a year are the crystal sets of boyhood days. Today there are two chief markets — hospitals and youths. Headphones connected to crystal sets, with the bedspring serving as antenna and a nearby radiator or electric out let plate as ground, provide adequate local-station reception in hospitals without disturbing other patients. The youth market for these sets is well worth encouraging, because those who play with radio today are most likely to become the enthusiastic service technicians of tomorrow. Furthermore, an interested and alert lad can be mightly useful around your shop on busy Saturdays, long before he starts his formal technical training. Get the right boy, and he'll be tickled to take his pay in the form of used parts and test equipment that's now gathering dust on the shelves.

Another thought — hook up a crystal set with phones at the front of your shop, and keep a few of the deluxe sets on hand for sale. Put up a small, simple sign something like "MODERNCRYSTAL SET — LISTEN AS LONG AS YOU LIKE" and watch how it brings back memories of bygone days. It'll ease your rush-hour tension too, just through knowing that your customer is being entertained while waiting his turn for your attention.



SALARIES. Total payroll of any TV service organization, large or small, should not exceed 40 per cent of gross income if a year-end profit is to be shown, according to an excellent new RCA booklet, "This Business of Radio and TV Servicing." If your ratio of payroll to sales is higher, three things need looking into: the budget, the size and efficiency of your technical staff, and your service rates.



BENT NECK. Many have undoubtedly mused that if the neck of a picture tube could be bent at right angles near the base of the funnel, television cabinets could be made a lot shallower. Success in doing just this is announced in a recent issue of "Philips Technical Review." This European tube manufacturer has bent the neck somewhat more than 90 degrees in order to fold it partly back along the funnel. A small 70gauss magnet is used to get the electron beam around this bend. The construction permits a longer neck, which gives more room for the deflection yoke and gives even better focusing than with conventional straight-necked tubes. The first tube to be placed in production is type MW36-22, having about a 10- by 13-inch screen. There are as yet no plans for U. S. sale, since this small screen size would not interest the American market. The cabinet of the set using this tube is only 13.6 inches deep.



BIG BEN. We thought we had one on Reader's Digest. They ran an item saying that people in Australia hear the chimes of Big Ben before those on the street right below the famous tower. It turned out, however, that math and memory both were shakier than we care to admit, and Reader's Digest was right.

The radio waves, fed by a mike right alongside the chimes, travel the 13,000 miles from London at a speed of 186,000 miles per second and hence take about 1/14 second. During this time, sound waves cruising along at 1,100 feet per second will get only 79 feet, which is far less than the height of Big Ben's tower.

You can readily apply these figures to an interesting local example when next called wpon to speak before some local luncheon club or evening gathering. For example, those watching a football game on TV hear the game-ending gun before the people in the stands and even before the players hear it — provided the pickup mike is near the point where the gun is fired.



GOLDFISH. In one California research laboratory, goldfish are used to trace electromagnetic lines of force between electrodes immersed in an aquarium. When voltage is applied between the electrodes, the goldfish line up for minimum head-to-tail tickle, corresponding to minimum potential. Attempts to photograph the entire wave pattern for a given set of electrodes have not worked out too well, however, because some goldfish are always getting out of line and seeking less ticklish locations. BUSES. A bus company owner in Cumberland, Maryland claims TV is forcing him out of business by keeping patrons home nights. The same lament comes from bus operators in many larger cities. Even in London, a recent fare boost was blamed on TV. Thought for meditiation: Is it better for the minds and morals of people to step out nights or to watch television? Our conclusion: In the United States, people get what they want, so television servicing booms.



COMMERCIALS. British TV seems at first thought to be the American dream come true -- no commercials, no interruptions, no urgent pleas to test and comparebut critic Jack Gould of the New York Times says they can have it. Though the peace of the English living room is indescribably soothing and delightful for a time, there is a catch. You can get trapped into a solid 90 minute wordy play about Joan of Arc or something, with no station selector switch with which to seek relief. Television there is government-controlled, and there's only one station per locality. We in the U.S. are missing some excellent BBC presentations but on the other hand are escaping from some colossal bores.



GUNLESS. Confirmed rumors have it that two of the largest television picture-tube manufacturers in this country are getting somewhere with their work on a picture tube that has no electron gun. It'll be only two or three inches thick, permitting it to be hung on the wall like a picture, with the receiver and controls conveniently located in an end-table type of cabinet alongside the favorite viewing chair.

We managed to get a few inklings of construction details. Based on these, here's our guess as to how the thing will work. There'll be two sheets of glass with transparent conductive metallic lines of the sides facing each other. One glass will have around 525 horizontal lines and the other about one-third more vertical lines, corresponding to U.S. standards for lines and aspect ratio. Between these conductive grids will be the phosphor. A voltage pulse will be applied to one horizontal line and one vertical line at a time. Where these lines cross, there will be double voltage and the phosphor will glow. Scanning will be obtained by using electronic counter circuits, probably with tiny germanium diodes, to apply the voltage pulse to each conductive line in turn. Thus, each vertical line will get the pulse in sequence while one horizontal line is activated, with the process repeating for the next lower horizontal line, and so on.

So far, this only gives scanning. Getting modulation of spot brillance is the real problem on which much work remains to be done. It may be possible to have a transparent metallic grid sheet between the metalized lines on the glass, with the phosphor on both sides for energizing by the video signal. It may be possible to modulate the scanning voltages themselves, if the proper phosphor for the purpose can be found. They may even go to a black-trace tube, which is lighted in absence of signal and is darkened proportionately to the video signal during scanning. In any event, it looks as if it'll still be a vacuum tube, because the phosphor chemicals work best in a vacuum.

Such a picture tube has interesting possibilities. The larger it is, the easier becomes the construction, since the metalized lines get farther apart. Color would seem easy to achieve in large size, because there will then be room for three sets of lines in each direction to activate the dot patterns of three different colors of phosphors.

So far, no patents have been granted in Washington on this tube. Application for a patent means revealing details to competitors; hence, the companies may prefer to hold up on patent protection until they're almost ready for production. When that will be, nobody knows; it may be five years or ten, so don't make your customers enthusiastic to the point where they'll wait for it.



UNLIMITED. While visiting the home folks out in St. Paul, Minnesota this summer, the sign "Appliances Unlimited" in a suburban shopping center caught our attention and fancy. It turned out to be the business name for a dealer handling TV, radio and white goods. For a TV servicing business name, how about twisting it around to something like "Television Service Unlimited?"

BIRDNOTES. Because bird calls in their natural state are more or less a blur of high-frequency notes, magnetic tape was used on one radio program to let listeners hear the calls in slow motion. By dubbing twice at half-speed, calls were reduced two octaves and spread out to four times the original duration. This brought the highest notes down to middle whistling range and at the same time reduced the complexity of the notes. Running commentary was mixed with the calls, with the natural and the slowed-down calls both included. The work was done by Mortimer Goldberg of the CBS radio staff.

Many other tricks can be done with magnetic tape if you have a couple of machines for dubbing back and forth. For another program, CBS recorded "Twinkle, Twinkle, Little Star" as played on a flute and tuba, each on separate tape; then they did tricks to boost the tuba notes up three octaves into the flute range and cut flute notes down three octaves into the tuba range. The result was out of this world. So was "America" when scored, played on a piano, recorded backward, and the tape reversed for playback. As a result, the reverberation of the piano came before the note, giving more the effect of an organ.

For a sales-stimulating contest that'll get them talking and coming into your store, record a lot of familiar sounds at unfamiliar speeds and let people record their guesses on score cards for prizes. Put it on tape and play it every half hour in your store during the contest period, so people can look at the new models of TV sets while waiting for the program or while listening. Here are ideas: a slowed-down bicycle bell sounds like a large fire bell; a crying baby sounds like a sobbing woman. For more tricks with tape, get on the mailing list of Audio Record, published free monthly for recording enthusiasts by Audio Devices, Inc., 444 Madison Avenue, New York 22, N. Y.



FIRE. In one small New Jersey community, the chief of the volunteer fire department resigned because of the drawing power of TV. Last straw was a call right in the middle of a popular TV program, and he had to go out on it all by himself.

TV SUPPLEMENTARY SHEET NO. 7

MODEL & CHASSIS	PART #	CATALOG !	FUNCTION	DESCRIPTION	LIST	MODEL &	PART #	CATALOG #	FUNCTION	DESCRIPTION	LIST
SONORA					TRICE	CHASSIS	PA-4451-1	AG-58-5	Vert.	500K Ω carbon	\$1.25
305	N-7172	AG-60-Z	Vol./	500K Ω carbonSPST	\$1.25			FS-3	Hold	Sook II Calban	
323 324 325	N-7338	KSS-3/SWB	Sw.	1 Meg./50K Ω Conc.	00.		* Some Mode	ls Use Part # PA	-4443-2		_
332	N-7336	KTV-336	Vert./ Hor. Hold	Dual carbon	\$3.10	STEWART- WARNER					
	N-7341	AG-84-5 FKS-1/4	Height	2.5 Meg. Ω carbon	\$1.25	9202-A B.C. DA.DB DD,	508889	AG-44-5 RS-2	Bright.	50K Ω carbon	\$1.25
	N-8053	RTV-335	Bright./ Contrast	50 K/2500 Tap 2000 Ω Conc . Dual carbon	\$3.70	DDA.E.F,FA	508891	AG-19-5 RS-2	Vert. Lin.	5000 Ω carbon	\$1.25
	N-8071	AG-15-S FKS-1/4	Vert. Lín.	3000 Ω carbon	\$1.25		508893	RTV-313	Height/ Vert. Hold	2.5 Meg./1 Meg. Conc. Dual carbon	\$3.10
350 351 352	N-7341	AG-84-5 FKS-1/4	Height	2.5 Meg. Ω carbon	\$1.25		509314	RTV-309	Contrast/ Vol./Sw.	750/1 Meg. Top 200K 2W-W.W./carbon	\$4.30
	N-8071	AG-15-S FKS-1/4	Vert. Lin.	3000 Ω carbon	\$1.25	STROMBERG-				Conc. DualSPST	
	N-8158	RTV-342	Contrast/ Vol./Sw.	2500 Top 500/500 K Ω Conc. Dual carbon SPST	\$4.30	CARLSON 417C5-M 417C5-50	145079	AG-19-5 FKS-1/4	Vert. Lin.	5000 Ω corbon	\$1.25
	N-8279	AG-é1-S KSS-3	Vert. Hold	1 Meg. Ω carbon	\$1.25	417C5-DEC 417TX	145100	AM-86-5 FKS-1/4	Height	6 Meg. Ωcorbon	\$1.25
	N-8280	AG-44-S KSS-3	Bright.	50K Ω carbon	\$1.25	Series 417	145128	RTV-75	Hor./ Vert. Hold	50K/2 Mey. Conc. Duol carbon	\$3.10
	N-8280	AG-44-S KSS-3	Hor . Hold	50KΩ carbon	\$1.25		145129	RTV-314	Controst/ Bright	300/100K Ω 2W-W.W./ carbon Conc. Duol	\$3.10
5212	PA4411	A43-5000	Vert.	5000 Ω 2W-W.W.	\$1.25		145132	AG-27-5 FKS-1/4	Hor. Drive	10K Ω carbon	\$1.25
5250	PA4431	FKS-1/4	Lin. Height	2.5 Meg. Ω carbon	\$1.25		145142	AG-64-Z FS-3/SWB-2	Vol ./Sw .	250K Ω carbon DPST	\$1.25 .75
		FKS-1/4				421CDM 421CM	145079	AG-19-5 FKS-1/4	Vert. Lin.	5000 Ω corbon	\$1.25
	PA4435-3	AK-69 KSS-3/SWB	Vol./ Sw.	330K Tap 60K Ω carbonSPST	\$1.85 .00	421TX	145100	AM-86-5 FKS-1/4	Height	6 Meg. Ω corbon	\$1.25
	PA4443-2	AG-61-5 FS-3	Vert. Hold	1 Meg. Ω carbon	\$1.25		145128	RTV-75	Hor./Vert. Hold	50K/2 Meg. Conc.	\$3.10
CHASSIS 215172	PA4444-2	AG-44-5 FS-3	Hor . Hold	50KΩ carbon	\$1.25		145132	AG-27-5 FKS-1/4	Hor. Drive	Duol corbon 10K Ω carbon	\$1.25
	PA4445-2	AG-49-5 FS-3	Bright.	100K Ω carbon	\$1.25		145140	RTV-227	Controst/	1000/100K Ω 2W-W.W.	\$3.10
	ذ9444	A43-1000 FKS-1/4	Hor . Drive	1000 Ω 2W-W.W.	\$1.25		145142	AG-64-Z RS-2/SWB-2	Bright. Vol./Sw.	carbon Conc. Dual 250K Ω corbanDPST	\$1.25 .75
	PA4452	AG-58-S FKS-1/4	Focus	500K Ω carbon	\$1.25	SYLVANIA					
	PA4453	A43-1000 FS-3	Contrast	1000 Ω 2W-W.W.	\$1.25	228-11 22M-11 23B-11	153-0001 37-73213-1	AG-61-5 FKS-1/4	Height	1 Meg. Ω carbon	\$1.25
5288 5239	PA-4411	A43-5000 FKS-1/4	Vert. Lin.	5000Ω2W-W.W.	\$1.25	23M-11	153-0007 R73197	AG-55-S FKS-1/4	Hor. Drive	250K Ω corbon	\$1.25
5291 5292 5293 5294	PA-4426-1	A 10- 1500 FKS-1/4	Focus	1500 Ω 4W-W.W.	\$1.85	CHASSIS 1-507-1	153-0009 R73154	AG-01-5 FKS-1/4	AGC	1 Meg. Ω carbon	\$1.25
5295 5296A	PA-4431	AG-84-5 FKS-1/4	Height	2.5 Meg. Ω carbon	\$1.25		153-0010 R73156	AG-19-5 FKS-1/4	Vert. Lin.	5000 Ω carbon	\$1.25
5297A 5298	PA-4442-4	AG-40-5 FS-3	Contrast	25K Ω carbon	\$1.25		153-0014 37-73687-1	AG-83-\$ FKS-1/4	Vert. Hold	1.5 Mey. carbon	\$1.25
	PA-4444-2	AG-44-5 FS-3	Hor. Hold	50K Ω carbon	\$1.25		153-3007 R73202	A43-300 FKS-1/4	Controst	250KΩ 2W-W.W.	\$1.25
	PA-4445-2	AG-49-5 FS-3	Bright.	100K Ω carbon	\$1.25		153-3009 37-73748-1	A10-20K FKS-1/4	Width	20KΩ 4W-W.W.	\$2.20
	PA-4446	A43-1000 FKS-1/4	Hor. Drive	1000 Ω 2W-W.W.	\$1.25		157-0009 R73153		Vol./\$w.	2 Meg./1 Meg. Top 200 K Ω Conc. Dual corbon	\$4.30
	PA-4450-1	RTV-349	Tona/Vol./ Sw.	i Meg/330K Tap 65K Ω Conc. Dual carbon DPST	\$4.45					SPST	



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While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this Index.



The Color Television articles in this issue are directed toward the practical interpretation of the color television system standards which the Federal Communications Commission has been petitioned to adopt. That these standards will be adopted seems virtually certain, and such action may well have taken place before these words are in print. Outlining the fundamental application of the system to the best of our ability is then presently logical and, we hope, helpful. However, we do not want our objective to be misunderstood. We are neither promoting nor decrying the prospect of commercial color television.

The articles provide the technical background; it is the purpose of this column to point out a few of the commercial factors which may be of assistance to the individual in forming his own evaluation and future planning.

First, no one should delude himself about the eventual prospects of color television. Its birth, growth, and maturity are as inevitable as night following day. As a parallel, consider the growth of color photography in print, slide and movie form. Those who have experienced the enjoyment that prints or projections in color can provide are ordinarily limited in their pursuance of this medium only by the increased cost of it. Granting that the comparison is not accurate with respect to the exact nature of reproduced color, it still points up the basic fact that the appeal of the color form is much greater.

Second, here are some factors which may serve to temper over-enthusiastic planning based on immediate color TV.

Color TV receivers will be relatively high in price. Popular estimates range from \$750 to \$1000. Simplifications in design and production improvements are not likely to appreciably reduce these figures during 1954.

Color TV receiver production will be limited during the coming year. Present estimates range from 50,000 to 100,000 sets during this time, dependent, of course, upon the date of standards approval by the FCC.

Color TV programming is quite likely to be sparse. If the general impression is true that staging, lightning, and technicial production costs are substantially increased, then it would seem that initial programming would be directed toward public event rather than studio programs.

Another point to bear in mind here, is that additional telecasting equipment must be provided to TV transmitting stations, and that network facilities are uncertain. Present microwave facilities can be satisfactory, but the bandpass characteristic of coaxial line is not suitable for color transmissions.

In spite of statements and promotions to the contrary, there is little doubt but that the predicted coming of color television has hurt black and white TV receiver sales. It is equally true that it will continue to do so; however, it doesn't follow that service operations on black and white TV receivers would be similarly affected. Actually, the likelihood is the other way. . . that more people will have existing black and white receivers serviced to stay in operation until the purchase of a color receiver seems in order.

The foregoing premises are fairly well established. The unknown factor (and consequently bothersome to most people) is the degree of willingness or reluctance on the part of the public to make a considerable investment in a color television receiver, with relatively small picture area as compared to the presently most popular black and white size, the 21-inch.

In the course of the next year, and particularly the next few months, all of you are going to be bombarded by color TV manufacturer promotions, technician writeups and customer questions. We repeat . . . your interests will be best served if you are adequately informed, but not misled. The practical aspects of installation, maintenance, and service operations on color television receivers have not yet arrived; neither has the income nor the profit therefrom. As far as service operations are concerned, black and white television will continue to furnish the great bulk of the revenue for a long time to come *

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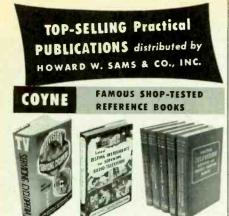
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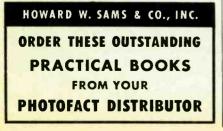
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2. Models marked by an asterisk (*) have not yet been covered in a standard Folder. However, regular PHOTOFACT Subscribers may obtain Schematic, Alignment Data or other required information on these models without charge by supplying make, model or chassis number and serial number. (When requesting such data, mention the name of the Parts Distributor who supplies you with your PHOTOFACT Folder Sets.)

3. Production Change Bulletins contain data supplementary to certain models covered in previously issued PHOTOFACT Folders, and are listed in this Index immediately following the listing of the original coverage of the model or chassis. These Bulletins should be filed with the Folders covering the models to which the changes apply.

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Columin 241 (1) Columin 24	Chassis UL5K1	Chassis 20X1, 20Y1 Tel. Rec. 1001	Ch. 30B1) Models 4H166A, B. C. CN Tel, Rec.	7T04-UL (See Ch. 5N1) Model 7T06 (See Ch. 4B1)	Ch. 21E1) Model 26X37 Tel Rec (See Ch
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033, 032, 034, 035 (Ch. 173) Tel. Pec. 034A, 035A (Ch. 173) Tel. Pec. 036, 037 (Ch. 183) Tel. Pec. 036, 037 (Ch. 183) Tel. Pec. 0368, 037 (Ch. 183) Tel. Pec. 0368, 037 (Ch. 183) Tel. Pec. 0368, 037 (Ch. 183) Tel. Pec. 144-5 Tel. Pec. 820, 821, 822 (Ch. 143) Tel. Pec. 820, 831 (Ch. 151) Tel. Rec. 830, 637 (Ch. 153) Tel. Rec. 830, 637 (Ch. 153) Tel. Rec. 830, 637 (Ch. 153) Tel. Rec. 830, 631 (Ch. 153) Tel. Rec. 830, 631 (Ch. 153) Tel. Rec. 830, 631 (Ch. 153) Tel. Rec. 830, 631, 862 (Ch. 153) Tel. Rec. 830, 631, 862 (Ch. 153) Tel. Rec. 830, 631, 862 (Ch. 173) Tel. Rec. 830, 637, 878 (Ch. 173) Tel. Rec. 830, 887 (Ch. 183) Tel. Rec. 830, 887 (Ch. 183) Tel. Rec. 830, 887	612 (Ch. 142) Tel. Rec97A-6 613 (Ch. 149) Tel. Rec97A-6
033, 032, 034, 035 (Ch. 173) Tel. Pec. 034A, 035A (Ch. 173) Tel. Pec. 036, 037 (Ch. 183) Tel. Pec. 036, 037 (Ch. 183) Tel. Pec. 0368, 037 (Ch. 183) Tel. Pec. 0368, 037 (Ch. 183) Tel. Pec. 0368, 037 (Ch. 183) Tel. Pec. 144-5 Tel. Pec. 820, 821, 822 (Ch. 143) Tel. Pec. 820, 831 (Ch. 151) Tel. Rec. 830, 637 (Ch. 153) Tel. Rec. 830, 637 (Ch. 153) Tel. Rec. 830, 637 (Ch. 153) Tel. Rec. 830, 631 (Ch. 153) Tel. Rec. 830, 631 (Ch. 153) Tel. Rec. 830, 631 (Ch. 153) Tel. Rec. 830, 631, 862 (Ch. 153) Tel. Rec. 830, 631, 862 (Ch. 153) Tel. Rec. 830, 631, 862 (Ch. 173) Tel. Rec. 830, 637, 878 (Ch. 173) Tel. Rec. 830, 887 (Ch. 183) Tel. Rec. 830, 887 (Ch. 183) Tel. Rec. 830, 887	630, 631 [Ch. 159] Tet. Rec. 630, 631 (Ch. 170) Tel. Rec.
034, 0338 (Ch. 173) tel. Rec. 150-7 036, 6378 (Ch. 183) Tel. Rec. 038, 639 (Ch. 183) Tel. Rec. 038, 639 (Ch. 183) Tel. Rec. 820, 821, 822 (Ch. 143) Tel. Rec. 820, 827, 828 (Ch. 143) Tel. Rec. 820, 827, 828 (Ch. 143) Tel. Rec. 830, 631 (Ch. 153) Tel. Rec. 954, 837 (Ch. 153) Tel. Rec. 830, 557 (Ch. 153) Tel. Rec. 830, 837 (Ch. 153) Tel. Rec. 830, 837 (Ch. 153) Tel. Rec. 830, 837 (Ch. 153) Tel. Rec. 840 (Ch. 153) Tel. Rec. 840 (Ch. 153) Tel. Rec. 840 (Ch. 157) Tel. Rec. 760, 877, 878 (Ch. 170) Tel. Rec. 770, 871, 872 (Ch. 170) Tel. Rec. 770, 871, 872 (Ch. 171) Tel. Rec. 840, 881, 882, 883, 884, 885, 886, 887 (Ch. 183) Tel. Rec. 150, 897, 878 (Ch. 183) Tel. Rec. 840, 897, 898, 897 (Ch. 183) Tel. Rec. 974, 978 (Ch. 183) Tel. Rec. 974, 978 (Ch. 183) Tel. Rec. 9750, 871, 872 (Ch. 172) Tel. Rec. 974, 978 (Ch. 183) Tel. Rec. 974, 975 (Ch. 183) Tel. Rec. 974, 975 (Ch. 183) Tel. Rec. <td>632, 633 (Ch. 160) Tel. Rec. *</td>	632, 633 (Ch. 160) Tel. Rec. *
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B30, B37 (Ch. 133) Tel. Rec. 934, B37 (Ch. 133) Tel. Rec. 936, B37 (Ch. 133) Tel. Rec. 937, B38 (Ch. 133) Tel. Rec. 937, B38 (Ch. 133) Tel. Rec. 938, B36 (Ch. 133) Tel. Rec. 938, B37 (Ch. 136) Tel. Rec. 938, B37 (Ch. 136) Tel. Rec. 938, B37 (Ch. 137) Tel. Rec. 939, B37, B378 (Ch. 137) Tel. Rec. 930, B37, B378 (Ch. 137) Tel. Rec. 150, B37, B378 (Ch. 137) Tel. 840, B37, Ch. 1832, B34, B35, 840, B37 (Ch. 183) Tel. Rec. 150, B37, B378 (Ch. 137) Tel. 840, B37, Ch. 1832, B34, B37, 168, B378 (Ch. 133) Tel. 840, B37 (Ch. 183) Tel. Rec. 168, B378 (Ch. 183) Tel. Rec. 17, 918 (Ch. 152) Tel. Rec. 974, 915 (Ch. 152) Tel. Rec. 974, 916 (Ch. 152) Tel. Rec. 974, 917 (Sc. 172), 950A, 914, 915 (Ch. 152) Tel. Rec. 974, 918 (Ch. 164] Tel. Rec. 974, 918 (Ch. 164] Tel. Rec. 975, 953 (Sc. 184) Tel. Rec. 974, 918 (Ch. 164] Tel. Rec. 974, 918 (Ch. 164] Tel. Rec. 974, 918 (Ch. 164] Tel. Rec. 975, 953 (Ch. 184) Tel. Rec. 974, 918 (Ch. 164] Tel. Rec. 975, 953 (Sc. 184) Tel. Rec. 974, 918 (Ch. 164] Tel. Rec. 975, 953 (Ch. 184) Tel. Rec. 975, 953 (Ch. 184) Tel. Rec. 976, 961, 962 (Ch. 176) Tel. Rec. 976, 961, 962 (Ch. 176) Tel. Rec. 976, 961, 962 (Ch. 176) Tel. Rec. 976, 963, 964 (965) (Ch. 136) Tel. Rec. 976, 963, 964 (965) (Ch. 136) Tel. Rec. 976, 964, 965 (Ch. 186) Tel. Rec. 976, 964, 965 (Ch. 186) Tel. Rec. 976, 964, 965 (Ch. 1	830, 831 (Ch. 151) Tel. Rec.
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 21 CIBY (Ch. TS-292AY, BY, CY)
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 21 CID., DY (Ch. WTS-292A, AY, B, Y, CY) Tel, Rec. (See PCB 63–Set 191-13)
 21 CIT, Ch. TS-292A, PK, CY) Tel, Rec. (See PCB 63–Set 191-13)
 21 FL, FL (Ch. TS-293L, A) (Ch. TS-292A, PK, CY) Tel, Rec. (See PCB 63–Set 191-13)
 21 FL, FL (Ch. TS-293L, A) (Ch

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- A-T1817, HM [Code 123] (Ch. 81, H-1, H-1A] Tel. Rec. (See PCB 83 —Set 224-1 and Model 53-T1824 —Set 201-7]
- -T1856, HM, L, W (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)

- H-1A) Tel. Rec. [See PCB 83-Ser 224-1 and Model 53-T1824-Ser 201-7] A-12233 (Code 128) (Ch. 91A, J-2) Tel. Rec. [See PCB 66-Ser 203-1, PCB 82-Set 223-1 and Model 53-T1853-Ser 185-10] A-12234 (Code 128) (Ch. 91, J-2) Tel. Rec. [See PCB 66-Ser 203-1, PCB 82-Set 223-1 and Model 53-T1853-Ser 185-10] A-12262M (Code 128) (Ch. 91, A-12271 (Fill Rec. [See PCB 66-Ser 203-1, PCB 82-Set 223-1 and Model 53-T1853-Set 185-10] A-12271 (Code 123) (Ch. 81, A-127271M (Code 123) (Ch. 81, A-127271M (Code 123) (Ch. 81, A-127272 (Code 123) (Ch. 81, A-127274 (Code 123) (Ch. 81, A-127274 (Code 123) (Ch. 81, A-11824-Set 201-7) A-12274. Site 201-7) A-12274. Si

- Model 53-T1853—Set 185-10) A-T22755 (Code 129) (Ch. 81A, D-81) Tel. Rec. 227-10 A-T2277, L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (See PCB 83—Set 2224-1 and Model 53-T1824—Set 201-7)
- T1824—Sef 201-71 A-12275 (Code 128) (Ch. 91A, J-2) Tel. Rec. (See PC8 66—Set 203.1, PC8 82—Set 223-1 and Model 53-T1853—Set 185-10) A-12279 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (See PC8 83— Set 224-1 and Model 53-T1824— Set 2201-71 AT2280 (Code 128) (Ch. 914. 13)
- Set 201-7] A-T2280 (Code 128) (Ch. 91A, J-2) Tel, Rec. (See PCB 66-Set 203-1, PCB 82-Set 223-1 and Model 53-T1853-Set 185-10)
- A-T2281 (Code 128) (Ch. 91A, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
- A-T2288, HM (Code 123) [Ch. 81, H-1, H-1A] Tel Rec. [See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)

- 13...Set 72..1 and Model 33.
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 A.T2288HMS, S (Code 128) (Ch. 91A, J.2) Tel. Rec. (See PCB 66 Set 203.1, PCB 82—Set 223.101
 A.T2289 (Code 128) (Ch. 91A, J.2) Tel. Rec. (See PCB 66 Set 203.1, PCB 82—Set 223.1 and Model 53.T1833—Set 185.101
 A.T2289 (Code 128) (Ch. 91A, J.2) Tel. Rec. (See PCB 66 Set 203.1, PCB 82—Set 223.1 and Model 53.T1853—Set 185.101
 A.T2292, L (Code 128) (Ch. 94, A, J.5 and Rodio Ch. RT-10) Tel. Rec. (For TV Ch. Only See PCB 85—Set 226.1 and Model 53.T2285—Set 226.1 and Model 53.T2285—Set 226.1 and Model 53.T2285—Set 213.5]
 A.T2294 (Code 128) (Ch. 94, J.5 and Rodio Ch. RT-11) Tel. Rec. (For TV Ch. Only See PCB 85—Set 226.1 and Model 53.T2285—Set 213.5]
 A.UT1816, L (Code 123) (Ch. 81, H-1, H-1, H-1A) Tel. Rec. (For TV Ch. Only See PCB 85—Set 224.1 and Model 53.T2285—Set 224.1 and Model 53.T22

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	101.1) 181. Rec. (See PCB Set
1	52-T2252 (Code 124) (Ch. 71, G1)
	Tel. Rec. (Also see PCB 57-Set
	52.T2253 (Code 121) (Ch 44 D4
-	D4A) Tel. Rec. (Also see PCB
	57-Set 191-1)
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	52-72252 (Code 124) (Ch. 71, G1) Tel. Rec. (Alto see PCB 57-Set 191-1) 52-72253 (Code 121) (Ch. 44, D4, D4A) Tel. Rec. (Alto see PCB 57-Set 191-1) DIAJ Tel. Rec. (See PCB 56-Set 190-1 and Madel 52-72106-Set 171-9) 52-72256 (Code 121) (Ch. 41, D1, 52-72256 (Code 121) (Ch. 41, D1,
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Ξ.	171-9)
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	Tel. Rec. (Also see PCB 57-Set
	53-T1827, -F, -HM (Code 126) (Ch.
	91, J-1) Tel. Rec. (See PCB 66-
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	53-T1827, -F, -HM (Code 128) (Ch.
	53-T1827, -F, -HM (Code 128) [Ch. 91, J-2] Tel. Rec. (See PCB 66- Set 203-1, PCB 82-Set 223-1 and Model 53-T1853-Set 185-
	and Model 53-T1853-Set 185-
	53.T1852 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also See PCB 83 —Set 224-1)
	H-1A) Tel. Rec. (Also See PCB 83
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	Tel. Rec. (See PCB 57-Set 191-1
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	H-1A) Tel, Rec. (Also See PCB 83
	-Set 224-1)
	53-T1852HM (Code 123) (Ch. 81,
	T1824-Set 201-7)
	53-T1852L (Code 123) (Ch. 81, H-1,
	H-1A) Tel. Rec. (Also See PC8 83
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	G-1) Tel. Rec. (See PCB 57-Set
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	G-4 and Radio Ch. RT-9) Tel.
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	53-T2127 (Code 1261 (Ch. 91, J1)
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	53-T2152, L (Code 124) (Ch. 71, G1) Tel, Rec. (See PCB 57—Set 191-1 and Model 52-T1802—Set
	53-T2152, L (Code 124) (Ch. 71, G1) Tel, Rec. (See PCB 57—Set 191-1 and Model 52-T1802—Set 179-9)
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PHILCO-Cont. PHILCO--Cont. 53-7223 (Code 123) (Ch. 81, H-1, H-1A) Tol. Rec. (Alto see PC6 83 --Set 224 f). (Alto see PC6 83 --Set 223 f
 33-T2255 (Code 133) (Ch. 81, H1)

 Tel. Rec.
 201-7

 53-T2260 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Alto tee PCB 83-Set 224-1)
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 53-T2260 (Code 123) (Ch. 42, C2)
 Tel. Rec.

 73-T2262 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec.
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 53-T2262 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec.
 186-10

 53-T2262 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec.
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 53-T2264 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec.
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 53-T2264 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec.
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 53-T2264 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec.
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 53-T2266, L (Code 123) (Ch. 91, J1) Tel. Rec.
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 53-T2266, L (Code 123) (Ch. 91, J1) J-2) Tel. Rec.
 185-10

 53-T2266, L (Code 123) (Ch. 91, J1) J-2) Tel. Rec.
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 53-T2266, L (Code 128) (Ch. 91, J1) J-2) Tel. Rec.
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 53-T2266, L (Code 128) (Ch. 91, J1) J-2) Tel. Rec.
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 53-T2266, L (Code 128) (Ch. 91, J1) J-2) Tel. Rec. (Also tee PCB 60-S5 H203-1, PCB 82-Set 223-1 and Model 53-T1853-Set 185-10

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 53.U1827 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53:11833—Set 185-10)
 53.U1852 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model 53:U1853, L (Code 126) (Ch. 91, J-1 Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53:11833, L (Code 126) (Ch. 91, J-1 Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53:11833.Set 185-10)
 53.U18212 (Code 123) (Ch. 91, H-1, H-1A) Tel. Rec. (For TV Ch. see 53:T1824—Set 201-7, for UHF Tuner see Model UT21A—Set 223-91 PHILHARMONIC 223-9) 53-U2125 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83-Set 224-1 and Model 53-T1824-Set 201-7, for UHF Tuner tee Model UT21A-Set 231-9) 53-U224 (c

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 53.U2272 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model S3.T1824—Set 201-7, for UHF Tuner see Model UT21A—Set 223-9)

 73.U2255 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model S3.U2260 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model S3.U2260 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model S3.U2260 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (For TV Ch. see PCB 83—Set 224-1 and Model S3.U2266, L (Code 126) (Ch. 91, J-11) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 128-10) S3-U2266 (Code 128) (Ch. 91, J-11) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 128-10) S3-U2269 (Code 126) (Ch. 91, J-11) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10) S3-U2279 (Code 126) (Ch. 91, J-11) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10) S3-U2277 (Code 126) (Ch. 91, J-11) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10) S3-U2277 (Code 126) (Ch. 91, J-21) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 128-10) S3-U2277 (Code 126) (Ch. 91, J-21) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 224-1 and Model S3-T1824—Set 201-7, for UHF Tuner tee Model UT21A—Set 203-1, PCB 83—Set 224-1 and Model S3-T12285 (Code 126) (Ch. 94, J-4 and Rodio Ch. RT-10) Tel. Rec. (See PCB 83—Set 224-1 and Model S3-T1823—Set 224-1 and Model S3-T1823—Set 224-1 and Model S3-T183-S17283—Set 233-101 Model 53-T288—Set 234-1 and Model S3-T183-T288—Set 234-1 and Model S3-T183-S17285—Set 234-1 and Model S3-T34, S5562 ... 188-11 S3-5563 ... 189-13 S3-566 (Code 126) (Ch. 94, J-4 and Rodio Ch. RT-10) Tel. Rec. (For TV Ch. Only See PCB 85— Set 234-1 and Model S3-T2285— S5559 ... 213-60

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 6174, 6173, 6176 [Ch. KC547A, AT] Tel. Rec. (Also be PCB 12—Set 120-1]

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 6184 [Ch. KC5 48, T and Radio Ch. Rc-1090] Tel. Rec. [For TV Ch. see PCB 12—Set 120-1]

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 71128 (Ch. KCS476) Tel. Rec.

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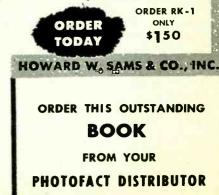
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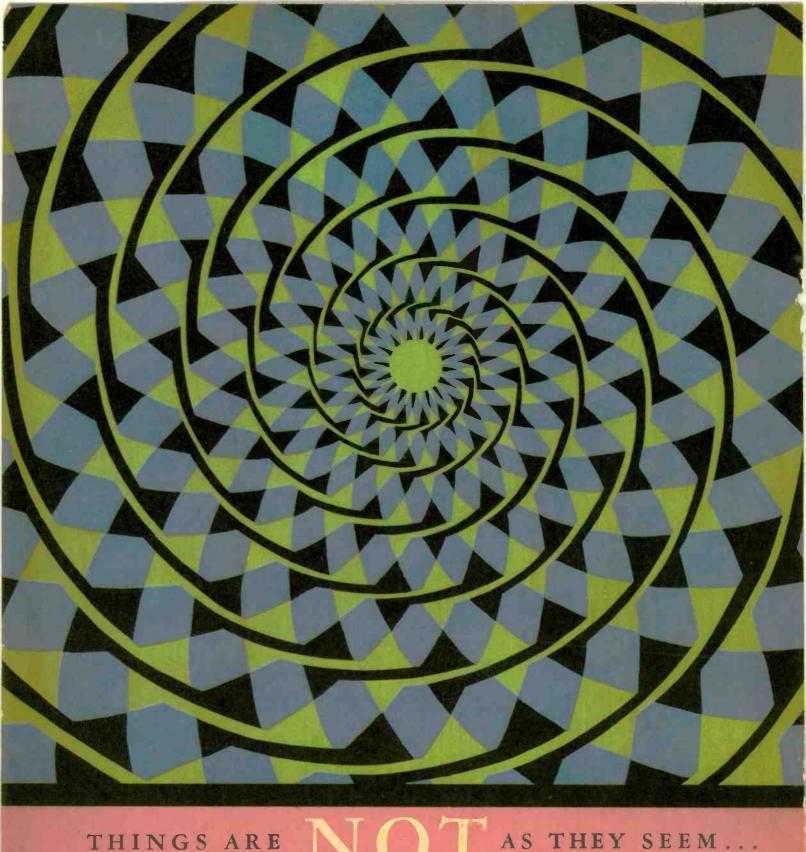
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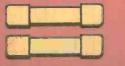
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