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PF REPORTER

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What's New in Color TV?

Color Servicing in the Home

Test Equipment for Color TV

Case Histories of Color TV Troubles

Isolating Chroma Troubles by Symptoms

Fundamentals of the Color TV System

How chroma information is combined with video to produce a complete color TV signal.

To understand what makes color TV possible, we first need to have some idea of how colors are produced in nature. The basic underlying principle goes back to *electromagnetic radiation,* or energy transmitted by wave motion. This phenomenon takes many different forms (such as radio waves, X-rays, and cosmic rays), and it occurs over a tremendously broad range of wavelengths or frequencies. A small slice of this frequency spectrum can be detected by the human eye, and is thus known as light energy.

The eye not only responds to the strength or amplitude of the light energy, but also is affected by the frequency of the light waves entering the field of vision. White light corresponds to a broadband "signal" covering the entire visible range of frequencies. On the other hand, light energy concentrated within a narrow band of frequencies stimulates the eye to see some particular color. The lowest frequencies produce a sensation of red light; as the frequency is increased, different colors appear one after the other, in the same order as seen in the rainbow (orange, yellow, green, blue, and violet).

When white light shines on various objects, they absorb some of the light energy and reflect the rest. This effect is usually frequency-selective; that is; some wavelengths are reflected more readily than others. The predominant wavelength of the reflected light determines the hue of the object, commonly called its "color." The narrower the band of frequencies reflected, the purer the color. In most natural objects, the dominant color is diluted (or we can say its *saturation* is reduced) by miscellaneous random-frequency reflections. These might be compared to "cross talk" caused by poor selectivity in a radio receiver; they do not prevent the basic "message" from getting through, but they detract from its clarity.

Another property of an object's appearance to the eye is its *brightness,* which depends on the amplitude of the reflected energy. Brightness is also related to the light sensitivity of the eye, which does not follow a flat response curve, but reaches a peak near the middle of the visible spectrum (Fig. 1).

Black-and-white TV responds to this quality of brightness, but affords no method of varying the frequency of the light output from the CRT; thus, it can reproduce different colors only as various shades of gray. This is sufficient to develop a recognizable image, but greater realism is made possible by adding a system of frequency-selective light emission that creates a sensation of color.

This system is based on the fact that single-frequency light emission is not the only way to produce a specified color. A combination of several widely-separated frequencies is also interpreted by the eye as a single color, distinctly different from the colors that correspond to the original frequency components. Almost any hue can be formed by mixing or blending certain other hues. In fact, it has been determined that light sources of only three basic colors can produce virtually any

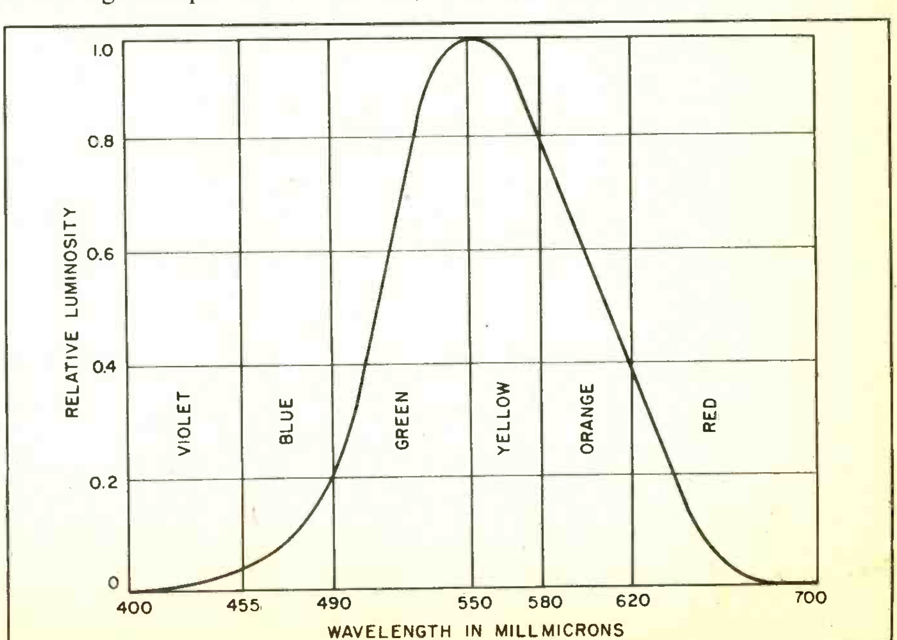

Fig. 1. Eye has varying sensitivity to different colors, as shown by curve.

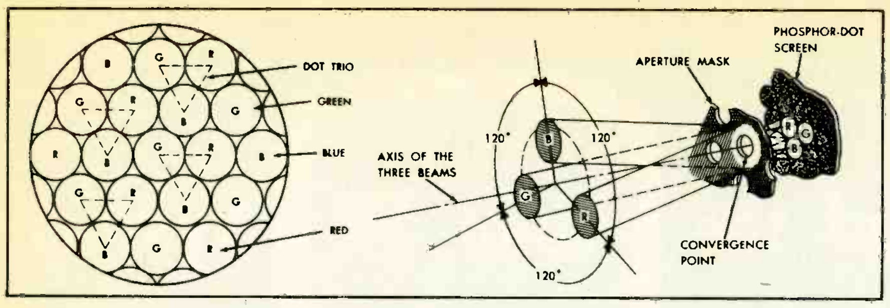

Fig. 2. Electron beams pass through aperture mask and strike phosphor dots.

color in the spectrum when combined in various proportions. The most suitable hues for this purpose, called *primaries,* are green, blue, and red.

Therefore, the color-TV system is a three-way additive process. A trio of camera tubes, equipped with color filters, capture the red, green, and blue components of the light from the televised scene. The transmitted RF carrier is modulated with these triple outputs in a manner that enables the receiver to develop a separate signal for each primary color. These signals are applied to a picture tube having three independent electron guns, mounted parallel to one another in a triangular arrangement. The screen of this tube is coated with a combination of three different phosphors, which respectively glow red, green, and blue when struck by a beam of electrons. The phosphors form a pattern of tiny dots (Fig. 2A). To make sure that each beam energizes the correct set of dots, an *aperture mask* or *shadow mask* is mounted inside the picture tube, just behind the screen. Perforations in this metal plate are aligned with the electron guns and trios of dots so that each beam is allowed to fall only on the correct dot in each trio, as shown in Fig. 2B.

As the three electron beams simultaneously scan the tube face, they constantly produce changes in the relative brightness of the three phosphors. At normal viewing distances, the varying proportions of the three primary colors appear to blend into an almost infinite variety of hues and shades. One specific ratio of red, blue, and green illumination results in either white or some shade of gray, depending upon the over-all brightness of the screen.

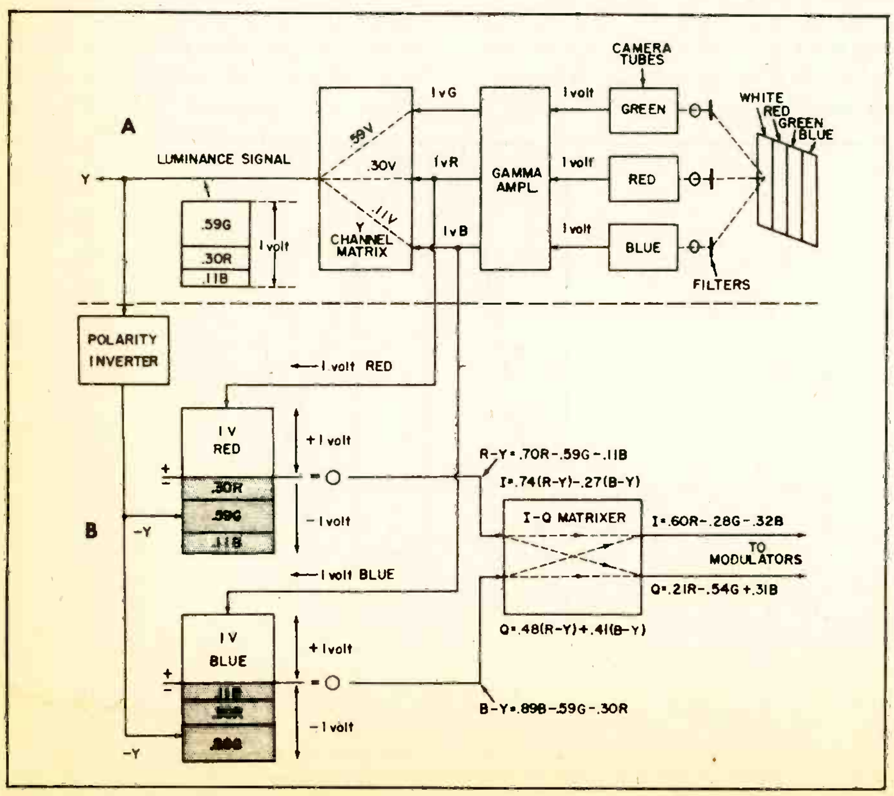

Fig. 3. Block diagram of transmitter circuits that form Y and chroma signals.

How Color Signals Are Produced

An important requirement of the color-TV system is that it be compatible with the standard monochrome system, so black-and-white sets can develop a usable picture on color programs. To satisfy this requirement, the color signal contains an equivalent of the monochrome video signal (called the *luminance* signal) which reproduces the transmitted scene only according to its brightness.

This output, often called the Y signal, is made up of definite proportions of the signals from the three color camera tubes. Since the average human eye is almost twice as sensitive to green as to red, and five or six times as sensitive to green as to blue (Fig. 1), the Y signal utilizes different amplitudes of the three primary-color signals. As shown in Fig. 3, the Y-channel matrix combines 59% of the green signal, 30% of the red signal, and 11% of the blue signal to produce brightness information.

The following simplified explanation will omit the amplitude-linearity correction introduced by the gamma amplifier in an actual transmitter. Assuming that the camera is scanning a white object of a brightness which produces a 1-volt output from each camera tube, the Y channel will receive a combined signal level of 1 volt—with .59 volt contributed by the green tube, .30 volt by red, and .11 volt by blue. This output will register as white on the CRT of a properly-adjusted black-and-white receiver.

If the camera then scans a red object just bright enough to produce a 1-volt output from the red camera tube only, the Y-signal amplitude drops to .30 volt. This causes a black-and-white CRT to reproduce a moderately dark shade of gray. Scanning a green object of comparable light output results in a Y amplitude of .59 volt, which shows up as a lighter gray. On the other hand, a 1-volt "blue-only" signal develops only .11 volt in the Y channel, and this is interpreted by a black-and-white set as a very dark gray.

Chroma Signals

Since the luminance signal already contains part of the information developed by the color camera,

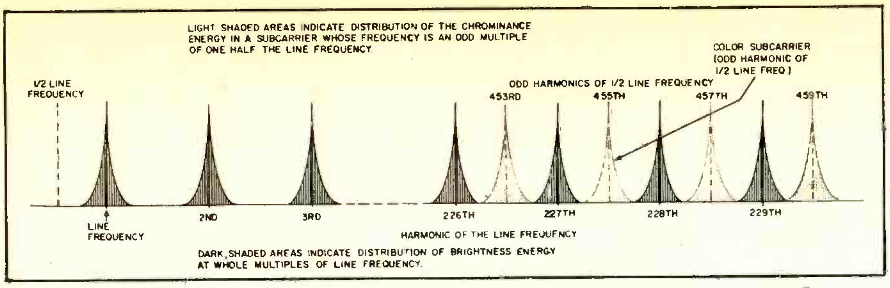

Fig. 4. Chroma and video signals are both transmitted in the same frequency band; interference is minimized by interleaving the peaks of signal energy.

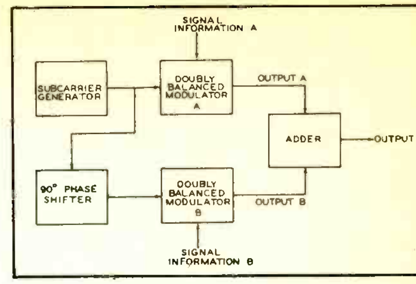

Fig. 5. Chroma signal is developed by this divided-carrier modulation system.

the remainder of the color-TV signal must be designed to *complement* the luminance output. This is done by simply subtracting the Y signal from each of the camera outputs, resulting in *color-difference* signals. These are modified into a *chroma* (sometimes called *chrominance)* signal, which is used to modulate the RF carrier separately from the Y signal. The chroma information is processed by the color receiver to reconstruct the original differences in the outputs of the three camera tubes.

The development of the color-difference signals can be traced in Fig. 3. The Y signal is fed through a polarity-inverting stage to produce –Y, which is then mixed with the positive-polarity outputs from the individual camera tubes. If a white area is being scanned, the –Y output is equal to the camera-tube output. These two signals then cancel, producing a color-difference voltage of zero. Cancellation can occur just as well at any other output-voltage level, as long as all three camera outputs are equal; therefore, the color TV receiver can produce all the various shades of gray.

When the camera-tube outputs are unequal, the Y signal does not balance out the respective color voltages, so one or more color-difference signals are developed. For example, suppose that the camera in Fig. 3 scans a pure red object and delivers 1 volt from the red camera tube to the R – Y color-difference matrix. At the same time, the matrix receives –.30 volt through the Y channel; so the resultant R – Y output is .70 volt. In scanning a green object of equal light intensity, there is zero output from the red camera tube, but the green tube applies 1 volt to the luminance input. This causes a negative Y signal of –.59 volt to arrive at the R – Y matrix, and since this Y signal is subtracted from zero, the net R – Y output is –.59 volt. A blue object likewise produces no red-camera output, but causes –.11 volt of Y signal to be passed through the R – Y matrix.

Generally speaking, then, the R – Y output is derived by combining 70% of the red output in positive polarity, 59% of the green output in negative polarity, and 11% of the blue output in negative polarity. In short, R – Y equals .70R –.59G –.11B. This fixed percentage of each camera-tube output is always used in making up the R – Y signal, even though the camera-output voltages themselves are constantly fluctuating.

It can be similarly demonstrated (or worked out mathematically) that the B – Y signal equals .89B –.59G –.30R. The third color-difference signal (G – Y) need not be developed for modulating the transmitter, since this signal can be produced at the receiver by combining fixed proportions of R – Y and B – Y. Negative polarities of both signals are required, in the ratio of 51 parts of R – Y to 19 parts of B – Y. The G – Y signal can also be expressed in terms of the three camera outputs, as .41G –.30R –.11B.

The R – Y and B – Y signals are not directly used to modulate the RF signal at the transmitter, but are recombined into two other signals. This extra step is necessary because only a limited bandwidth is available for transmitting the chroma information. To insure maximum usable color detail in the picture, with the greatest possible economy of bandwidth, the reaction of the eye to small areas of various colors is carefully taken into consideration.

In areas less than approximately ⅛" square on a 21" CRT screen, corresponding to video-signal frequencies above 1.5 mc, colors cannot be recognized at normal viewing distances. Since these areas all appear gray, whether or not they con-

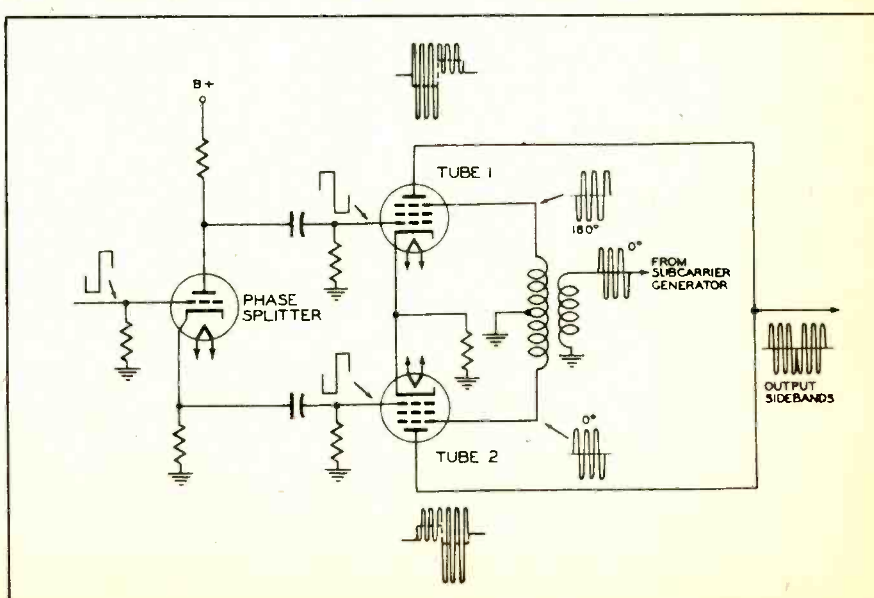

Fig. 6. This doubly-balanced modulator combines the I and subcarrier signals.

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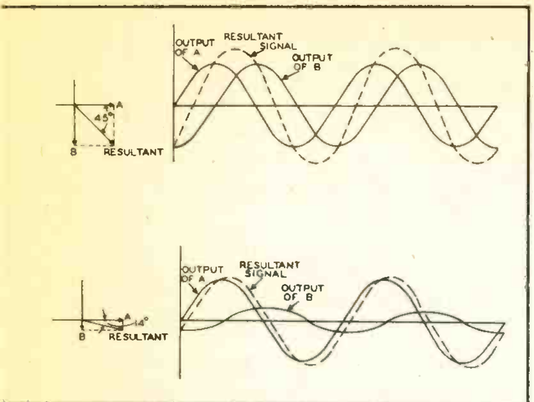

Fig. 7. Transmitted chroma signal is resultant of two modulator outputs.

tain color, no chroma-signal components need to be transmitted to reproduce such fine details. In slightly lager areas (between ⅛″ and ⅜″ square), the eye can distinguish between "warm" and "cool" colors; however, the former all take on an orange cast, while the latter tend to appear cyan (greenish - blue) in color. This means that only these two hues need to be transmitted at modulating frequencies between 0.5 and 1.5 mc. The signal employed for this purpose, called the I (in-phase) signal, is developed by combining the color-difference signals in the proportion of +.74 (R – Y) –.27 (B – Y). As noted in Fig. 3, this signal actually contains components of all three camera signals, the ratio being .60R –.28G –.32B.

Objects larger than ⅜″ square on a 21″ screen, corresponding to video frequencies below 0.5 mc, can

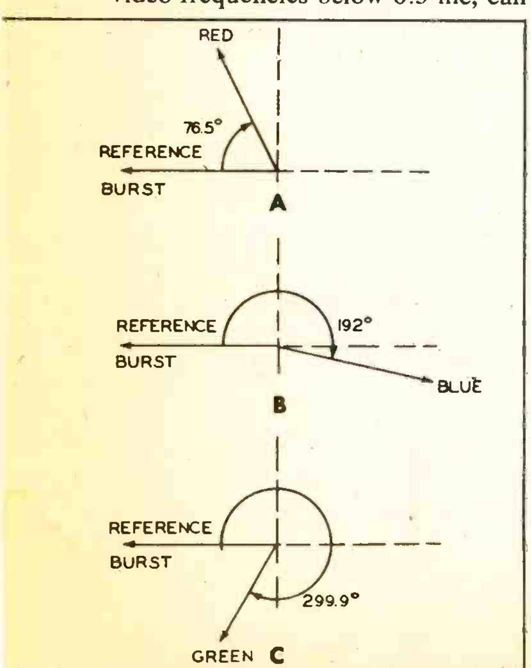

Fig. 8. Chroma - signal phase angles corresponding to three primary colors.

be seen in full color; thus, additional narrow-band chroma modulation is needed. A second chroma-signal component, the Q (quadrature) signal, is therefore transmitted to supply the receiver with further color information besides that contained in the I signal. Its makeup in terms of the color-difference signals is .48 (R – Y) +.41 (B – Y). Expressed as proportions of the three camera-tube signals, it is composed of .21R –.54G +.31B. The meaning of the terms "I" and "Q" will be clarified in the next section, which describes how the modulation process is performed at the transmitter.

Modulating the Color Subcarrier

When the compatible color-TV system was still in the planning stage, one of the most difficult problems to be overcome was that of finding a place for the color signal within the standard 6-mc TV channel. Practically all the available frequencies seemed to be occupied by the sidebands of the video and sound carriers.

Fortunately, it was discovered that the video-signal energy produced in scanning an image is concentrated at certain frequencies — specifically at whole multiples (harmonics) of the scanning rate. Very little energy is generated at frequencies in between these points of concentration (see Fig. 4). Thus, it was proved possible to transmit color information within the same frequency band as the video (luminance) signal, by concentrating the color energy in the voids between the peaks of video-signal energy. This process, called *interleaving,* is achieved by placing the chroma information on a subcarrier whose frequency is an odd multiple of one-half the horizontal sweep frequency.

A subcarrier is a signal which is first amplitude-, frequency-, or phase-modulated by a lower-frequency is an odd multiple of one-modulate a higher-frequency RF carrier. After being detected and separated from the main carrier, the subcarrier must go through an additional step of demodulation to recover the low-frequency information it conveys.

In color TV, the frequency of the chroma subcarrier must be low enough so that it and its sidebands

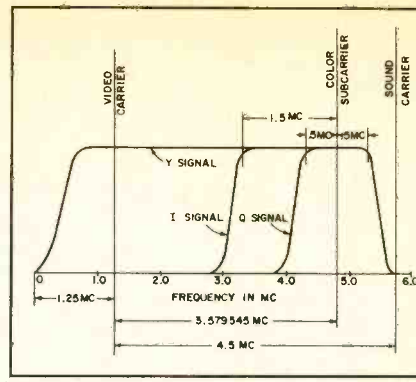

Fig. 9. I portion of chroma signal has greater bandwidth than the Q portion.

can pass through the video detector without objectionable distortion or attenuation. On the other hand, the subcarrier frequency should be as high as possible, in order to minimize chroma interference in the black - and - white picture. If the chroma signal occupies the upper end of the video-frequency range, the worst interference it can produce is a pattern of fine dots. Also, black-and white sets can be designed to exclude the chroma-signal frequencies, with only a slight loss in picture detail.

The desired amount of color detail in the picture establishes the upper limit of the chroma sidebands at 0.6 mc above the subcarrier. Since the maximum practical bandwidth of TV transmitters and receivers is approximately 4.2 mc, the subcarrier frequency should be no higher than 3.6 mc. Of all the odd harmonics of half the horizontal sweep frequency, which one comes closest to meeting the requirements of the chroma subcarrier? The 455th harmonic, at exactly 3.583125 mc, was tentatively chosen as a subcarrier when the color - transmission standards were first being formulated. However, this frequency did not work out well in practice, because the subcarrier heterodyned with the 4.5-mc

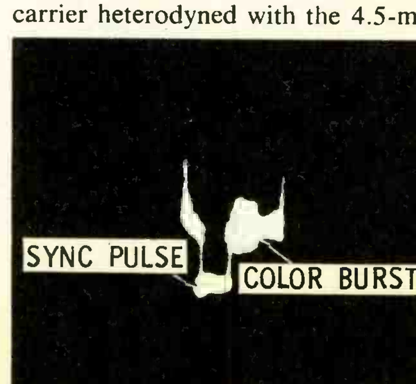

Fig. 10. Color burst is transmitted immediately after horizontal sync pulse.

sound IF signal to produce an objectionable interference pattern on black - and - white receiver screens. Experiments showed that the interference could be minimized by making the unwanted beat frequency also equal to an odd harmonic of one-half the horizontal scanning rate.

To take this extra requirement into account, it was necessary to adjust the horizontal frequency itself. Thus, for color transmissions, the line-scanning rate is slightly reduced to 15734.264 cps—still within the 1% frequency tolerance allowed in existing specifications for black-and-white television. The vertical scanning frequency is also adjusted, to 59.94 cps. As for the chroma subcarrier frequency, its value was established at 3.579545 mc, with a tolerance of only about ±10 cps. (The frequent reference in technical literature to a "3.58-mc subcarrier" is simply a rounding off of figures for the sake of convenience.) The subcarrier and scanning frequencies are developed from a single source to simplify the problem of maintaining the necessary frequency accuracy.

Divided-Carrier Modulation

During the discussion of the signals used for modulating the color subcarrier, it was pointed out that two separate signals (I and Q) are used to convey the color information. Consequently, the color-TV transmitter must provide for modulating one subcarrier with both these signals.

One way of accomplishing this feat is by using divided-carrier modulation (see block diagram, Fig. 5). The subcarrier generator produces a sine wave of constant frequency and amplitude, which is then applied to a

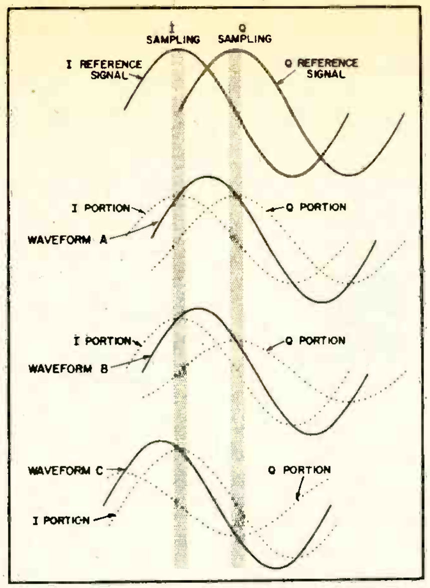

Fig. 11. Sampling time occurs at peaks of I and Q chroma-signal components.

pair of doubly-balanced modulator circuits. The signal is fed directly to modulator A, but is shifted in phase by 90° before being applied to modulator B.

Fig. 6 is a schematic of modulator A, with waveform drawings included to help explain the operation of the circuit. The modulating signal (previously referred to as the I signal) is passed through a phase-splitter circuit to produce two signals of opposite polarity, and these are applied to the control grids of two modulator tubes. The subcarrier signal is coupled into the modulator through a transformer with a tapped secondary. This arrangement also results in two equal-amplitude signals, 180° out of phase, and these are applied to the suppressor grids of the modulators.

Examine the plate waveforms of these tubes, and notice that each output is a subcarrier- frequency signal whose amplitude is high during the positive half-cycle of the grid signal, and low during the negative half-cycle. Furthermore, the subcarrier waveforms at the two plates are 180° out of phase. Since the plates are tied together, the resultant output signal has an amplitude equal to the difference between the two plate signals. For example, on the first half-cycle of the subcarrier waveform in Fig. 6, the output is a combination of a strong positive peak from tube 1 and a weak negative peak from tube 2; thus, the resultant is a fair-sized positive peak. On the second half-cycle, a strong negative peak from tube 1 combines with a weak positive peak from tube 2, producing a moderate negative peak. Note that the resultant phase of the high-frequency component in the output at any given time agrees with the phase of the plate signal having the greater amplitude.

This system produces a combination of amplitude and phase modulation of the subcarrier. When the signal coming into the grid circuit of the phase splitter increases in amplitude, the splitter produces stronger outputs which create a greater unbalance between the modulators; therefore, the amplitude of the output signal increases. In addition, the phase of the sidebands in the output signals changes by 180° each time a polarity reversal occurs in the modulating signals coming from the phase splitter.

Of course, an absence of modulation at the control grids of tubes 1 and 2 allows the tubes to conduct equally; then the subcarrier signals are completely concelled, and there is no output.

Modulator B works in exactly the same manner as modulator A, except that the subcarrier input is delayed 90°, and the phase splitter receives the Q signal instead of the I signal. The *output* of modulator B may either *lead or lag* that of A, according to the polarity of the modulating signals applied to each circuit.

Both outputs are fed into the adder stage (Fig. 5), which combines them into a single waveform that varies continuously in both amplitude and phase, and is suitable for modulating the RF picture carrier of the TV transmitter. Because of the 90° phase relationship between the I- and Q-modulated subcarrier signals, vector analysis is

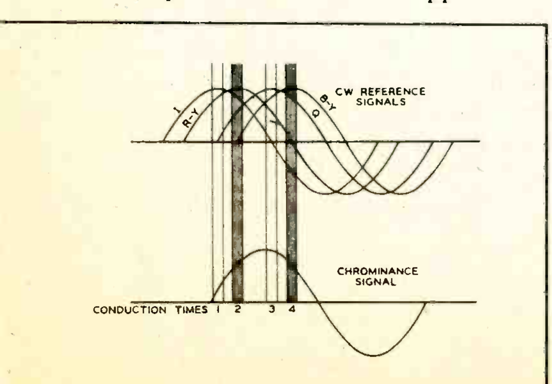

Fig. 12. Comparison of sampling times for the I, Q, R – Y, and B – Y signals.

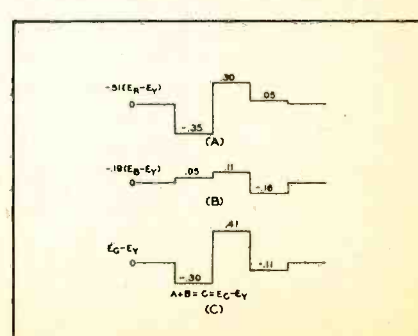

Fig. 13. Formation of G – Y signal voltage by combining R – Y and B – Y.

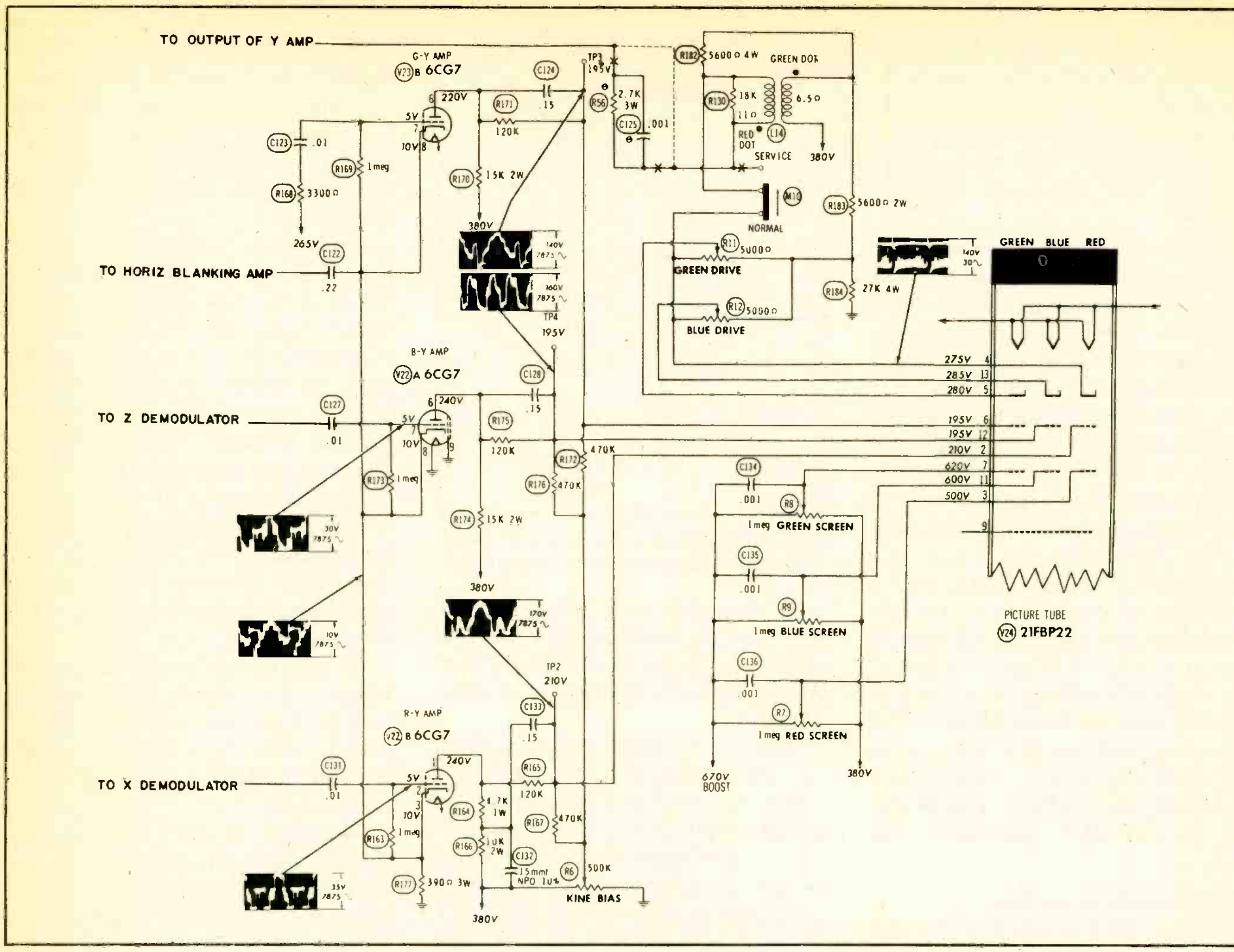

Fig. 14. X and Z matrixing and CRT-drive circuitry of late-model color set.

necessary to demonstate the phase and amplitude of the resultant output from the adder. A couple of examples are shown in Fig. 7. Part A of this figure shows that equal I and Q signals produce a net output which differs in phase from each original signal by 45°. On the other hand, if a strong I signal from modulator A is combined with a weak Q signal from modulator B, the resultant (Fig. 7B) is very close to I in both phase and amplitude.

The phase difference between the adder output and the original subcarrier constantly varies, and the instantaneous phase angle may have any value between 0° and 360°. Every phase angle corresponds to some specific color; for example, the pure primary hues produce the signal phases shown in Fig. 8.

During the modulation process, the bandwidth of the I and Q signals is limited to the frequency range indicated in Fig. 9. Both upper and lower sidebands of the Q signal are utilized, but modulating frequencies above 0.5 mc are attenuated. On the other hand, the I channel uses a type of vestigial-sideband operation, similar to that of the picture carrier itself. The upper sideband is attenuated beyond 0.5 mc, but lower-sideband frequencies as high as 1.5 mc are transmitted full strength.

The chroma subcarrier is suppressed, leaving only its sidebands as modulation on the picture carrier. Therefore, the receiver must supply a substitute 3.58-mc signal to take the place of the original subcarrier during demodulation. The phase of this signal must remain very accurately locked in step with the transmitter subcarrier. Accordingly, the local oscillator at the receiver is crystal-controlled to maintain a frequency of 3.579545 mc, and color-sync circuitry is employed to control the phase of the oscillator-output signal. The input to the color-sync section is a sample of the original subcarrier (color burst). This signal, shown in Fig. 10, is transmitted for a short interval during the horizontal blanking pulse in the video signal.

For further information on the operation of the frequency- and phase - control circuitry, refer to "Understanding Color Sync" in this issue.

Several other receiver circuits associated with the chroma signal (the bandpass amplifier, color killer, etc.) are also given extensive coverage elsewhere in this issue. Therefore, this article will skip over these circuits, and will concentrate on explaining how the chroma signals are demodulated and applied to the tricolor picture tube.

Chroma Demodulation

The process of demodulating the chroma signal can be more easily understood if the following facts are kept firmly in mind:

1. The chroma signal arriving at the demodulator is always a sine wave of constant frequency, although both the phase and the

amplitude of this sine wave undergo continual variations.

2. At the transmitter, the chroma signal is formed by combining two other signals (I and Q)—each of which is modulated by a different portion of the color-difference information.

3. The demodulator must break down the chroma signal into its I and Q components (or equivalent) so that the color modulation in both these components can be recovered.

The articles, "Chroma Bandpass and Demodulator Circuits" and "What's New in Color TV" in this issue include schematics of typical demodulator circuits in current use. In both these basic types of circuits, dual stages are required. Each stage receives a chroma input and a locally-generated 3.58-mc reference-oscillator signal. While the chroma signals are identical, the reference signals are deliberately applied out of phase; this is the key to separating the chroma input into its components.

Because of this phase difference between the reference-signal inputs, the two demodulators alternately "sample" the chroma signal (i.e., conduct for a brief interval) at two different times during each cycle. The exact sampling times depend on the phases of the reference signals. As the color TV system was originally planned, these signals were intended to have the same phases as the 3.58-mc inputs to the balanced modulators at the transmitter. They were likewise given the same designations, I and Q. In a demodulator of this type, one stage is driven into conduction on peaks of the I reference signal, and the other on peaks of the Q signal. The demodulator output during each of these sampling intervals is determined by the amplitude of the chroma-signal voltage at the sampling time. The amplitude changes constantly, according to modulation content; in Fig. 11, notice how the sampling times intercept different points on the sinusoidal chroma waveform (solid line) as the latter is shifted in phase by its modulation.

The dotted lines in Fig. 11 trace the waveforms of the original I and Q signals that were combined to form the chroma signal. As the illustration points out, the I and Q demodulators automatically sample the chroma signal at the right time to detect the peak amplitude of the I and Q signal components. Either the positive or the negative peaks may be sampled; different polarities simply produce different colors.

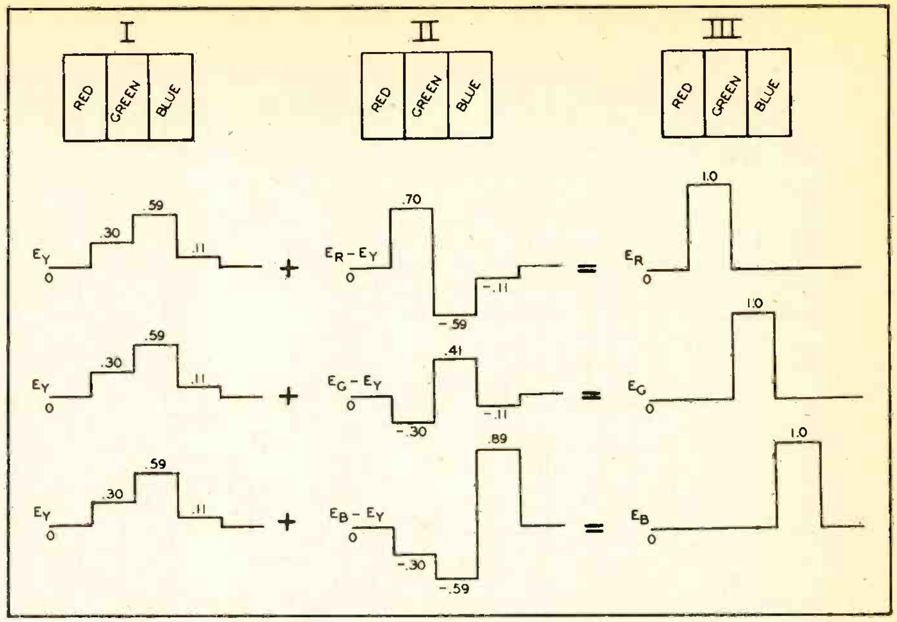

Fig. 15. Y and color-difference signals add to form primary-color signals.

As cycle after cycle of the 3.58-mc chroma signal is sampled, the output-voltage variations of the demodulators trace out a replica of the I and Q signals that were originally applied to the phase-splitter circuits of the balanced modulators in the transmitter. Any 3.58-mc signals that may remain in the output are removed by filtering.

Recovering Color-Difference Signals

Remember than the I and Q modulation was developed from color-difference signals, which in turn were obtained by subtracting the luminance signal from the color-camera outputs. This process must be reversed in the circuitry following the demodulator, so that the three color signals can be made available to the CRT of the receiver.

The I and Q signals can be recombined into color-difference signals, according to specific formulas related to those given earlier in this article for converting R – Y and B – Y into I and Q. This operation can be carried out in special matrixing circuitry following the demodulators, but there's an easier way. Since the color - difference signals contain definite percentages of I and Q "ingredients," they can be obtained directly from the demodulators—thus dispensing with the matrix. The only change needed in the demodulators is an alteration of the phase difference between the locally-generated reference signals and the transmitted color subcarrier. For example, in Fig. 12, a slightly greater lag in reference-signal phasing enables the demodulators to sample the peak amplitudes of the R – Y and B – Y components in the I and Q signals. I and Q, as such, do not have to be detected.

The only disadvantage of this system is that, since a pure I signal is not recovered, the added detail transmitted in the I channel between 0.5 and 1.5 mc cannot be faithfully reproduced in sets using direct demodulation of color-difference signals. Therefore, the bandpass of the chroma circuits in these sets is simply reduced to take in only about 0.5 mc on either side of the subcarrier. Since color-difference demodulation considerably simplifies the circuitry with only a slight loss of color detail, all present-day sets use this system. Any arrangement which produces *any two* of the color-difference signals is theoretically usable, since the third signal can be derived from the first two. For best results in practical circuitry, R – Y and B – Y are generally recovered by the demodulators, and these outputs are combined in the proportions shown in Fig. 13 to produce G – Y.

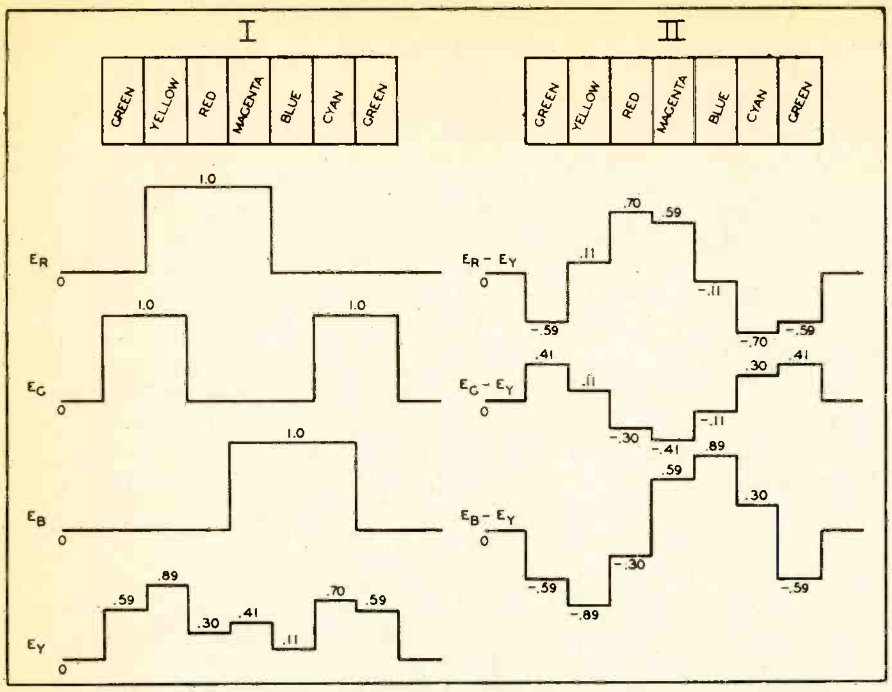

Fig. 16. Signal voltages corresponding to primary and complementary colors.

In some systems of the type just described, the outputs of the demodulators are not *exactly* R – Y and B – Y, but are modified to meet various requirements of the stages between the demodulators and the CRT. This is true of the circuit in Fig. 14, which is used in many late-model color receivers. To produce B – Y and R – Y outputs from the color - difference amplifier tubes V22A and V22B, – (B – Y) and – (R – Y) inputs must be used in order to compensate for phase inversion in the amplifiers. In addition, since the conduction of V22A and V22B is affected by the small signal developed across common cathode resistor R177, true color-difference outputs can be obtained only by modifying the grid signals to complement this cathode signal. The cathode circuit develops a combination of X and Z signals in the correct ratio to produce +(G – Y). This resultant signal is amplified without phase inversion by V23B, which functions as a grounded-grid stage.

The output signals of the color-difference amplifiers have the correct amplitudes and waveforms for matrixing with the luminance signal. This matrixing is the last step in recovering the original red, green, and blue camera-tube signals.

Adding Luminance

Modern circuits such as the one in Fig. 14 have done away with elaborate chroma-and-Y matrixing circuits of the type used in early color sets. The picture tube itself is now used to combine the color-difference and luminance signals. The appropriate color-difference signal is fed to the control grid of each gun in the CRT, and a Y signal of negative polarity is applied to the cathode. Since the cathode and grid inputs both have a – Y component, these portions of the signals do not affect the grid-cathode bias of the gun. Therefore, the bias is determined by the R, G, or B component of the color-difference signal.

This process is illustrated in Fig. 15, which shows the waveforms involved in scanning one line of a simple color-bar pattern that contains only the three primary hues. The figures are expressed per volt of camera-tube signal, and do not reflect the actual voltage levels on the CRT elements.

During transmission of the red bar, the red gun receives full drive (E_R = 1.0) because a Y signal of .30 adds to a R – Y color-difference signal of .70. However, when the same Y signal is applied to the blue and green guns, it is cancelled by a –.30 color-difference signal; so there is no output from either gun. In a similar manner, scanning the green and blue bars causes full conduction of the green and blue guns in succession.

To give an idea of how the primary colors can be obtained to produce other hues, Fig. 16 shows the waveform involved in scanning a color-bar pattern containing complementary as well as primary colors.

This word *complementary* calls for a bit of explanation. When equal amounts of two primary colors are mixed, they produce another color, which is defined as the complement of the third primary. In mixing colored light sources, as is the case in color TV, the complement of red is cyan (a greenish-blue); that of green is magenta (a reddish-purple); and that of blue is yellow.

The first complementary color encountered in the bar pattern of Fig. 16 is yellow — a bright color with a high luminance value of .89. Note that the B – Y signal cancels the luminance signal at the blue gun when the yellow bar is being scanned, but the R – Y and G – Y signals add to the luminance signal. The result is full output from the red and green guns, with no output from the blue gun. Similarly, the blue and red guns conduct equally to produce magenta, and the blue and green guns produce cyan.

If a white or gray bar were scanned, no color-difference information would be transmitted, and so the luminance signal alone would drive all three CRT guns at the proper levels to produce white or gray. Incidentally, the drive controls in the cathode circuits (similar to the background controls used in older color sets) adjust the balance of the DC cathode voltages so that the truest possible gray tones can be produced at all brightness levels. In conjunction with the drive-control adjustments, the screen controls are used to improve gray - scale tracking by adjusting the accelerating-grid voltages on individual guns.

Actual color-picture signals are much more complicated than those used as examples in this article, since natural colors include many "in-between" hues and many different levels of saturation and brightness. The compatible color TV system is sufficiently flexible and sensitive to reproduce practically all colors present in transmitted scenes. ▲

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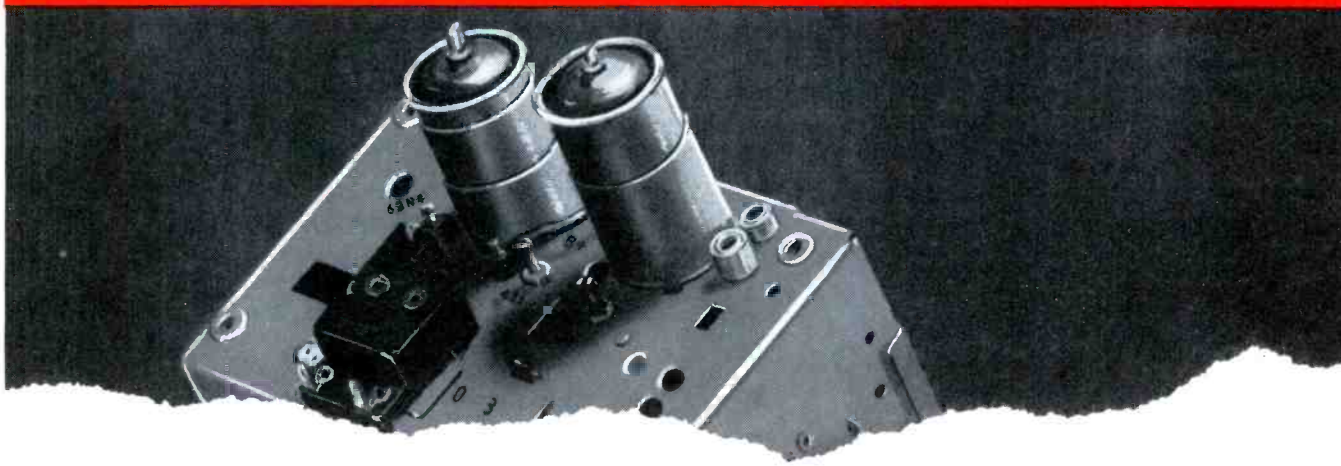

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PF REPORTER

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VOLUME 11, No. 11 NOVEMBER, 1961

CONTENTS

ABOUT THE COVER

The color TV "picture" is taking on a more rosy hue this year. Interest is perking up among manufacturers, dealers, servicemen, and the public. In recognition of this rising enthusiasm, we are devoting this entire issue to a "coverage in depth" of color TV from the serviceman's point of view.

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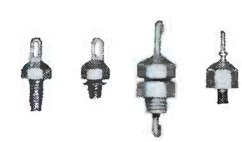

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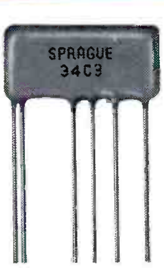

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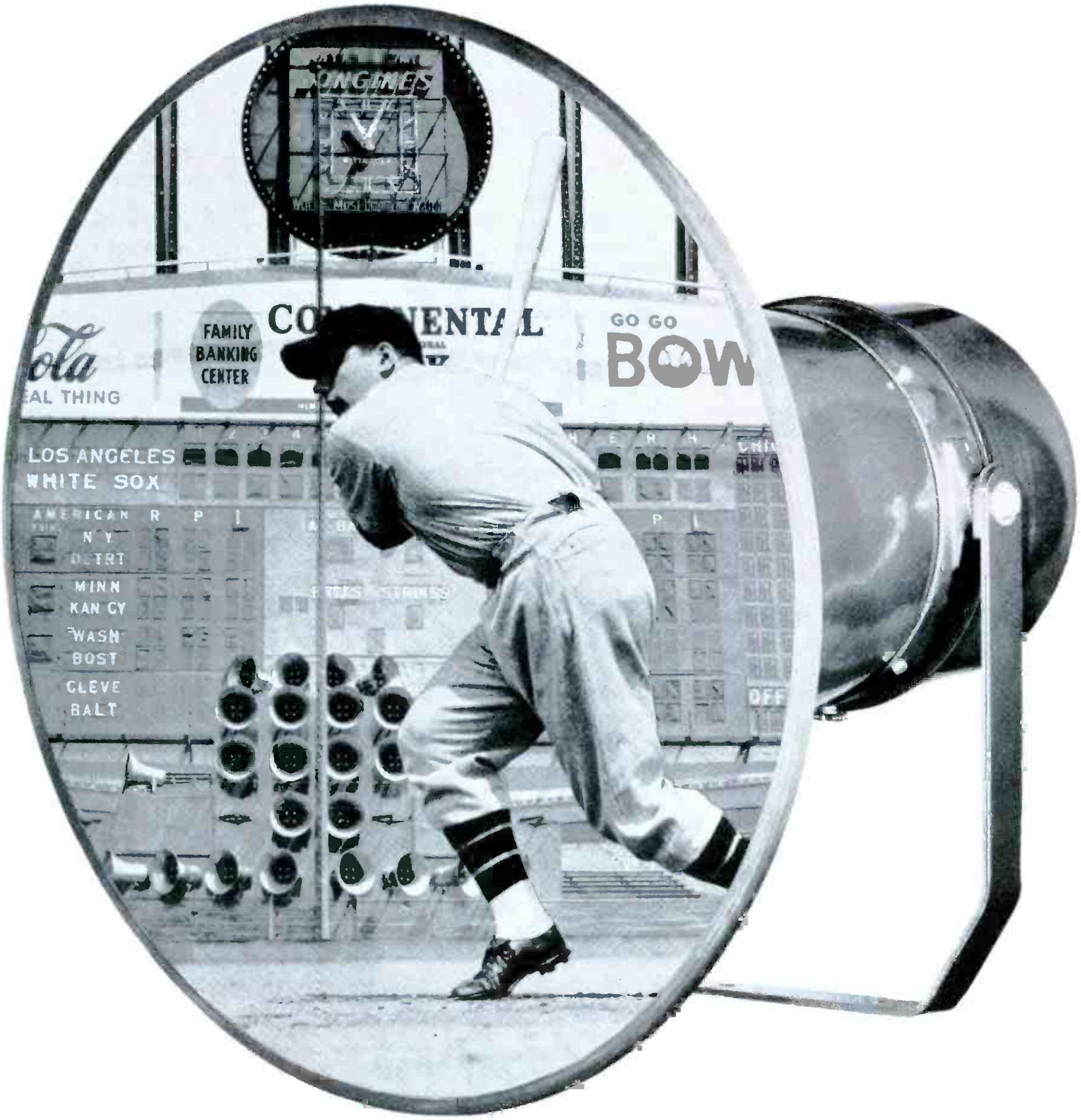
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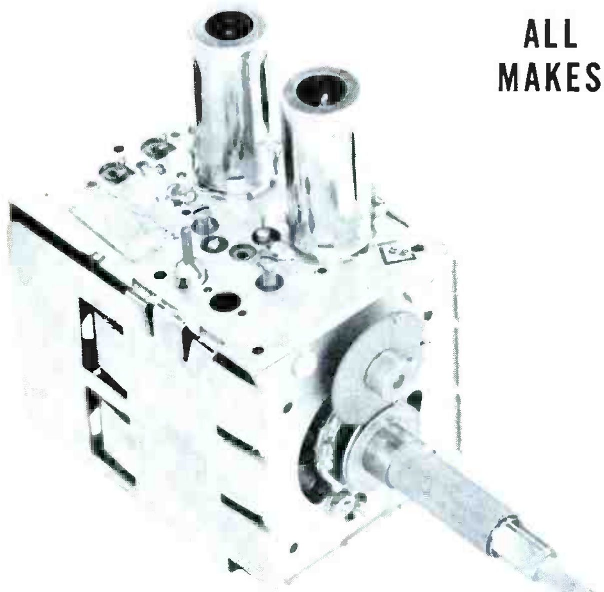

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LETTERS TO THE EDITOR

Dear Editor:

I am a new subscriber to your magazine and find it very enlightening. In your September *Letters* section, there is an item mentioning a recommended tube-stock list for servicemen. Would it be possible to obtain a copy of this list?

THOMAS J. DAME

Cohoes, N.Y.

Bet you thought we went "all out" to answer your request, when you saw "Stock Guide for TV Tubes" in the October issue. Actually, the Stock Guide is a regularly-scheduled feature which appears twice a year, normally in April and October. Although we do our best to keep it down to one page, the latest edition was expanded to keep you informed on more of the newly-introduced tube types.—Ed.

Dear Editor:

I somehow managed to squeeze my name into the appropriate spaces on your subscription order blank. A publishing business should know better than to use such a piddling little coupon for something as important as subscriptions. There isn't nearly enough space for conveniently supplying the information sought. I suspect that the guy who makes up your schematic illustrations also does coupons.

GEORGE KARMAS, Ph.D.

Bound Brook, N. J.

Didn't you know? The coupon is designed to serve as part of a training course. If an applicant can fill out the blanks as directed, he qualifies to service transistor radios!—Ed.

Dear Editor:

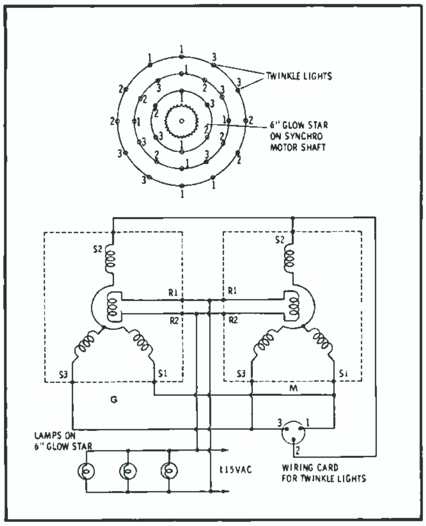
Earlier this year, you asked for ideas from readers on possible uses for a pair of synchros. Here's one for the coming holiday season. The enclosed diagram is of an action-light display I built last year for a Christmas program at our church.

I took a polished aluminum sheet about 2′ in diameter, and drilled 30 holes in three concentric circles for mounting medium-sized "twinkle lights." By drilling the holes to exactly the right size and countersinking them, I was able to use the glass envelope of the lights as insulation from the aluminum. For decoration, I mounted each light through the center of a 3″ glow star, and trimmed the display with Christmas-tree ornaments and bright green tinfoil "leaves."

Connecting the lamps in three groups as shown in the first drawing, I connected them to the three terminals of a wiring card as follows: Group 1 to terminals 1 and 2; group 2 to terminals 2 and 3; group 3 to terminals 1 and 3. Then I connected the card to the stator terminals of the synchro motor as detailed in the second drawing. Mounting the motor in the center of the display, I attached a 6″ glow star to the rotor shaft. I fastened three more lights to the back of this star in a triangular pattern, and connected them in parallel across the rotor leads of the motor.

The synchro generator was remotely located, and its rotor shaft was driven by a motor geared down to produce from 5 to 20 rpm. Here are the various actions which resulted:

The lights on the 6″ star pulsated six times per revolution, as the star rotated



clockwise. The inner circle of lights appeared to turn counterclockwise, the middle circle went clockwise, and the outer circle went counterclockwise. In addition, the whole display appeared to rotate clockwise.

J. E. KINGSTON

Seattle, Wash.

Bet you had heads turning, too.—Ed.

Dear Editor:

Can you give me any information on servicing an electric blanket that doesn't heat up?

A.M. ROWLEY

Jackson, Mich.

The recent Sams book, How to Repair Small Appliances, *gives helpful information on this subject. As for methods of "cooking" the unit to be sure you've made a lasting repair, we suggest you wait for colder weather.—Ed.*

Dear Editor:

I used some of the "Homeowner's Antenna Handbooks" you offered in your February, 1959 issue, and know they sold some antennas for me. I'm wondering if any more copies of this booklet are still available, as my supply is long gone. If you do have some left, please let me know and tell me the price.

LLOYD HOFFART

Lloyd's Radio & TV
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• *Please turn to page 21*

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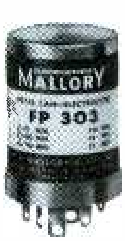

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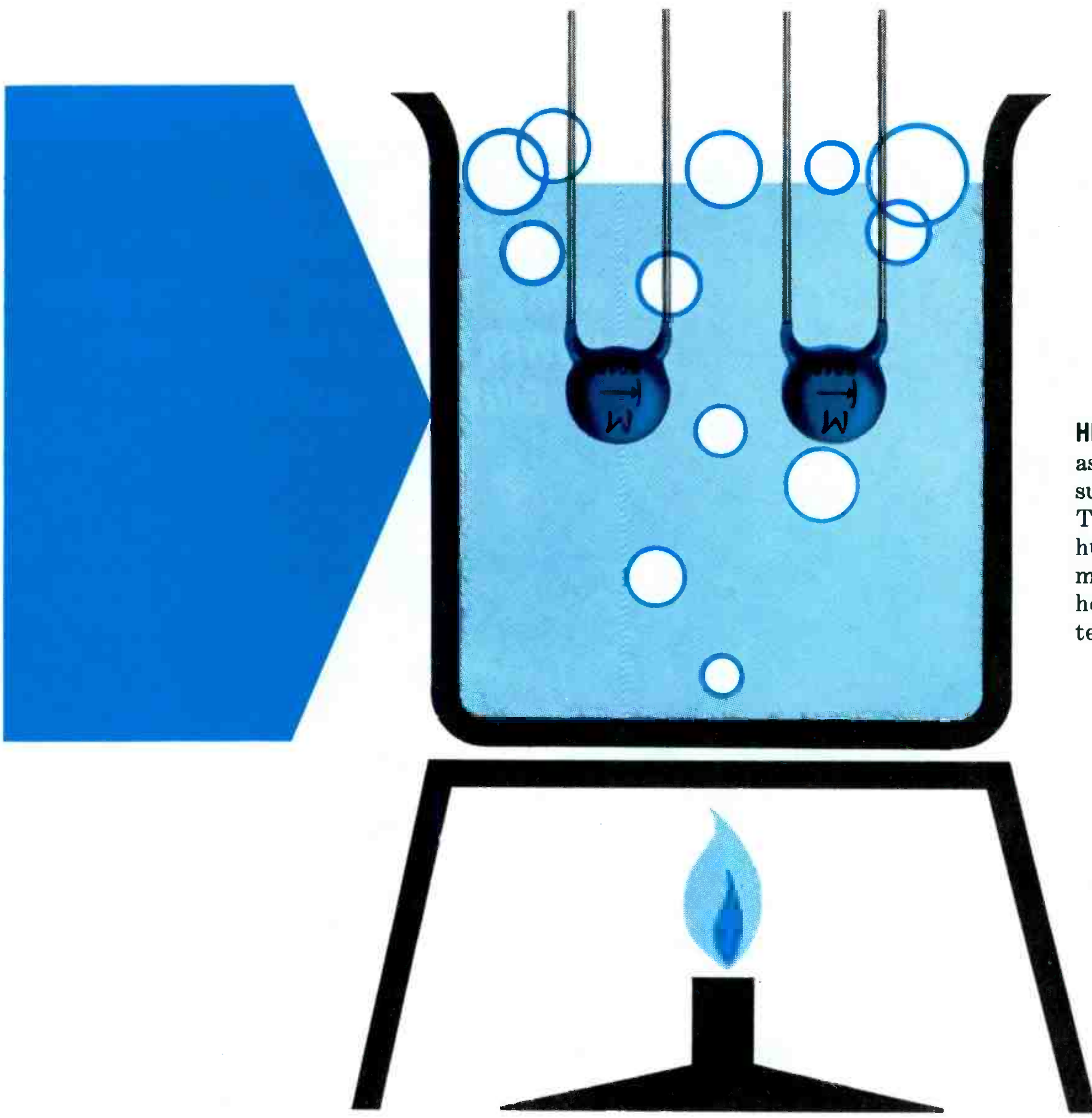

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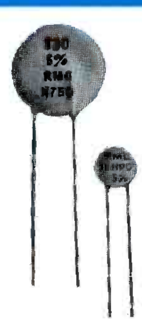

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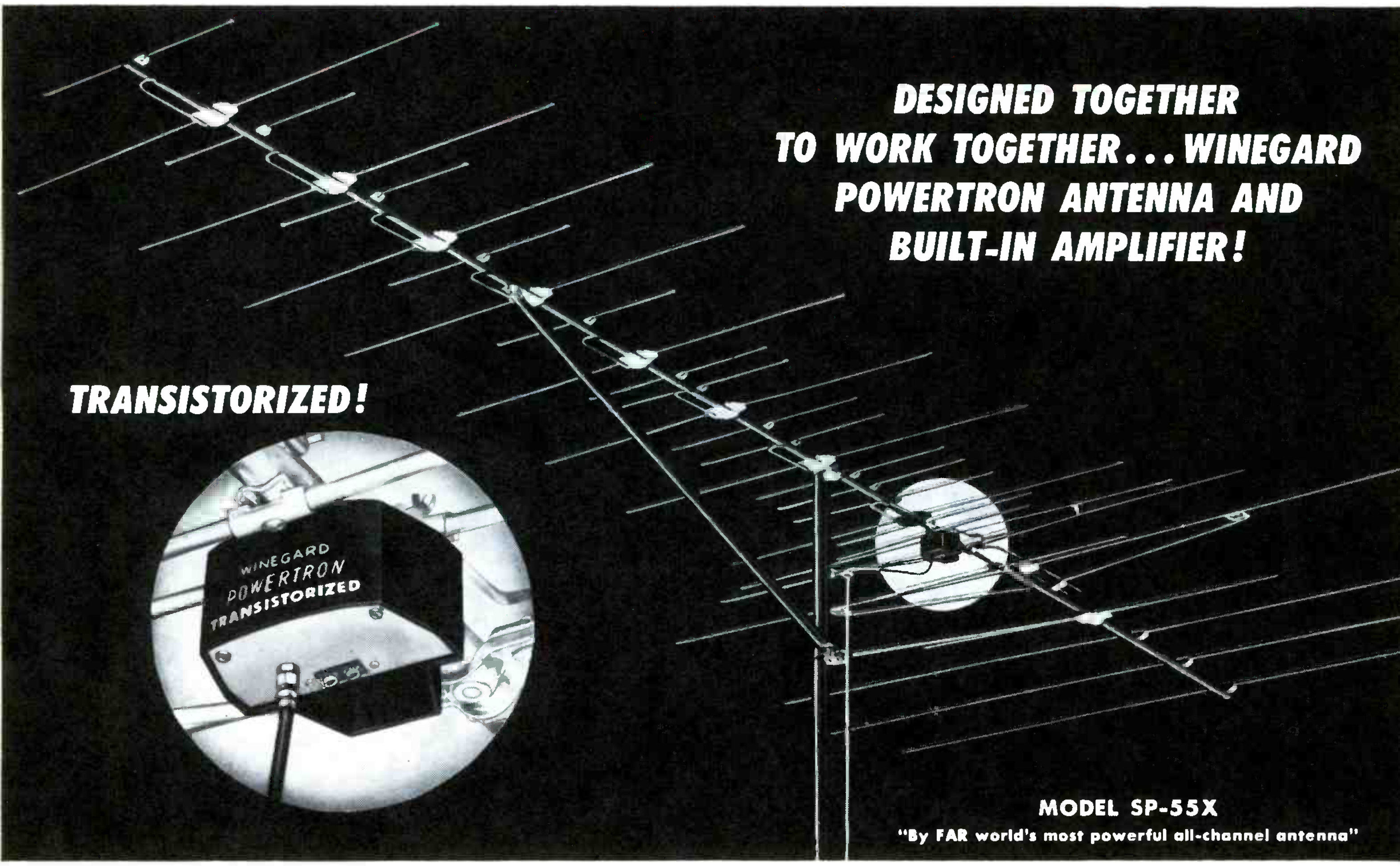

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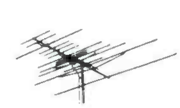

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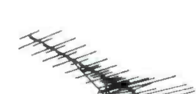

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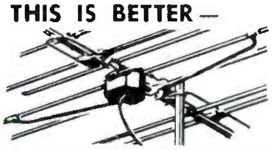

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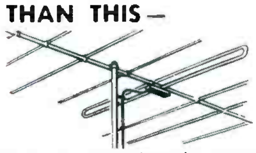

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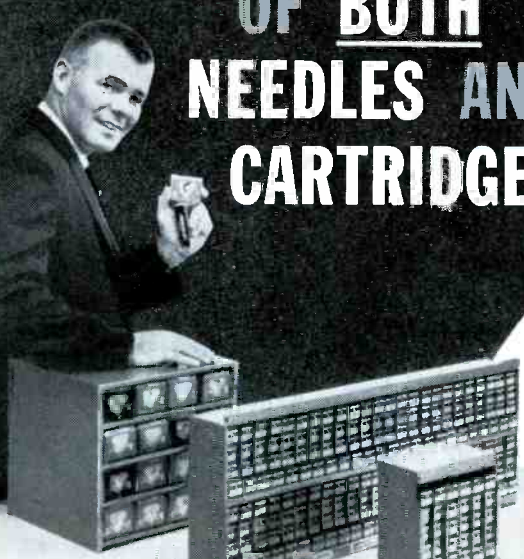

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Letters

(*Continued from page 14*)

We still have a limited number of copies available on a "first come, first served" basis. In quantities of 50 or more, price is 3c each. For orders of 1000 or more, 2c each.—Ed.

Dear Editor:

Although *PF Reporter* is the best service magazine I have ever read, I would like to see it include several more things:

1. A radio-tube stock guide.
2. Short-cuts and time-savers in servicing. (I know several that I have never seen printed in your magazine.)
3. An edition containing all the oscilloscope waveforms covering the entire TV receiver. (You have these in practically every issue, but it is inconvenient to look through all the different issues to find what I want.)

I'd keep such a magazine on my bench for reference, and I'm sure there are others who would do the same.

RALPH SCHROER

Lima, Ohio

Replying in the same 1-2-3 order:

1. Have you seen the "Radio and Hi-Fi Tube Guide" in our July, 1960 issue? It lists all post-World War II types that are important enough to keep in stock, including those for auto radios and hi-fi amplifiers as well as for portable and home radios. We don't publish stock lists as often for radio tubes as for TV tubes since stock requirements change more slowly.

2. Send 'em in! Although we no longer have a regular department for "short-cut" service hints, we can always find room for original and useful ideas.

3. The series of Sams books, 101 Key Troubleshooting Waveforms by Bob Middleton, *is made to order for you. Volumes 1 through 4 cover horizontal AFC-oscillator, horizontal sweep, vertical sweep, and sync circuits in that order. Besides typical waveforms, the books include abundant information on how to connect the scope and interpret the results of tests.—Ed.*

Dear Editor:

Mr. Charlie Bennett (October *Letters*) evidently is not an electron chaser. He must have a full trash bin of junked TV sets.

H. HOGAN

A & H Electronics
Savannah, Ga.

Now is a good time to repeat that opinions expressed by readers in this column are not necessarily those of the staff! We don't challenge Mr. Bennett's electronics "savvy," even though we're glad to have someone sticking up for the "electron-chasing" methods we recommend.—Ed.

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2595	Grid Grounding Box	grounds kinescope control grids . . . each switch and cord color coded for quick connection
2548	Interlock Cheater	protects you from shock hazard . . . permits insertion of a voltage probe
2589	Alignment Tool	two-in-one tool for alignment of concentric controls . . . saves time
2596	Color Viewer	three viewing filters simplify phase and matrix adjustments, let you handle many service calls in-the-home

COLOR TV TUBE MICROSCOPE

Precision pocket-size scope that magnifies dots 25 times for SIMPLE and ACCURATE adjustment of purity magnet, yoke, and rim magnets.

CATALOG NO. 2594
DEALER NET 1950

and FREE! useful Color TV service book included with each kit

Zenith, and other leading color TV set manufacturers, recommend using Walsco Degaussing Coils and Color TV Accessory Tools in equipment servicing. And only Walsco is ready now to outfit you with all the tools you need!

For more information, write for Specification FR3554.

GC ELECTRONICS

WALSCO ELECTRONICS CO.
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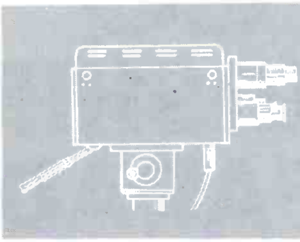

The Electronic Scanner

200 Attend Color Clinic at Harrisburg

A 2½-hour servicemen's clinic on "Problems of Servicing Color TV at a Profit" was recently held in the sales rooms of **D & H Distributing Co.,** Harrisburg, Pa. Jointly sponsored by **D & H** and **Hickok Electrical Instrument Co.,** the clinic was conducted by **Hickok's** Tom Clements and Harry Fallon.

G-E Expands Color-CRT and Receiving-Tube Lines

Three types of tricolor picture tubes—the 21AXP22A, the 21CYP22A, and the 21FBP22—are now available through **General Electric** tube distributors, according to a recent announcement. In addition, Thomas S. Knight, Dealer Products Manager for **G-E's** Electronic Components Division, stated that 55 types of receiving tubes were added to the **G-E** line as of September 1.

Castle Opens Tuner Service in New Jersey

Gunnar B. Hansen, director of **Castle TV Tuner Service, Inc.,** has announced the opening of a modern TV-tuner servicing plant in Cliffside Park, N.J. The new eastern plant offers distributors and servicemen the same specialized service on all types of tuners as **Castle's** Chicago and Toronto facilities.

JFD to Expand Antenna-Manufacturing Facilities

A 25,000-square-foot plant is to be constructed at Oxford, N.C., to house all engineering and production facilities for the lines of exact-replacement portable-TV antennas and other indoor antennas made by **JFD Electronics Corp.** To be known as **JFD-Southern, Inc.,** the new subsidiary is said to be the first in a series of nationwide expansion moves by the parent company. Company officers shown looking over the plans are (left to right) V. P. Harvey Finkel, plant manager Morris Goldberg, president Albert Finkel, V.P. Edward Finkel, and Jerry Berger, manager, contract division.

Toshiba Color Set Scheduled for Spring Introduction

A 28-tube, 14" color TV set has recently been announced by **Tokyo Shibaura Electric Co.** According to reports, the 14" tricolor tube used in the set has three guns and employs a shadow mask. The receiver is expected to be placed on the market next spring, but no price has been announced.

Technicians Encouraged to Capitalize on Color Opportunities

Speaking to graduates of a special three-week color-service training course, H.F. Bersche—Manager, Distributor Products Department, **RCA Electron Tube Division**—urged them to start capitalizing on the current opportunities offered in color TV. The course, held at Harrison, N.J., was sponsored by **RCA** distributor **Krich-New Jersey, Inc.**

Jerrold Buys TACO

Sidney Harman, President of **Jerrold Electronics Corp.,** recently announced the firm's purchase of **Technical Appliance Corp. (TACO)** for $2.7 million. Present **TACO** management personnel will retain their existing duties. This is **Jerrold's** second major expansion in less than a year; the company acquired **Harman-Kardon, Inc.** last February.

New Combination Offer from Perma-Power

A cultured-pearl heart pendant on a gold-filled chain is currently being included in each package of **Perma-Power** "Vu-Brite" TV picture-tube brighteners—either the C-401 (parallel) or C-402 (series) type. This promotion, timed to coincide with both the holiday gift season and the peak of demand for brighteners, will continue until December 15th.

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We are celebrating 31 years of cooperation between Philco and the Independent Service Dealer with even better FREE OFFERS than ever before. Remember . . . Philco offers you these free gifts with your total purchase of Philco Branded Tubes, Parts, and Accessories!

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Imported White Cashmere Sweater with Genuine MINK Shawl Collar

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HALLMARK

With Initial (AD #3935)

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Men's Genuine Jet Black ONYX 10K Solid Gold Ring

A most elegant style that every man would be proud to wear. Plain top or initial in gold.

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32" length, water repellant, quilt lined. Knit collar, cuffs, pocket welts. "Natural" color, 34 to 46.

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TOY SHAGGY DOG

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TOY CASH REGISTER

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ALL OFFERS GOOD UNTIL DECEMBER 15, 1961

FREE OFFERS

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Now . . . Your Total Order of Philco Branded Tubes, Parts, Accessories . . . Is Credited toward the FREE Items You Want!

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Upholstered metal table, contour back upholstered chairs. Two tone, Tan frame, Mocha fabric.

Table Only (AD #3771)
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2 Bridge Chairs (AD #3772)
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Complete 5-Pc. Set with your purchase of $425

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LUGGAGE

Solid, seamless, scuff proof. Weather resistant U.S. Royalite, fiberglass reinforced. Feather-weight, aluminum dustproof closure.

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TRAIN CASE AD #3759	14"	FREE	with $245 order
ROUND HATBOX AD #3763	16"	FREE	with $225 order
OVERNIGHT CASE AD #3760	21"	FREE	with $245 order
WARDROBE AD #3764	24"	FREE	with $375 order
PULLMAN AD #3761	26"	FREE	with $375 order

Million Miler Air Exec ATTACHE CASE

18" x 14" x 5". Removable file, removable desk.

FREE

with purchase of $245

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Las Vegas Executive Game Chest

10½" Roulette Wheel, Bowling Dice Game, Dice, Dominoes, Chess, Checkers, Chips, Cards, Horse Race Game, Chess Board, directions and carrying case.

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Tom Thumb TOY BANK VAULT

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with your purchase of $200

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CHROMA BANDPASS & DEMODULATOR CIRCUITS

This coverage will familiarize you with typical circuits and the troubles which most often develop . . . by Warren J. Smith

A considerable percentage of color-service bench jobs are concerned with chroma bandpass amplifiers and demodulators. These circuits, despite their apparent simplicity, can harbor a surprising variety of troubles. Familiarity with the differences in chroma-circuit arrangements is of prime importance to the service technician, because conflicting symptoms may be observed when similar failures occur in different color sets.

Bandpass-Amplifier Circuits

The bandpass amplifier is actually nothing more than a narrow-band video amplifier tuned to pass the sidebands of the 3.58-mc color subcarrier. Fig. 1 is a schematic of a typical one-stage bandpass circuit of recent vintage, also showing how the chroma and luminance signals are taken from the first video amplifier. In the chroma channel, note that the composite video signal is coupled through small capacitor C102 (which attenuates the lower video frequencies) to chroma takeoff coil L22. The latter is tuned to accentuate a band of frequencies between approximately 3 and 4 mc, including the color signals to be amplified. The 3.58-mc color-burst signal, also developed across L22, is fed through C103 to the burst amplifier for use in color synchronization. The burst signal must be kept out of the bandpass amplifier, to prevent the possibility of its causing yellowish interference in the color picture. For this purpose, the chroma bandpass amplifier is cut off during horizontal retrace time by positive pulses applied to the cathode from the horizontal blanking amplifier.

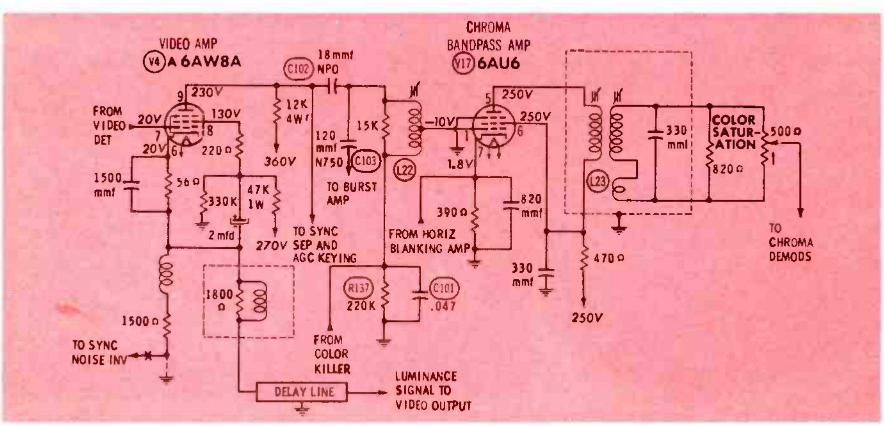

Fig. 1. Typical one-stage chroma bandpass amplifier from recent-model set.

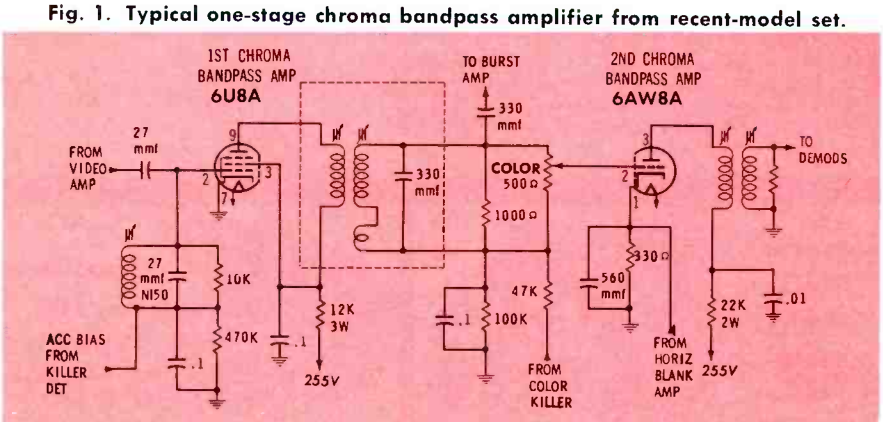

Fig. 2. Two-stage bandpass amplifier with automatic chroma control.

During black - and - white reception, the color-killer stage develops a negative bias voltage across R137 and C101, which is applied to the grid circuit of the bandpass amplifier to hold this stage in cutoff.

The amplified chroma signal is coupled to the demodulators through transformer L23, which contributes to shaping the over-all bandpass response. The demodulators are driven through a color-saturation control which permits adjustment of the chroma-signal amplitude. A low-impedance control circuit is employed to minimize the attenuating and phase-shifting effects of shunt capacitance at the relatively high frequencies being used.

Two-Stage Circuit

Some color sets, both current and older models, use two bandpass-amplifier stages. The extra gain pro-

• Please turn to page 82

isolating chroma troubles by symptoms

A logical analysis will tell you where to start looking for the defect . . . by Joe A. Groves

Pale, washed-out color, loss of color sync, wrong hues, complete absence of color — all these symptoms fall into the category of chroma trouble. In order to localize the causes of these symptoms in the shortest possible time, it is imperative that you develop a logical troubleshooting procedure.

The first thing to do is find the general trouble area. Since misadjusted controls, trouble in the AGC, RF, IF, or video circuits, and even antenna-system defects, can produce color-trouble symptoms, such possibilities should be checked prior to bench testing. Also, in this discussion, we are assuming all tubes have been tested. For further information on this subject, see "Color Servicing in the Home" in this issue.

On the bench, trouble can be conclusively isolated to the chroma circuits (Fig. 1) by injecting a video signal from a color-bar generator to the video amplifier circuit. If the set fails to produce a normal color display, you can be sure there is trouble in the chroma section.

Once you have determined that something is wrong in the chroma circuits, the next step is to isolate the trouble to a certain stage or group of stages. After this is accomplished, simple voltage and resistance measurements will help you pinpoint the defect. Chroma troubles are most easily isolated by thinking in terms of circuit blocks as shown in Fig. 1. Stirring up a mental image of such a block diagram may serve your needs adequately in using this time-tested approach; on the other hand, you may prefer to rely on a drawing. In either case, the blocks will help you decide where to make the most meaningful checks to compare with known-good test results.

In Fig. 1, notice that the various signal paths are shown by means of different types of lines. The thin solid lines show the luminance and blanking signal paths that are also common to black-and-white reception; the medium solid lines show the paths of the detected chroma (color) signals; the dashed lines point out the reference-oscillator and synchronizing-circuit paths; and the heavy solid lines show the circuits that receive the composite chroma signal. Once you become thoroughly familiar with the various circuit paths, you'll have reached an important milestone in servicing chroma troubles. You'll also have a clearer understanding of the logic behind Chart I, which lists the test points normally used in troubleshooting the chroma section.

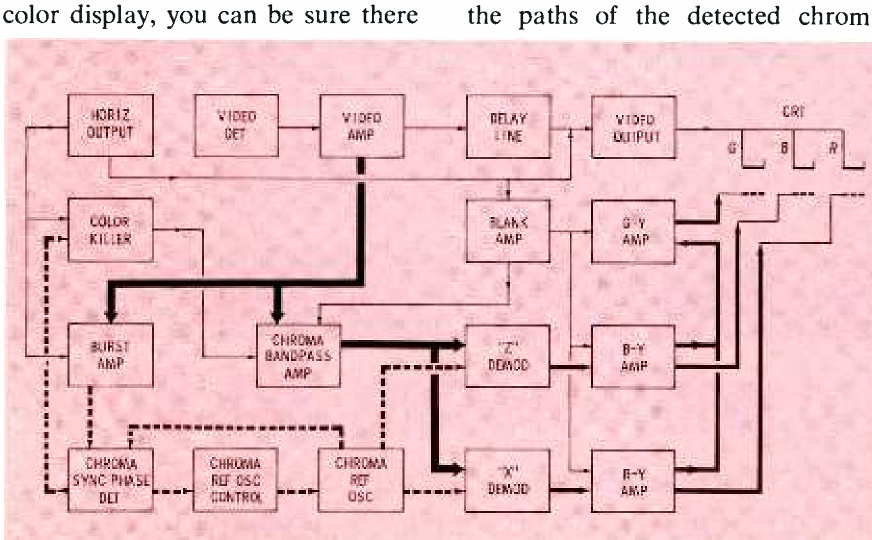

Fig. 1. Learn the signal paths shown on this block diagram to help isolate trouble.

What Waveforms to Expect

Knowing normal signal paths will prove to be of little value unless you know what kind of signals you're dealing with. This is why an oscilloscope is so vitally important for troubleshooting. Naturally, unless you are servicing several color sets each day, you won't be able to remember all of the humps and hollows of the complex waveforms you'll find in the color stages following demodulation; but when you check the waveforms anywhere up to and including the demodulator inputs, you should quickly be able to tell whether or not you are receiving the proper signal.

Some of the standard troubleshooting waveforms are shown in Fig. 2. The pattern of Fig. 2A is typical of what you should find at the grid of the burst amplifier. Referring to Fig. 1, you'll note there are two signals fed to this stage. The high-amplitude keying pulse from the horizontal section is easily recognized in Fig. 2A; however, without knowing that the ripple along the base of the waveform is the chroma signal, you could easily

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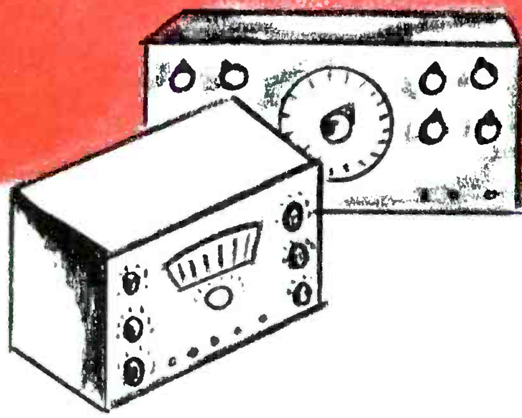
Chart I—Step by Step Procedure for Pinpointing Trouble After Isolating to Chroma Section

SYMPTOM	TEST SETUP	TEST POINT	ANALYSIS	EVALUATION
No color	Inject video signal from color-bar generator to output of video detector; use oscilloscope and VTVM as indicated.	1. Bandpass amp. grid	Check for presence of proper chroma waveform.	If absent, check chroma path from video amplifier. If present, proceed to next step.
		2. Bandpass amp. stage	Check for proper voltages at all tube elements.	If plate, screen, or cathode voltages are extremely low, make resistance measurements. If grid bias is excessive, proceed to next step.
		3. Color killer stage	Check for presence of proper plate waveform; measure voltages at all tube elements.	If waveform is absent, check coupling circuit from flyback. If voltages are abnormal, make individual component tests in appropriate circuit.
		4. Demodulator inputs	Check for presence of chroma input signal.	If absent, check circuit from the bandpass amplifier. If present, proceed to next step.
		5. Demodulator inputs	Check for reference oscillator input signal.	If absent, check voltages in reference oscillator and control circuit; check individual components in appropriate circuit.
Washed-out color	Same as above.	Same as above	Same as above.	Trouble caused by reduced signal amplitude. Check peak-to-peak amplitude of above waveforms, measure voltages at tube elements, and check individual components in appropriate circuit.
One primary color absent or predominant	Same as above.	1. Picture tube base	Make gray-scale adjustments; check the CRT; measure grid, cathode, and G2 voltages.	If any test is unsatisfactory, make additional checks in appropriate circuit. If all tests produce normal indications, proceed to next step.
		2. Affected color amplifier circuit	Check for proper voltages at all tube elements.	If voltage is abnormal, make resistance measurements and check individual components in appropriate circuit. If voltages are normal, proceed to next step.
		3. Demodulator feeding affected color circuit	Check for proper voltages at all tube elements.	If voltage is abnormal, make resistance measurements and check individual components in appropriate circuit. If voltages are normal, proceed to next step.
		4. Demodulator feeding affected color circuit	Check for presence of chroma and reference oscillator signals.	Make individual component tests in coupling circuit that fails to provide a signal.
All colors present, but all hues incorrect	Same as above.	1. Reference oscillator control stage	Check for proper voltages at each tube element.	If voltage is abnormal, check individual components in affected circuit. If normal, proceed to next step.
		2. Demodulator outputs	Make chroma sync phase adjustments; check shape and amplitude of output waveforms.	If any coil fails to respond to adjustment, check components in associated circuit. If no indication, proceed to next step.
		3. Chroma sync phase detector stage	Check shape and amplitude of waveforms; check for proper voltages at each tube element.	If reference signal is weak, check coupling circuit. If burst signal is absent or distorted, proceed to next step.
		4. Burst amplifier stage	Check for presence of proper grid waveform; check voltages at each tube element.	Check for presence of both chroma and keying signals. If either is absent, check associated circuit. If voltage is abnormal, check resistance and individual components.
Poor color sync	Same as above.	1. Reference oscillator section	Make chroma sync phase (AFPC) adjustments.	If unsatisfactory results, proceed to next step.
		2. Phase detector stage	Remove tube; adjust reference oscillator and control circuits.	If color can't be locked in, make voltage measurements and component tests in reference oscillator and control circuits. If lines stop, reinstall tube and proceed to next step.
		3. Phase detector stage	Check shape and amplitude of waveforms; check for proper voltages at each tube element.	If no reference oscillator signal, check coupling circuit. If burst signal shows signs of chroma, or it is absent, proceed to next step.
		4. Burst amplifier stage	Check shape and amplitude of grid waveform; check for proper voltages at each tube element.	If keying or chroma signal is absent, check appropriate coupling circuit. If voltage is abnormal, check individual components.

Answers to basic questions such as, "What do I need?" and "Where and how do I use it?" by Les Deane



test equipment for Color TV

Fifteen years ago, the average TV serviceman had never heard of a flyback and yoke checker, a CRT rejuvenator, or a test-pattern generator. In this pre-TV era, his most advanced signal tracers and generators had outputs only up through the FM band, and he seldom had occasion to measure anything over a couple of hundred volts —let alone 20 kv.

When television took the country by storm, radio technicians braced themselves for this new servicing opportunity. Many attended TV schools or service clinics; others relied on correspondence courses or textbooks for a TV education. After acquiring the necessary theoretical knowledge, they took to the field for practical experience. At this point, their utmost concern was the type of test equipment they would need to do the job.

Today, many servicemen are finding themselves in the same situation on color TV. They have most of the test instruments needed for use on black-and-white receivers, but are not sure if these are suitable for color, or if additional instruments are necessary. To help settle these questions, let's take a long look at the special requirements of color-receiver servicing.

Most of the components used in color circuitry are pretty familiar—capacitors, resistors, transformers, coils, tubes, etc. Therefore, checking individual components seldom presents any special problem. A conventional ohmmeter, capacitor tester, substitution unit, or tube tester is just as valuable in troubleshooting color circuits as in servicing any other electronic apparatus.

On the other hand, test instruments available for signal-tracing and alignment (sweep and marker generators, other signal generators, and oscilloscopes) do not always meet the special requirements of color TV servicing. Fortunately, many general-purpose TV-troubleshooting instruments produced during the past several years have been designed with color servicing in mind; however, it is important to check the specifications of individual units to make sure they have all the features needed for analyzing color sets.

The line-up of color test equipment is not complete without a couple of special-purpose instruments—the color-bar generator and pattern generator. These units are absolutely necessary for correctly performing some phases of color TV setup and alignment; they are also extremely helpful for troubleshooting.

Instruments Available for Servicing Color Sets

COLOR-BAR GENERATORS	PATTERN GENERATORS	CRT TESTERS	INSTRUMENT MFR.	WIDE-BAND SCOPES	SWEEP GEN. (VIDEO RANGE)	MARKER GEN. (VIDEO RANGE)
		T-471	ANCHOR			
		440	B & K			
		36-516	GC ELECTRONICS			
			EICO	460	368 360	324 322
656 660	656 660	CR 33	HICKOK	675 770	288X 615	288X 615
			JACKSON	CRO-2 600	TVG-2	
		800	MERCURY			
			PACO	S-55	G-32	G-30
E-440	E-420		PRECISION APP.	ES-150 ES-550	E-400	E-200C E-75
WR-61B WR-64A	WR-46A WR-64A		RCA	WO-91A		WR-49B
430	434		SIMPSON	458		
			TRIPLETT	3441-A	3434-A	
			WATERMAN	S-16-A		
250			WINSTON			

Getting Down to Business

Now that we've considered what *kinds* of instruments are needed by the color TV specialist, let's turn our attention to the problem of choosing particular pieces of equipment. The following sections describe the major categories of instruments, one by one. Necessary or desirable specifications and fea-

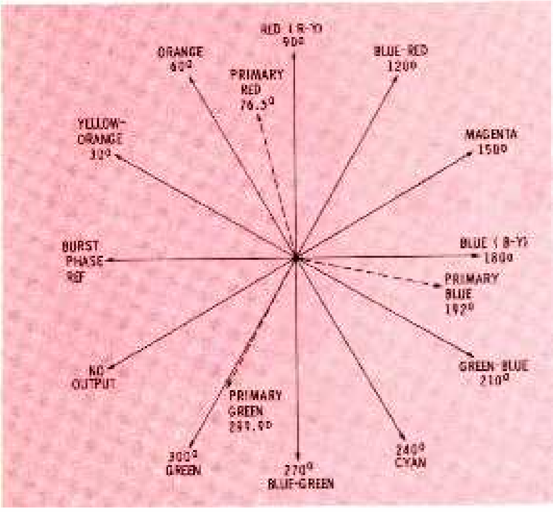


Fig. 1. Vector diagram shows relationship of various hues to burst reference.

tures are spelled out, and the principal uses of each unit in color servicing are outlined. Also, the chart accompanying this article identifies the major manufacturers who currently produce each type of test instrument employed in color work.

In addition to the major instruments that are a "must" for color troubleshooting and alignment work, numerous accessory items are available to speed and simplify color TV repairs. Many of these are illustrated just to the right of this column.

Color-Bar Generators

Although basic troubleshooting can be accomplished by using a color program from a local station as a signal source, a color-bar generator is more satisfactory for two reasons: It is always available, and it is much more reliable as a known standard for test signals and screen displays.

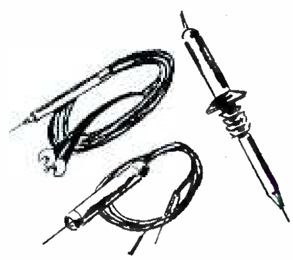
Three general types of bar generators are on the market. The first two, both called *rainbow generators,* supply an unmodulated 3.58-mc output that simulates a chroma signal. The third type of instrument, more elaborate than the other two, generates a complete NTSC color-bar test pattern, containing both luminance and amplitude-modulated chroma signals.

The simpler type of rainbow generator produces a continuous output that constantly varies in phase with respect to the reference-oscillator signal in the receiver. The result is a multicolored pattern on the picture tube—not a group of distinct

• *Please turn to page 66*

Test adapters for three-gun color tubes are available for universal applications or for use with specific tube testers.

Bench servicing of color chassis is much easier if you have a set of extension cables —for the CRT, yoke, convergence assembly, and high voltage.

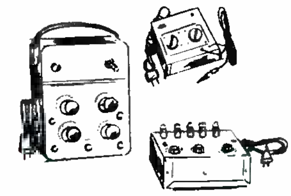


Probes are a "must" for accurate test indications. In color servicing, you'll need RF and high-voltage units for your meters, plus both low-capacitance and detector probes for your scope.

A degaussing coil is almost indispensable for obtaining good color purity. This large coil assembly eliminates stray magnetic fields in and around the CRT.

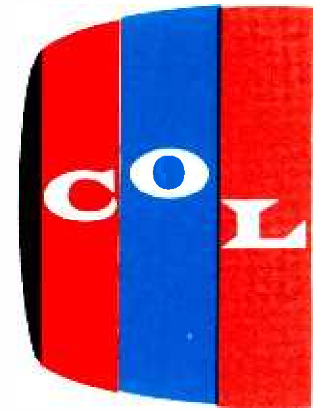
This little item is handy for checking convergence and purity in a color receiver. When series-connected between the CRT base and chassis, it permits each color gun to be turned off or on.

Multiple bias supplies are currently available from several manufacturers. These small instruments are called for during color TV alignment.



Since color TV owners want to prolong the life of the expensive three-gun picture tube as much as possible, a color CRT brightener is a good item to have on hand.

ACROSS THE BENCH
by Stan Prentiss

A bout with a 

Since color TV owners have a pretty good piece of hard-earned change tied up in their receivers, I usually try and make most of our color service calls myself. This particular afternoon was no exception, especially since the customer had complained of intermittent and then complete loss of color.

Arriving on the scene, I found the RCA Chassis CTC7A with an excellent black-and-white picture, but tuning it for a station-generated color stripe produced not one flicker of color at any setting of the fine-tuning, tint, and color controls. Fortunately, this owner was not one to monkey with the AGC, background, screen, and killer threshold controls, even if he knew where they were. Therefore, I did not take the trouble to check these controls, but proceeded to set up my color-bar generator (a crystal-controlled, keyed-rainbow type). Disconnecting the antenna leads and hooking up the generator, I tuned the receiver and generator to channel 3. The only pattern that came into view was a series of 10 faint, *colorless* bars. Thus, whatever the trouble was, at least I knew the antenna wasn't damaged or turned the wrong way.

Thinking that an RF-IF trouble (such as interelement leakage or low emission in a tube) might be killing the chroma signal, I decided to make one more signal-injection test. I removed the first video amplifier tube, plugged a tube mount in its place (Fig. 1), and fed a color video signal from the bar generator into the grid terminal. The result was identical to the first test—10 washed-out stripes without a trace of color. This at once eliminated the tuner and IF's as probable troublemakers, thus allowing me to concentrate on the two video (luminance) amplifiers and the various tubes in the chroma circuitry. Warming up my transconductance tube tester, I began to check all tubes in the color section, both video amplifiers, and the picture tube. Disconcertingly, most were quite good, although I did get an extra flicker or two on the short test from the 6U8A chroma reference oscillator. However, applying additional filament voltage failed to confirm any leakage. I thoughtfully replaced the tube in its socket, knowing that a substitute (unless carefully selected) would require a complete touch-up of the chroma sync and phase adjustments in the circuit of Fig. 2—reactance-tube plate coil L29, oscillator plate transformer L30, trimmer C111, and burst phase transformer L28.

Shifting my tactics, I took advantage of the tube mount still in the video amplifier socket, and checked the DC voltages at the screen and plate terminals with my 20,000-ohms-per-volt VOM. This test confirmed that B+ was what it should be.

To the Shop!

I explained to the customer that all tubes and main operating voltages were apparently good, but that there was a component breakdown somewhere in the video amplifier

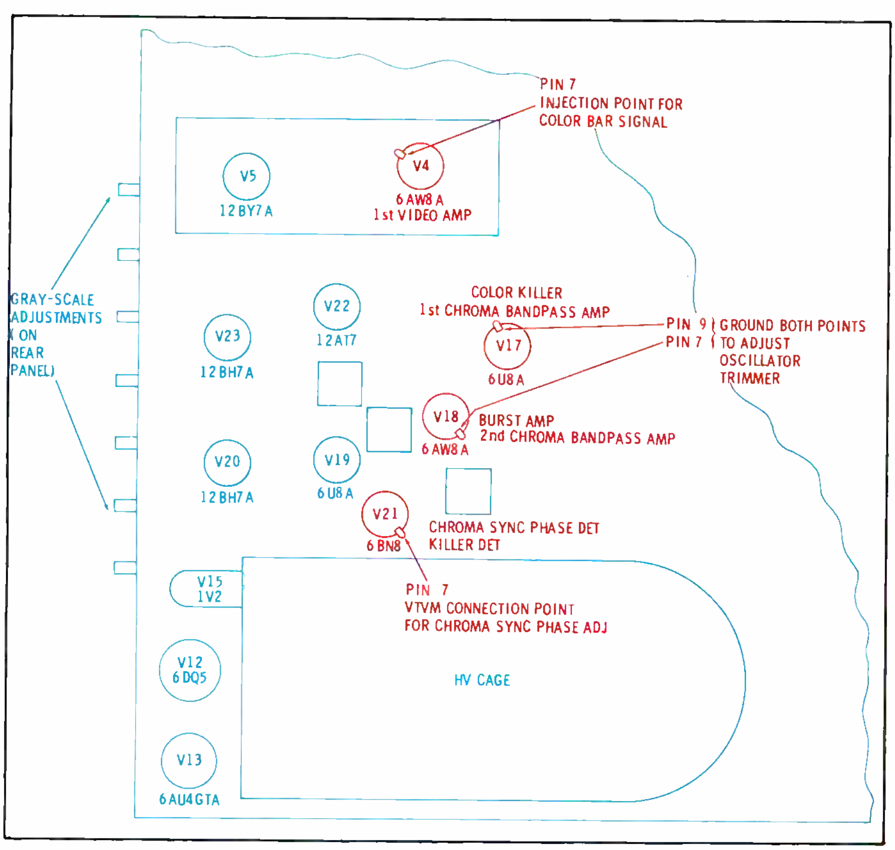


Fig. 1. Color test points provided by tube-socket adapters in RCA CTC7A.

OR Set

or color section. "I'm sorry," I said, "but to do this job right, I'll have to take the receiver into the shop." Since I hadn't yet stocked a spare color-CRT setup that would allow me to bring in the chassis separately, I added, "I'll send two of my boys around in the truck and have them pick it up."

About 10 the following morning, the color receiver arrived, cabinet and all. I promptly pulled the chassis, put a couple of drop cloths on top of the cabinet, and hooked up the chassis to the CRT assembly. By slightly repositioning and re-soldering the deflection-yoke leads, I was able to make all connections without disturbing the position of yoke—thereby avoiding a need for complete reconvergence after the job was done. I was also careful to make a good solid contact between the high-voltage supply and the CRT high-voltage anode, in order to prevent corona and arcing.

Signal-Tracing

Setting up the color-bar generator and wide-band scope, I again fed a keyed rainbow signal to the grid of video amplifier V4A, and inspected the results at the grid of first chroma - bandpass amplifier V17. This waveform (Fig. 3) plainly showed that 10 pulses of 3.58-mc signal, corresponding to the row of color bars, were being fed to the bandpass amplifier from the plate of V4. An 11th pulse, the color burst, was also present, although hidden by the vertical-axis scale markings in Fig. 3. The signal was a healthy 4 volts peak to peak.

The output of the second bandpass amplifier had a 12-volt amplitude, with the same waveshape as shown in Fig. 3. Nothing wrong here, either—so I traced the path of the burst signal back from the first bandpass transformer L25 (Fig. 2) to the burst amplifier V18A, and measured the amplified burst pip at the plate of this tube. It also looked good, as illustrated in Fig. 4—170 to 200 volts peak to peak, depending on control adjustments. So I went on to the plate of the chroma reference-oscillator control tube V19A. The signal here (Fig. 5) looked like a perfectly symmetrical oscillator waveform, but its amplitude was only 3 volts peak to peak. Now I appeared to be getting somewhere, for I knew that the control tube normally *shouldn't* have the same output-signal waveshape as the oscillator. Over at the plate of V19B, the oscillator section

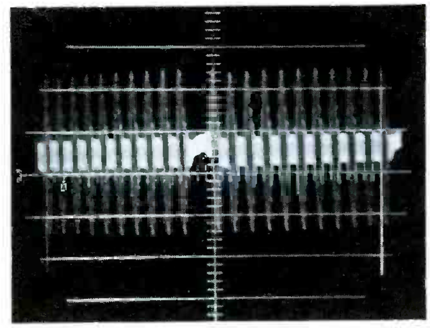


Fig. 3. Keyed rainbow signal as seen at grid of first bandpass amplifier.

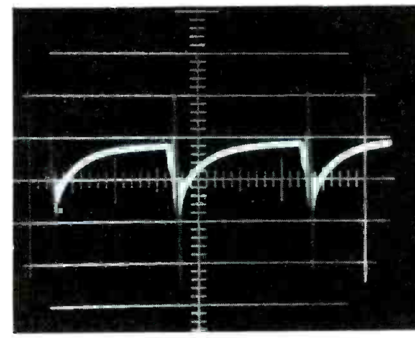


Fig. 4. Normal color-burst signal produces spikes at burst-amplifer plate.

of the tube, I could see that I was hot on the trail of the trouble. Whatever you might call the waveform at this point (Fig. 6), it wasn't a clean 3.58-mc oscillator signal. Furthermore, it was only 15 instead of 60 volts peak to peak. My DC scope also showed something else wrong at the plate. The waveform should have bounced up toward the top of the screen to indicate 275 volts DC, but it actually came to rest at a DC level of only 5 volts.

Repairs Were Easy

My guess was that something had

• *Please turn to page 97*

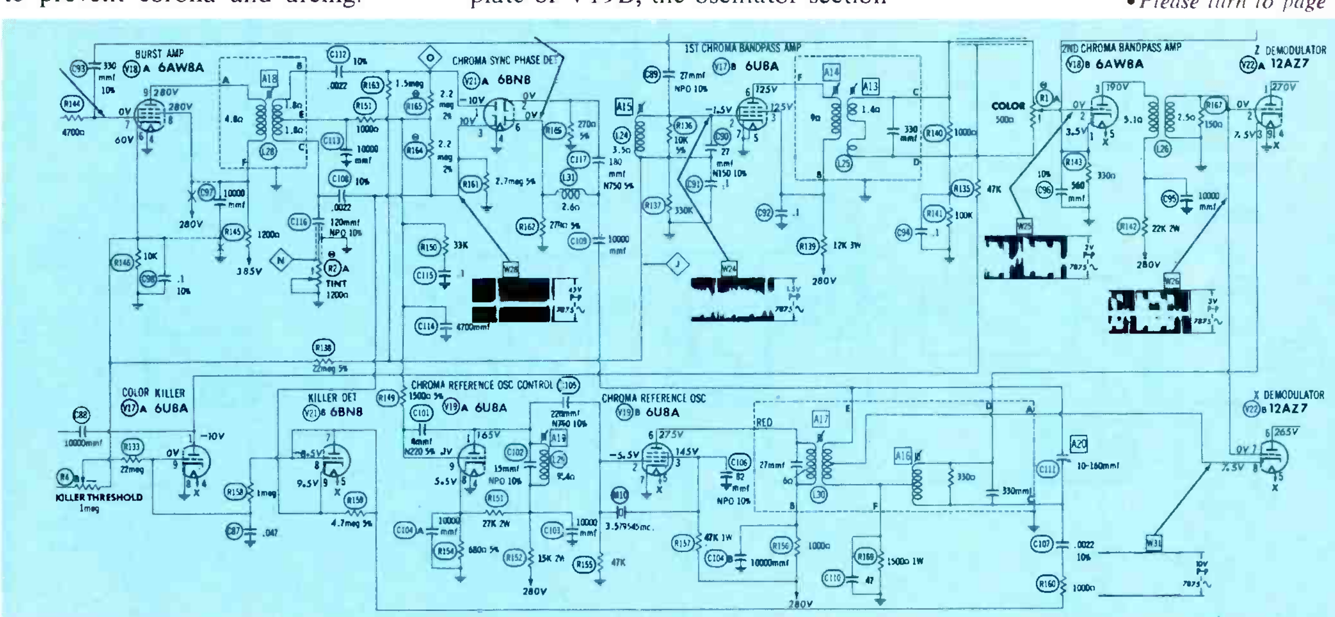


Fig. 2. Five different adjustments affect the chroma-phase alignment of the RCA Chassis CTC7A.

What's new in COLOR TV

Circuit features and service adjustments you'll find in sets introduced this year.

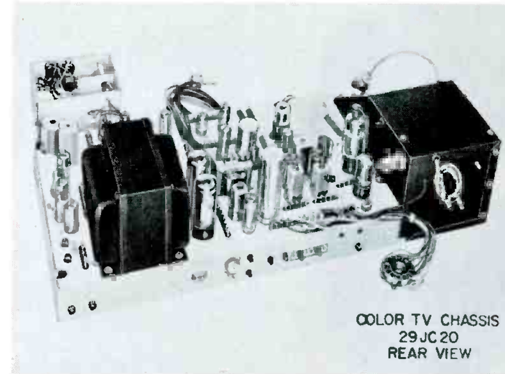


Fig. 1. Zenith Chassis 29JC20 is a horizontally-mounted, hand-wired unit.

The most significant trend in color TV this year can be summarized in two words — growing interest. Of all the major TV producers, only Motorola and Westinghouse have chosen to hold back from introducing color sets in their '62 lines. Consumers, dealers, and servicemen also show an increased awareness of color TV, so all signs point to a bright future for this product in the year ahead. The gross "take" for color TV — manufacturing, sales, service, and broadcasting —is predicted to exceed the $200 million mark in 1962.

'62 Sets in General

What are the new sets like? For

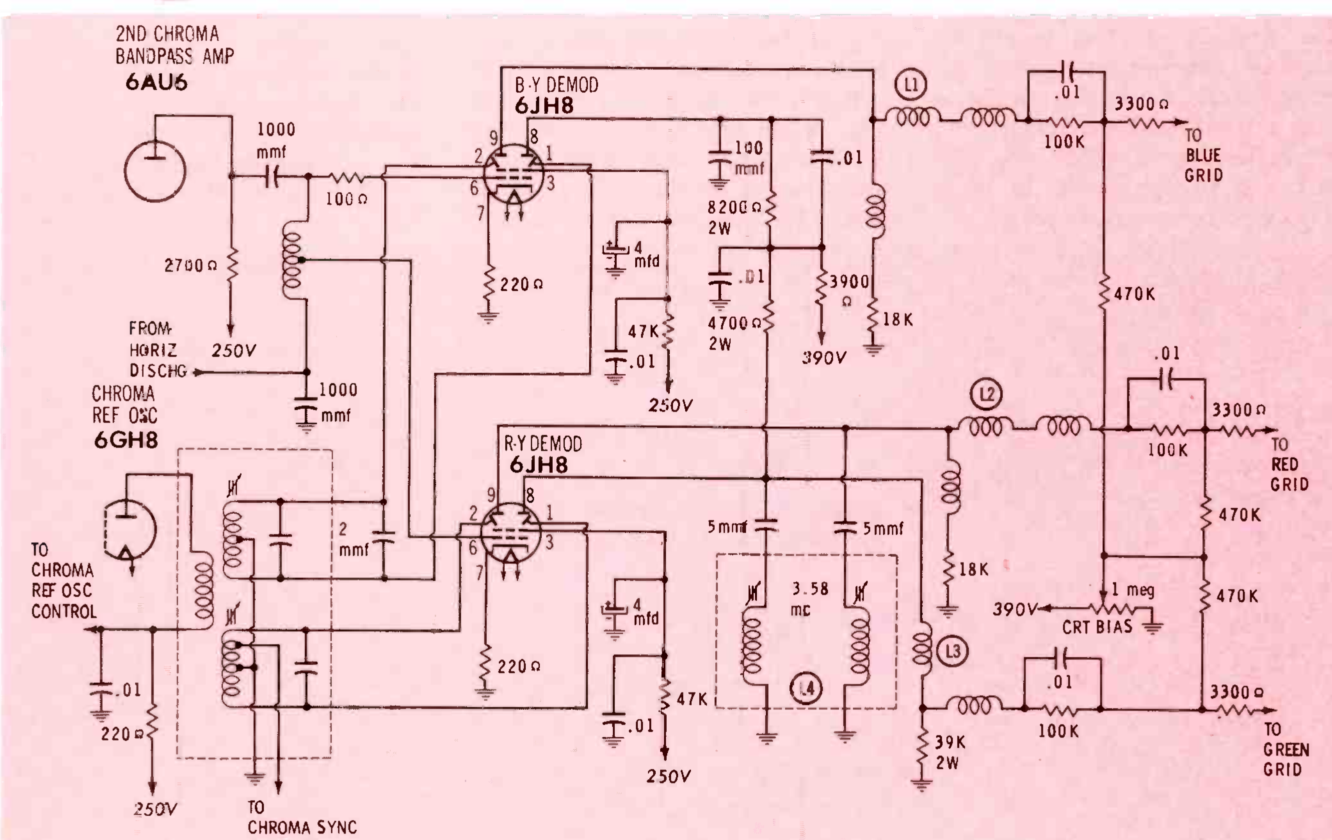


Fig. 2. Demodulator circuit in Zenith receiver uses 6HJ8 sheet-beam tubes.

the most part, they reflect a gradual evolution along the same lines evident in previous models. Although there are marked variations in design among different circuits, no totally new concepts have been introduced. Even the greatest departure from conventional circuitry — a Zenith chroma demodulator built around a sheet-beam tube — is based on a circuit which was used back in the dawn of color TV as an I and Q demodulator.

Nearly all sets are equipped with a newly-developed 21FBP22 or 21FJP22 (bonded) tricolor CRT featuring improved phosphors. However, some lines have retained the 21CYP22A that was popular in '61.

Receiving-tube complements range from 26 to 29 per chassis. Tuners in several models use a 6CW4 *nuvistor* RF amplifier. Aside from this, the only really unusual tubes are found in Zenith sets — a pair of 6JH8 demodulators and a pair of 3DG4 low-voltage rectifiers. Other tube types used in the chroma section of recent-model sets (including the '62 lines) are listed in "Color Servicing in the Home," elsewhere in this issue.

Many lines offer preset fine tuning, and also (in some models) wireless remote control. This year's remote units provide only on-off, volume, and channel-selector functions; the special eight-way control system found in some earlier color receivers is no longer available. Packard-Bell color sets have provisions for quick, plug-in field installation of a *Roto-Remote* wireless control system of the same type used with black-and-white '62 models.

All chassis are transformer-powered. In almost every case, the chassis contains several printed-wiring boards and is mounted vertically on one side of the cabinet. The lone exception—Zenith's Chassis 29JC20 (Fig. 1)—is hand-wired and horizontally-mounted. The underside is covered by a metal plate that can be removed for servicing when the cabinet is laid on its side.

Demodulator Circuits

As mentioned earlier, the new Zenith chassis employs a demodulator circuit that differs drastically from the triode-type X and Z demodulators found in all other new sets. Shown in Fig. 2, the circuit uses two 6JH8 sheet-beam tubes to produce R–Y and B–Y signals which are strong enough to be fed directly to the red and blue grids of the CRT. Each tube has only one cathode, but two plates. The cathode current is alternately switched from one plate to the other on alternate half-cycles of the chroma reference signal. As a result, positive R – Y and B – Y signals are produced at the pin-9 plates of the respective demodulators, while negative R – Y and B – Y signals appear at the pin-8 plates. The latter signals are then combined to form the G–Y signal which is fed to the green grid of the CRT. Coils L1, L2, and L3 are incorporated to filter 3.58-mc information from the demodulator output. In addition, tunable traps in L4 provide further attenuation of the unwanted 3.58-mc signal. As in the more conventional X and Z demodulator system, final matrixing of color-difference and luminance signals is accomplished within the CRT.

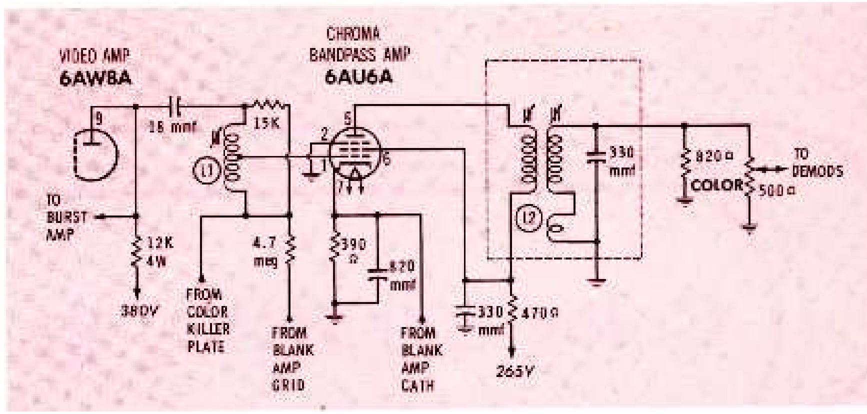


Fig. 3. Typical circuit of single-stage bandpass amplifier used in most sets.

The main advantages of the Zenith system are the high gain factor and dual-polarity outputs of the sheet-beam demodulators. These features make it unnecessary to use additional stages for phase inversion or amplification.

Bandpass Amplifiers

The bandpass amplifier circuits in the '62 sets follow three different patterns. Most manufacturers rely on one stage of chroma amplification fed by a signal from the plate circuit of a video amplifier; Fig. 3 shows a typical circuit of this kind. Chroma take-off coil L1 is tuned for a bandpass response that complements the video-IF curve, thereby producing a flat *over-all* response of the receiver to the chroma signal. The output of double-tuned trans-

•*Please turn to page 89*

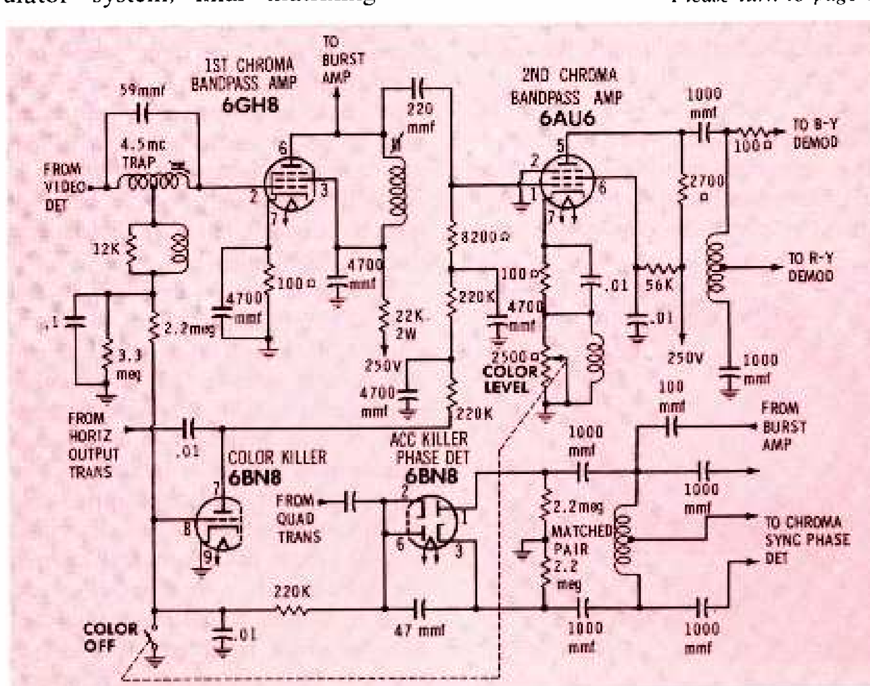


Fig. 4. *Automatic Color Control* is used with Zenith bandpass amplifier.

by Thomas A. Lesh

Color Servicing in the Home

Fundamentally, the home-call troubleshooting procedure for color TV receivers is the same as for black-and-white sets. You begin by carefully analyzing the screen to identify the symptom, and then ask yourself which sections of the receiver could develop faults leading to this condition. However, since you have to consider more factors in diagnosing what is wrong with a color set, you need to be especially critical in your observations. Misinterpreting a symptom can cause you to waste much time.

The first step in any color service job is to tune the set in to a monochrome signal and check the quality of the black-and-white picture. Since good color reproduction is impossible without proper luminance information, you must take care of all deficiencies that show up on monochrome operation before you can successfully attack the color problem.

Most such troubles can be handled exactly the same as in servicing conventional black-and-white sets. One important exception concerns the special components used to prevent color contamination—the purity magnets, static and dynamic convergence adjustments, and color-temperature (screen and background) controls. These items occasionally need adjustment—particularly if the set is moved to a new location, the CRT is replaced, the position of components on the neck of the CRT is disturbed, or gradual drift occurs with aging. However, symptoms of misadjustment are easily recognized and corrected according to procedures specified in service manuals. Adjustments should definitely be made in the home, so the actual operating conditions can be taken into account.

Fig. 1. Use of degaussing coil is first step in correcting poor color purity.

Magnetization of the CRT is not as severe a problem as in the early days of color, but a degaussing coil (Fig. 1) is still handy to have available for home calls. A quick job of demagnetizing the face and surrounding area of the picture tube may lick a color-purity problem and make it unnecessary to adjust any internal magnets or controls. Even if degaussing doesn't help, at least it doesn't do any harm and doesn't take long.

Once you have satisfied yourself that the set is producing a good-quality black-and-white picture, you can usually assume that the trouble is confined within the chroma section of the receiver—so you can concentrate on this section. (The only important exception to this rule is an antenna, RF, IF, or video trouble that discriminates against the color signal.) At this point, you need to decide which one of several possible color troubles is present in the set. The customer's complaint, and visual evidence from a color broadcast or test stripe, may provide an answer. However, for really accurate diagnosis, the most valuable service aid you can employ on home calls is a color-bar generator. This piece of equipment not only furnishes a reliable signal with which you're thoroughly familiar, but also frees you from dependence on transmitted patterns.

We can classify the observed color symptoms into four groups for convenient discussion: No color, weak or washed-out color, wrong colors, and loss of color sync. Each category calls for a slightly different troubleshooting approach.

No Color

If no tints of any kind can be seen in the picture when the color-bar signal or a color program is fed to the receiver, several controls should be checked for proper settings. The color-gain control (sometimes called a SATURATION or COLOR LEVEL control) may be turned too low for existing signal conditions, so try advancing its setting and see if color comes into view. Be suspicious if the knob must be turned

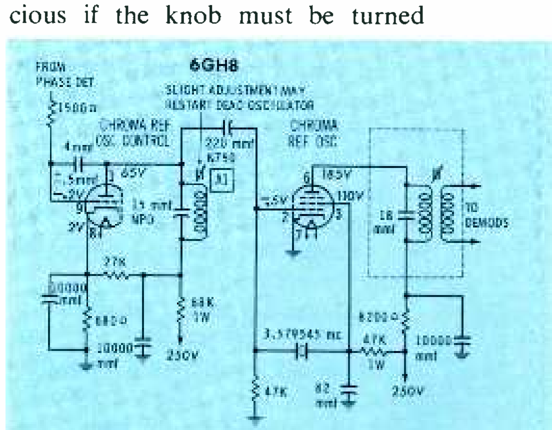


Fig. 2. Slightly retouching AI sometimes restarts a "stalled" color oscillator.

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- Vertical Deflection Yoke: By signal substitution for full height on picture tube.
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very far clockwise before color appears; this may indicate an abnormally weak chroma signal entering the receiver, or weak amplifiers, or both.

Also check the KILLER THRESHOLD control, which regulates the bias on the color killer. If this bias is too low, the incoming color signal is unable to cut off the killer tube, and thus cannot unblock the chroma channel. Although the control setting is not often disturbed by color-set owners, it's well worth checking for the troubleshooting information it can provide.

Some models have a COLOR ON-OFF switch, frequently ganged with one of the controls just described. It shouldn't be in the OFF position, but it might be!

One other control should also be checked. It's so obvious that you may miss it—the fine-tuning control on the tuner. At some settings, the local oscillator in the tuner may be misadjusted so that frequencies 3-4 mc away from the picture carrier (containing the color information) are greatly attenuated or almost completely blocked, even though most other frequencies are allowed to pass through the video IF strip. The set will then produce a fairly good black-and-white picture, but no color.

A defective antenna — with a loose lead, wrong orientation, or poor frequency response on the channel being received — may also cause poor pickup of color without seeming to weaken monochrome reception. The action of the antenna can be checked by observing set performance with a signal fed into the antenna terminals from the color-bar generator. (To avoid some very misleading indications, make sure that the RF output of the generator is not high enough to cause overloading, and that the generator and TV tuner are set to the same channel.) If normal color can then be produced, but poor color is seen on programs, the antenna system is obviously at fault.

Should the color-bar signal fail to produce color on the screen, further isolation testing is necessary. Loss of color could be due to faulty frequency response in the RF, IF, video detector, and possibly the video amplifier, as well as to trouble in the chroma section. To pin down the source, apply the video-frequency output of the bar generator (no RF or IF carrier) to the grid of the first video amplifier. In late-model sets, this chroma take-off test point is generally accessible through a test jack or terminal on the exposed side of the chassis.

If this test causes color to appear, proceed to check the RF-IF tubes. On the other hand, if a bar signal injected into the video amplifier fails to produce colors on the CRT, the first step is to check tubes in the chroma section. As indicated in Chart I, most of these are capable of developing defects that will interrupt either the chroma signal or the locally-generated 3.58-mc reference signal; naturally, a loss of either signal means "no color." The only tubes not likely to produce this symptom are the color-difference amplifiers that apply the color signals to the grids of the picture tube.

Incidentally, adjusting the 3.58-mc oscillator slug (Fig. 2) may fire off a balky oscillator and produce

Chart I—Normal Test Points for Isolating Chroma Trouble

FUNCTION	TUBE TYPE USED: (P) (T) (D)—PENTODE, TRIODE, DIODE SECTION	CHECK IN CASE OF:			
		WEAK OR NO COLOR	SOME COLORS MISSING	WRONG COLORS PRESENT	LOSS OF COLOR SYNC
chroma bandpass amp	6AU6, 6AW8A (T), 6EA8 (P), 6GH8 (P), 6U8A (P)	√			
chroma demodulator	6JH8, 12AZ7, 12BH7	√	√		
color difference amp	6CG7		√		
color killer	6AW8A (T), 6BN8 (T), 6EA8 (T), 6U8A (T)	√			
burst amp	6AW8A (P), 6EW6	√			√
reference osc & reactance tube	6EA8, 6GH8, 6U8A	√		√	√
chroma sync phase det	6AL5, 6BN8 (D)	√		√	√

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Current
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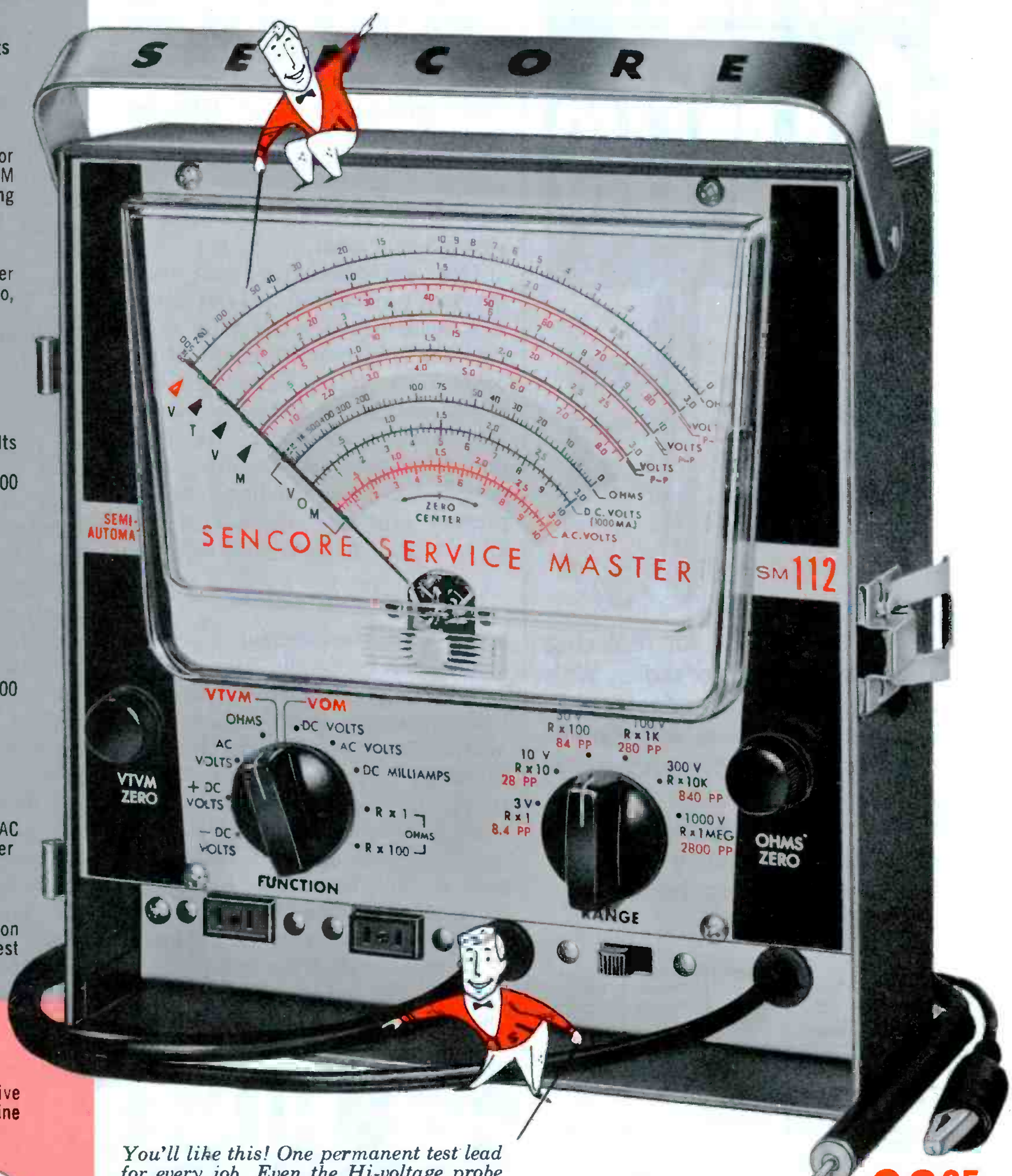

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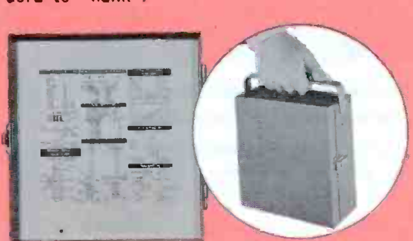

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color. If so, change the oscillator tube and adjust the circuit.

Weak, Washed-Out Color

This second symptom is actually just a milder form of the condition in which colors are lost altogether. The color signal is present, but not in sufficient amplitude to form the proper ratio with the luminance signal. You should check the same controls, tubes, etc., as you would if there were no color at all; but you should expect to find relatively slight misadjustments or tube defects. Antenna faults or mistuned RF-IF circuits which could cause "color drop-out" in fringe areas may simply produce weak color in strong-signal areas.

One chroma-circuit fault very likely to produce washed-out colors is a weak bandpass-amplifier tube. Another is incomplete cutoff of the color killer during color transmissions, resulting in excessive bias on the bandpass amplifier. Resetting the killer-threshold control may remedy the latter condition, but to prevent callbacks, make sure the killer tube is not gassy or leaky.

Wrong Colors

At least two distinct types of troubles are generally lumped under the single complaint, "The colors are wrong"; so it's necessary to analyze this type of symptom very carefully. Your most helpful "quick check" is to adjust the hue (tint) control while watching the picture. See if all tones can be made to appear normal; better yet, use a signal from a color-bar generator and attempt to reproduce the sequence of colors specified for your instrument. If you cannot obtain correct hues, stop and ask yourself, "*Do all the colors seem to be there?*" If not—for example, if the picture is noticeably deficient in shades of red—this suggests that one or more CRT guns are receiving insufficient color-signal drive because of a defect during or after chroma demodulation. The most likely trouble is a failure of one color-difference amplifier, or a malfunction affecting only one of the two demodulator stages.

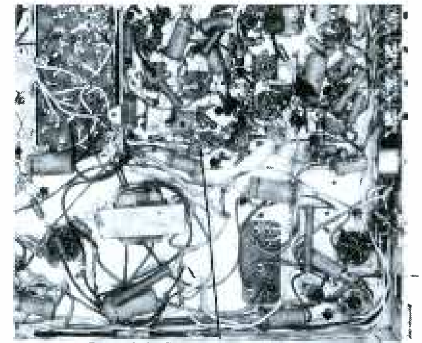

Fig. 3. For easier AFC adjustment, solder extension lead to the point shown.

If all colors are present, but appear in the wrong places on the screen, this implies that the 3.58-mc reference oscillator is producing a signal of the wrong phase. The hue control can normally produce a certain amount of phase shift. If it doesn't, or if it must be set near the end of its range to obtain correction, substitute for the reference oscillator/control tube and chroma sync phase detector. When replacing these tubes, be sure to readjust the slugs in the associated circuits. In recent color TV models, you can easily reach the necessary test points for performing touch-up adjustments in the home according to a simplified procedure using only a bar generator and VTVM, plus a couple of jumper wires. (For addi-

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If trouble is not located by now, isolate the trouble to a specific stage by touching the output of the harmonic generator to the base of each transistor and note spot where sound from speaker (or scope where no speaker is used) stops or becomes weak. The generator becomes a sine wave generator for audio stages to help find distortion.

If trouble points to a transistor, check it in a jiffy with the exclusive in-circuit power oscillator check provided by the TR110. A special probe is also provided for this.

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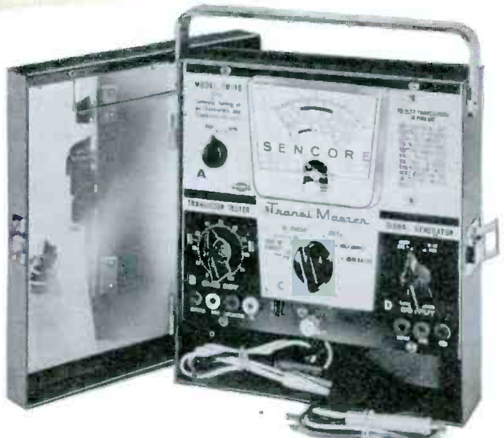

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tional information on this in-home adjustment method, see "Across the Bench" in this issue.) If some of your customers have earlier models, you might consider installing extension leads the next time their sets are in the shop, to facilitate future adjustments. For instance, in the RCA Chassis CTC7, a jumper could be connected between the chroma AFC diode resistors (Fig. 3) and brought out to the exposed side of the chassis. This test point, plus a few tube-socket adapters, would allow you to perform basic chroma-sync adjustments with the chassis in the cabinet.

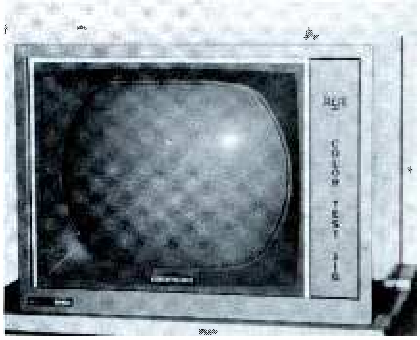
Loss of Color Sync

The final symptom to be discussed is the most nearly "self-localizing" of all chroma troubles. It overlaps with the "wrong colors" symptom to some extent, but is distinctly different in that the colors are broken up into horizontal or diagonal stripes or patches not corresponding to the video information. The trouble is simply that the reference oscillator is not operating on the correct frequency. If the color patches are stationary, the oscillator is locked in on some erroneous frequency; this is like an exaggerated case of the phase error described in the last section. Replacement of the oscillator/control tube or chroma phase detector may clear up the problem.

If the patches are not stationary, but constantly drift—producing a sort of "juke-box" effect—this means the oscillator is not synchronized with the incoming color-burst signal. As in black-and-white horizontal sync problems, the fault may be either a deficiency in the oscillator network itself, or a weak sync signal reaching the phase detector. Therefore, you should not stop at replacing the oscillator and phase detector tubes, but should also check the burst amplifier.

If Tubes Don't Help

The amount of in-home color servicing you can do, beyond checking controls and tubes, depends on the nature of the trouble and on the troubleshooting techniques you apply. You can obtain useful information about many troubles by making voltage checks at a number of points which are accessible without pulling the chassis. In some cases, you may even be able to reach and replace a bad part without undue fuss. However, it's often better to haul a color set into the shop than to attempt in-home repairs and wind up with the chassis, tools, and test equipment spread all over the customer's living room.



Shop Color Tube

When servicemen join in a gab session, and the talk rolls around to color TV, you'll often find that the conversation dwells as much on the size and handling of color TV cabinets as on the technical details of the circuits.

"Do you send out two men to pull a color set into the shop?"

"I try to do all the work I can in the home to avoid lugging the cabinets around."

"Have you tried pulling just the chassis and using your scope as an indicator?"

As a solution to the problem of providing bench service for color sets, RCA Parts and Accessories Div. of Camden, N.J. has just announced the availability of a *Color Test Jig*. Identified as stock number 11A1015, the unit consists of a tri-color CRT and associated components mounted in a special cabinet for bench use. Thus, if you're looking for a new way to deal with the physical problems of color TV service, the test jig offers a complete CRT bench setup.

In the parts line, RCA has developed a basic replacement stock for both the CTC10 and CTC11 chassis, and is now offering a kit of parts complete with a rack. Five extension cables have also been made available to meet various needs for use in servicing color TV receivers. ▲

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NPN TYPES

Low power

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ET9 IF amplifier
ET10 AF amplifier 9v.
ET11 AF amplifier 12v.

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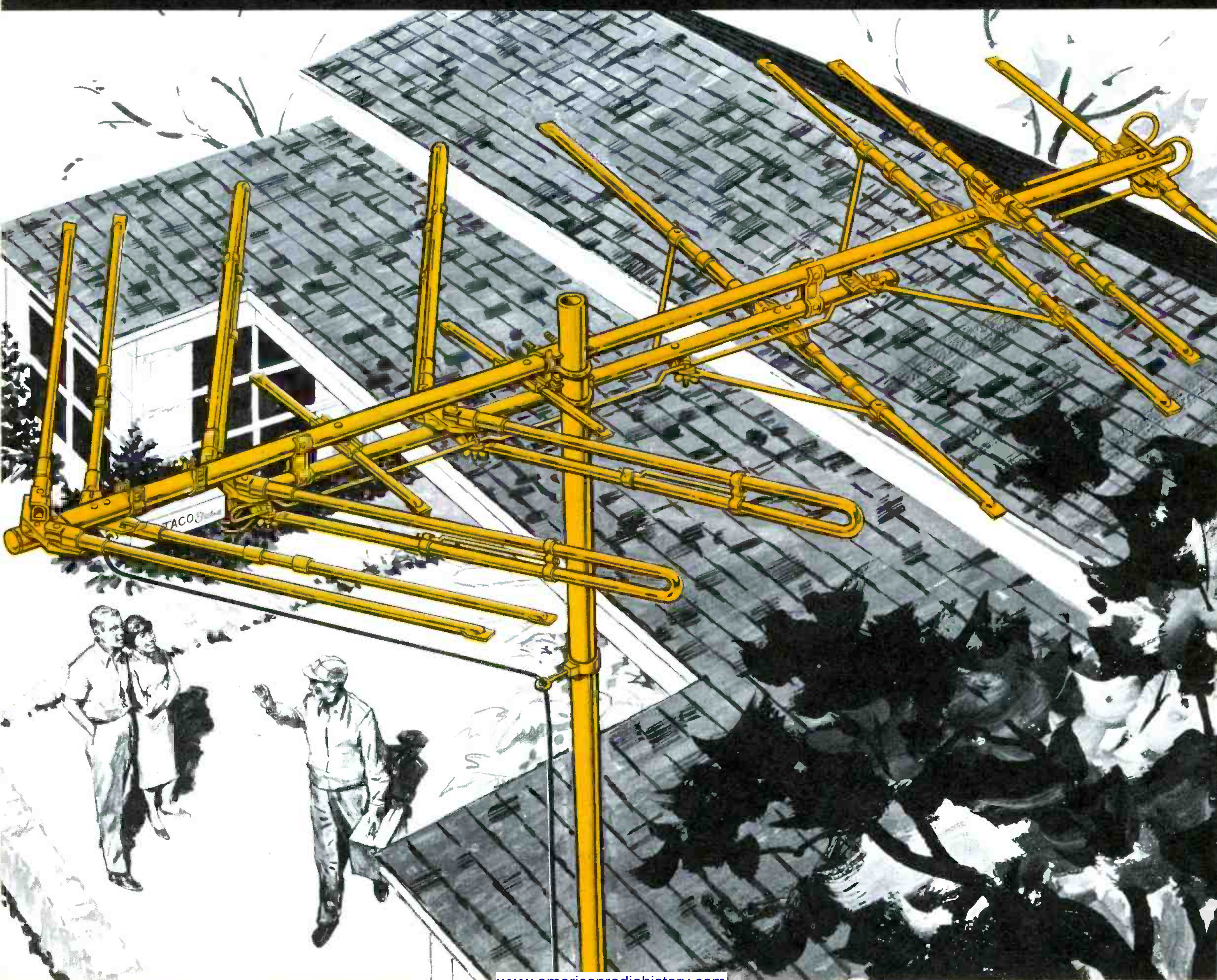

HOW THE NEW T-BIRD ELECTRA

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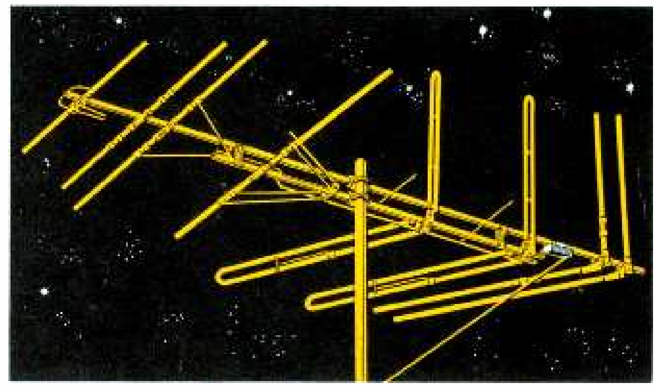
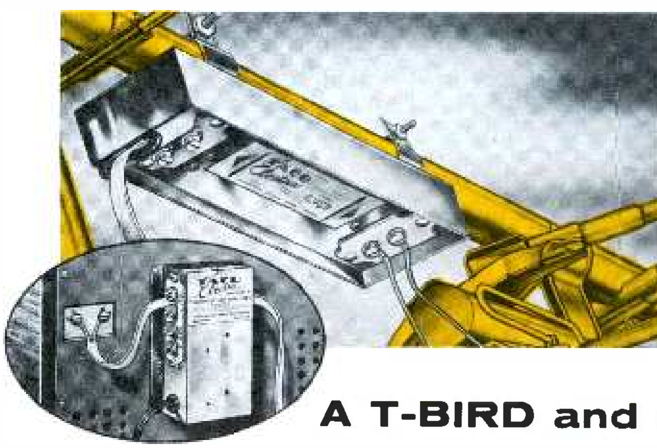
- 100% rustproof. Gold-anodized and iridited (a conductive coating). Exclusive stainless-steel U-bolts.
- Engineered to eliminate unnecessary elements or harnesses that add weight and invite wind damage.
- Chrome-alloy aluminum used throughout—twice as strong as other antennas.
- Complete pre-assembly makes installation fast, sure and permanent.





- TACO transistor preamplifier, designed by Jerrold, is matched to perform ideally with T-BIRD ELECTRA.
- Highest gain on both high and low channels, lowest System Noise Figure.
- No batteries, no polarity problems when connecting downlead.
- Remote a-c power supply feeds two sets.
- No maintenance worries—put up the T-BIRD ELECTRA and forget it!
- Every TACO antenna carries, in writing, a one-year warranty.

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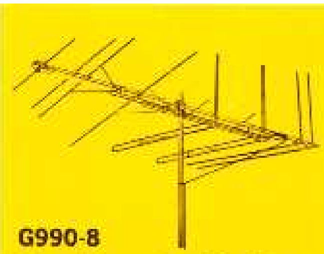

G990-8

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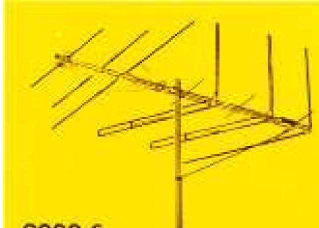

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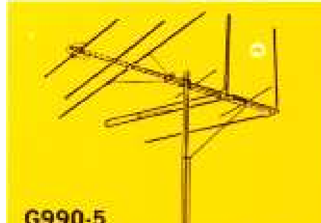

G990-5

Lowest-price T-BIRD ELECTRA. Offers all the inherent advantages of transistor amplification plus a matched system of amplifier and antenna. Brings in stations beyond the reach of ordinary antennas.

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UNDERSTANDING COLOR SYNC

by Thomas A. Lesh

How chroma phase-detector and reference-oscillator circuits operate.

Chroma information is applied to the composite color-TV signal by both amplitude- and phase-modulating a 3.58-mc subcarrier, which in turn modulates the picture carrier. However, only the sidebands of the chroma signal are actually transmitted; the subcarrier itself is suppressed at the transmitter. Before demodulation can be performed by the receiver, the subcarrier must be duplicated by a 3.58-mc local oscillator. The color-sync section of the receiver (see typical circuit, Fig. 1) includes this oscillator, plus the control circuitry necessary to keep it in step with the subcarrier generator at the transmitter.

A sample of the original subcarrier, called the burst signal, is transmitted immediately after each horizontal sync pulse in the composite color signal to provide for color synchronization. Burst amplifier V18 acts as a "color-sync separator" to recover the burst from the composite signal. This tube is fed a combination of burst and chroma information (Fig. 2A) from the video amplifier or chroma-bandpass section. It also receives a keying pulse (Fig. 2B) which permits it to conduct only during horizontal retrace time; therefore, the output of V18 contains only the color burst (Fig. 2C).

The amplified color-burst signal is developed across burst transformer L26, which is tunable for maximum transfer of signal energy from pri-

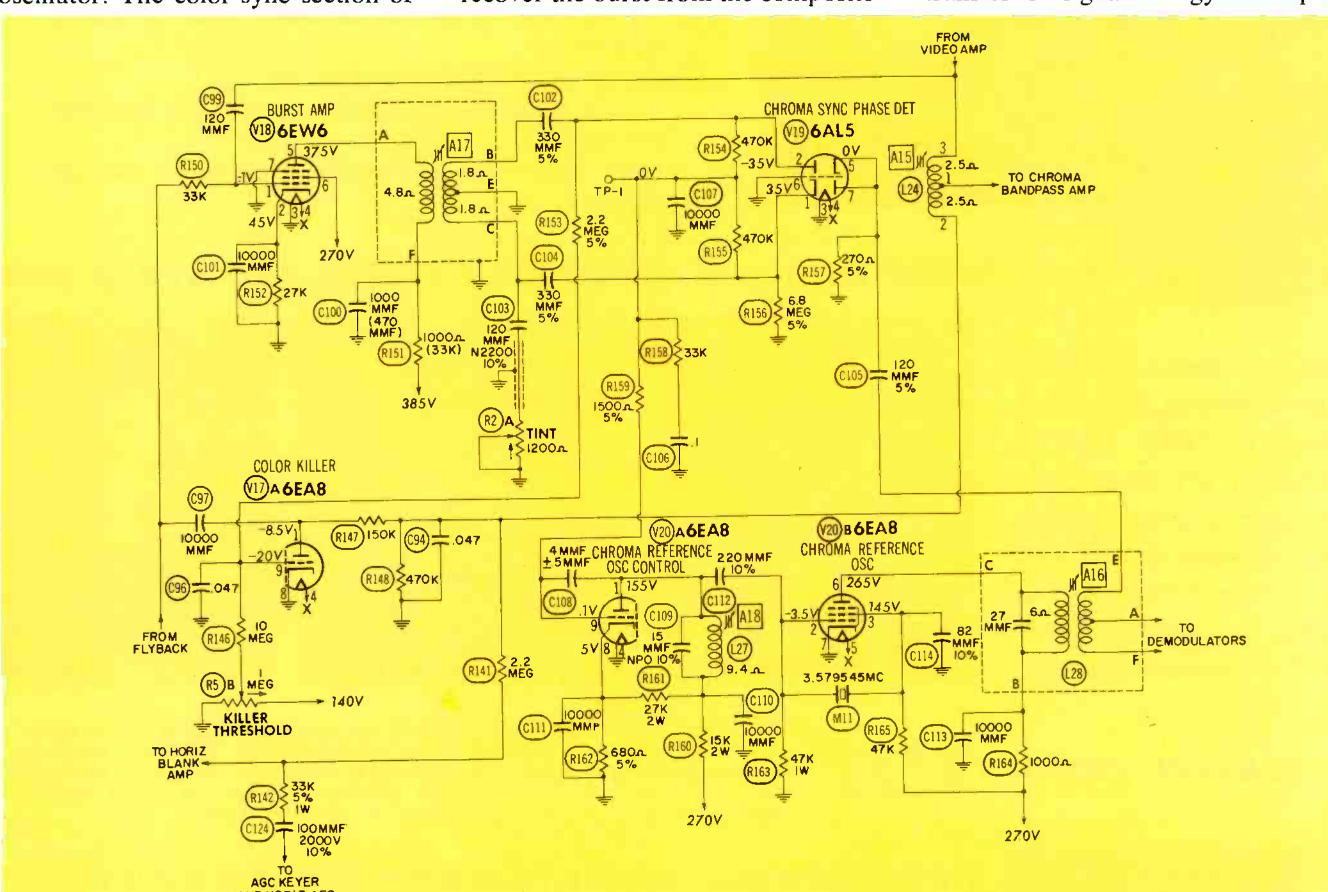
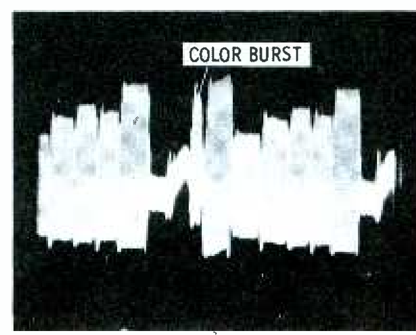


Fig. 1. Typical reference-oscillator, control, and phase-detector circuits.

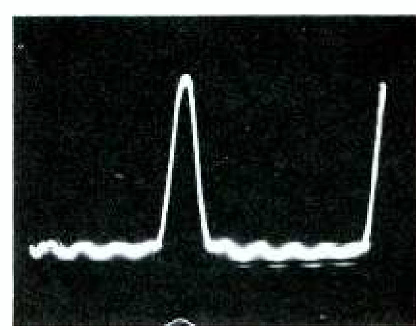
mary to secondary. The signal induced in the secondary is applied to phase detector V19, where its phase is compared with that of an output signal from the 3.58-mc reference oscillator V20B. Any error in the frequency or phase of the reference-oscillator signal is detected by V19, and a correction voltage is applied to control stage V20A. This correction voltage causes the control stage to alter oscillator operation until it is running at the proper frequency and phase.

Chroma Reference Oscillator

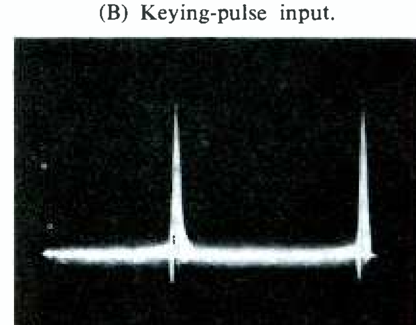
Before considering exactly how V20A exerts control, we should more closely examine the operation of the reference oscillator. The 3.58-mc output of this stage must enable the receiver to accomplish the reverse of the modulation process which takes place at the transmitter. Since the chroma information is originally obtained by combining two 3.58-mc signals which differ in



(A) Combined chroma burst input.



(B) Keying-pulse input.



(C) Amplified burst output.

Fig. 2. Burst-amplifier waveforms.

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phase by 90°, the local oscillator in the receiver must also provide two out-of-phase signals. These are fed from the oscillator plate circuit to a pair of chroma demodulators, which are keyed into conduction during peaks of their respective 3.58-mc signals. (The receiver of Fig. 1 utilizes the negative peaks, since the signals are fed to the cathodes of the demodulators.) By this process, the amplitude of the incoming chroma signal is sampled at two specific times in each cycle, to determine what proportion of the incoming signal at a given instant was contributed by each of the two original signals. From this information, the demodulators and later circuits are able to reconstruct the three color-difference signals used for driving the control grids of the tricolor CRT.

The oscillator (pentode section of V20) is a crystal-controlled, electron-coupled type. Its tuned plate circuit includes the primary of L28. The secondary of this transformer contains a phase-shifting network (adjustable in older sets, but not in newer models) which establishes the proper phase angle between the two outputs of the oscillator circuit.

Oscillator-Control Stage

The 3.58-mc crystal signal in the reference - oscillator grid circuit is applied to the plate of control tube V20A. A small amount of this signal is also fed back through C108 to the grid of the control tube, resulting in the development of an AC grid voltage which leads the signal voltage from the crystal. Thus, V20A acts as a capacitive reactance shunting the crystal circuit.

V20A conducts continuously. Its nominal level of plate-current conduction — and hence the nominal

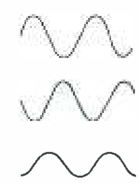


Fig. 3. Reference signal is normally in quadrature with incoming signals.

value of capacitance it contributes to the resonant circuit of the oscillator—corresponds to a grid voltage of approximately zero. When a positive or negative DC error voltage is fed from phase detector V19 to the grid of V20A, the plate current increases or decreases by an amount calculated to bring about the desired shift in oscillator phase. A positive-going change in grid voltage serves to increase the effective capacitance across the crystal circuit, thereby retarding the oscillator; a negative-going grid voltage has the opposite effect.

Phase Detector

The phase detector is similar to those commonly used with horizontal sweep systems. The burst input appears across the secondary of L26, the signal at terminal C being equal in amplitude to the signal at terminal B, but 180° out of phase with it. The feedback from the oscillator is taken from terminal E of L28 and fed to pins 5 and 7 of V19 through C105. The system is said to be in balance when the oscillator signal fed to the phase detector is in quadrature (90° out of phase) with the two burst voltages, as shown in Fig. 3. Under these circumstances, the oscillator signal goes through zero as the burst signal reaches maximum. The two

diode sections of the phase detector conduct equally at this time; thus, the net DC-voltage output of the stage (measured at TP-1) is approximately zero. A careful examination of an operating circuit will show that this zero output is maintained just as long as the signals are in quadrature. Any tendency to deviate from this condition produces a voltage output from the phase detector which brings about a correction in oscillator phase.

Troubleshooting

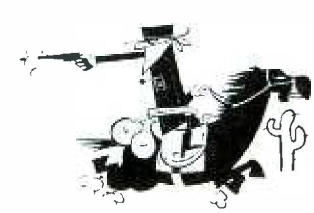
Since the color-sync section forms a closed-loop system similar to a horizontal AFC-oscillator circuit, the procedures used for analyzing troubles in this section must allow for the effects of feedback.

"Breaking the loop" (by removing the error voltage from the grid of the control tube) is a useful test method for isolating a defect to either of two circuit blocks within the color-sync section—the oscillator and control tube, or the burst-input circuit and phase detector. In the circuit of Fig. 1, this test can be most conveniently done by grounding TP-1. The result should be a nearly stable color pattern, with only gradual shifting of hues. If severe loss of color sync is still evident, the oscillator and control stage should be checked to find out the reason for off-frequency operation. On the other hand, an improvement in color stability is a clue to look for such troubles as unbalance in the phase detector or insufficient burst-signal amplitude.

The three or four slug adjustments in the various color-sync circuits should be checked early in the troubleshooting procedure, especially if the fault is only a minor phasing error which produces stable but incorrect hues in the picture. Such problems can easily be caused by slight misadjustment of a slug in the burst transformer, control-tube plate coil, or oscillator transformer.

Of course, tubes should be checked even before readjustment of the circuit is attempted. However, tube replacement alone is not likely to produce a complete repair, since one or more slugs may require readjustment to compensate for differences between tubes.

Troubles which do not respond to either tube replacement or circuit adjustment can be tackled by conventional troubleshooting methods, beginning with waveform and voltage analysis, and following through with individual component checks in the suspected stage. ▲



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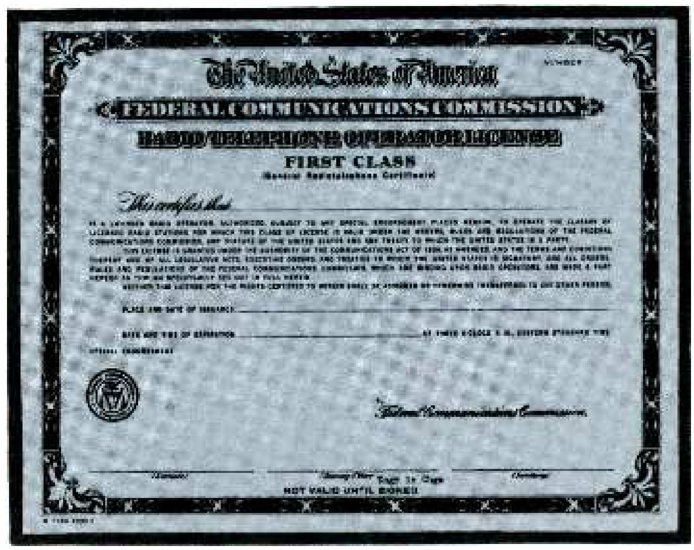

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19-S

by JOE A. GROVES

Service Promotions that Work!

More and more service dealers are becoming aware of the value of promotional campaigns directed at stimulating some special aspect of their service business. Many have found that well-planned and executed promotions can bring in much-needed revenue to smooth out slumps in service income, get the ball rolling when a new service has been added, or increase the total volume of service business enough to justify hiring another man. If you're planning a special promotion for any reason, you'll find that the following examples of successful programs offer some ideas well worth considering.

At the beginning, it must be pointed out that these are special concentrated efforts, keyed to promoting some specific activity—not consistent year-in-and-year-out advertising programs. Different campaigns will naturally vary in length according to their reasons for being. Also, decisions as to the medium used, total cost, timing, and intended audience are inseparably tied to the special needs of each individual case.

Color TV Service

For our first example, let's take a look at the color-TV promotion staged by Bill (who prefers to remain anonymous). His shop is a one-man operation in a metropolitan area. For two or three years the local TV stations had been increasing their color programming, and several of the larger dealers had been doing a fair job of selling color sets. However, no service shops in his trading area had done much to promote color service work. It seemed like a good time to start a push for color TV service.

Bill knew he couldn't expect enough color calls within the first year to pay for an all-out drive, and he didn't have enough capital to float a costly promotion for an extended period of time. Therefore, he planned his program around a direct-mail campaign to be sent to a select group. Also, he took advantage of the fact that his service truck would be seen by thousands of people as he went about his daily work.

He transformed his ordinary panel truck into a rolling billboard that attracted attention from every quarter. Working with a sign painter, Bill selected a complete rainbow of the brightest, most vividly-colored paints he could obtain. He then had his entire truck painted like a rainbow, leaving large white rectangles on each side and the back for a boldly-lettered sign.

For his mail campaign, Bill searched the phone book for the names and addresses of all doctors, dentists, and lawyers in his trading area. In addition, he obtained the mailing list from as many "working" organi-

zations as he could (such as the Jaycees, Lions, Rotarians, etc.). To complete his list, he added the names of other merchants in his area. He then had an odd-job typist prepare personalized form letters to send to each group of prospects. In the letters to doctors and dentists, he offered his services and talked of the elaborate test equipment at his disposal for **diagnosing** and **analyzing** color TV troubles. On the other hand, letters to lawyers stressed the **schooling** he'd received and his **vast library** of service information. Letters to club members and merchants pointed to the **established reputation** in the field of black-and-white TV service, and cited the added color service as an example of natural growth.

Approximately a month after the letters went out, Bill followed up with evening phone calls to inquire if the people on his mailing list were watching a popular show in color. From the answers he received, he obtained a list of known color-TV owners for use in future phases of his campaign. For those who didn't own a color set, he built his follow-up messages around various black-and-white TV themes — adding a P.S. that he stood ready to serve them when they obtained color sets.

When Bill evaluated his promotion at the end of six months, he found it to be definitely worthwhile.

Therefore, he continued it on the original basis, and now reports a steadily growing number of color-TV customers who have exhibited a high degree of loyalty.

Organ Tuning

From eastern Pennsylvania comes the story of a technician we'll call Jim—another serviceman who expanded his activities by means of a promotional campaign. The clue for his successful program was provided by a customer who called to request slight adjustments to the tuning of her electronic organ. She explained that it had recently been retuned. The job had been done with technical accuracy, she added, but the instrument just didn't sound quite as pleasing as it once did.

Jim, who happened to have a good ear for music, was intrigued by this case. If one organ owner wasn't quite satisfied with the pitch of an instrument, why wouldn't others feel the same way? He did considerable research, and learned to tune organs not just as a mechanical routine, but also to insure pleasing musical effects. Before long, he developed "custom organ tuning" into a full-fledged specialty business.

To find prospects for this service, he checked with music stores, dealers, and music teachers to obtain a list of organ owners. He decided to make personal phone calls to these people, and selected the hour from 9 until 10 in the morning for his initial contacts. Jim's initial conversation simply suggested the possibility of "custom-tuning," quoted the cost, and arranged to call back the following evening between 6:30 and 9—after the family had had time to talk over the idea.

The success of Jim's promotion doesn't mean that every other serviceman should go out and start retuning organs. Most of us would just make more competition for Crazy Otto! However, this story does illustrate how you can profit from promoting a service specialty for which you are particularly well qualified.

Antenna Repair

John, a technician in the Midwest, was in a different situation. Rather than planning a promotion for a new activity, he maintained his normal income level through the summer slump by means of a well-timed campaign for antenna repair business.

John lived in a rural area where he could bank on spring winds and rains causing considerable antenna damage. In order to gain a head start on his competitors, he conceived the idea for a pre-Easter push on antenna parts. He knew from previous year's records that his normal summer antenna repair business grossed a meager $300, and yet he felt this volume could be more than doubled if he hit on the right idea. Realizing he would sooner or later have to raise prices to keep profits from slipping, he decided to try a program with the theme, "Sign up now for summer antenna repair and save," announcing that his prices would be increased as of May 1.

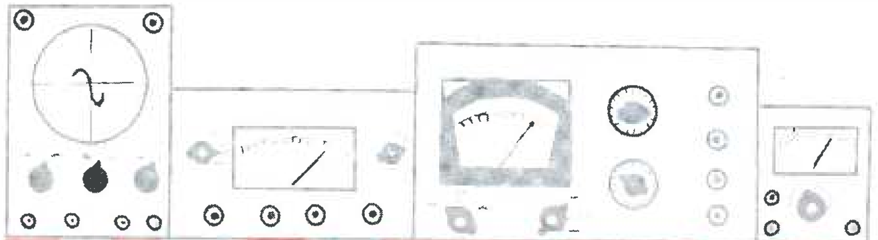
In choosing his advertising media, John reflected on the merits of a spring auto-radio tune-up campaign he'd announced in the daily paper of his county seat the year before. It had drawn considerable auto-radio repair, so the newspaper was selected as one of the advertising media to be used. In deciding how much to spend on his promotion, he figured his anticipated return ($600) and decided on a 10% advertising budget. This gave him $60 to work with. Since he was a consistent advertiser in the paper, he was able to run three-inch, two-column display ads every week during Lent at a low contract rate. In addition, he was able to have a thousand handbills printed. Some were distributed from house to house in selected neighborhoods; others were tucked under windshield-wiper blades on cars parked in the downtown business district.

The ads and handbills carried eye-catching photos of various antenna installations in need of major repairs. The copy accompanying the photos announced the coming increase in the price of his antenna work, and offered summer service at current prices if service was contracted for prior to May 1. He specified that each customer would have to present a copy of the ad to obtain the special rate, thus setting up a valid means of determining the effectiveness of his advertising dollar. How did it turn out? Antenna service directly attributed to the campaign grossed nearly $1000.

And So It Goes

Another dealer gave his service business a shot in the arm by preparing printed stickers that carried his name and phone number in addition to the numbers for police, fire department, and ambulance service. He arranged to have several supermarkets drop a sticker in every sack at the check-out counter. In a similar cooperative venture, gas-station operators checked the radios in the cars they serviced and provided a radio-TV shop owner with the names of customers who needed auto-radio repair.

We could spend all day recounting successful campaigns like these, but the examples already mentioned should be sufficient to show what it takes to make a promotion click. The program must be tailored to a specific type of needed service; the message must present a logical reason for the customer to accept the offers; realistic goals and advertising budgets must be established; and the results must be carefully studied to make future programs more effective. When a service promotion is built on these precepts, it's almost certain to bring gratifying returns. ▲



NOTES ON TEST EQUIPMENT

by Les Deane

Batteryless Bias

A bias source is indispensable in a service shop for such jobs as alignment and AGC troubleshooting. It would be more accurate to say that bias sources (plural) are indispensable, since it is often necessary to feed two separate bias potentials to different points in the same receiver. Recognizing this frequent need for a dual bias supply, Sencore, Inc., of Addison, Ill. has introduced the instrument pictured in Fig. 1. The two independently variable DC outputs of the BE113 *Align-O-Pak* are obtained by rectifying and filtering the AC line voltage; no batteries are employed.

Specifications are:

1. *Power Requirements — 117 volts, 50/60 cps, AC only; power consumption negligible; output isolated from power line;* ON-OFF *switch provided on panel.*
2. *Bias Outputs — two DC voltages (negative or positive), continuously variable from 0 to 20 volts; three color-coded leads supplied.*
3. *Regulation — maximum DC output change 20% for AC line variation of from 105 to 125 volts; maximum ripple content approximately 1/10 of 1%.*
4. *Panel Controls — two-watt potentiometer for adjusting each output voltage; 0- to 20-volt calibrations provided on panel.*
5. *Size and Weight — 1¾" x 4½" x 3½", 1 lb.*

Fig. 1. Sencore *Align-O-Pak* contains two independent 0-20V bias sources.

The Model BE113 derives its dual DC outputs from a simple AC-to-DC conversion circuit composed of a small power transformer, a single-plate selenium rectifier, and a three-section electrolytic filter capacitor. Both voltage controls are connected in parallel across the output. The –A and –B output leads, connected to the movable taps of the controls, have a negative potential with respect to a third lead coded COM (common). Thus, when the common lead is connected to chassis ground, two independent negative supplies are made available.

Since the common lead is insulated from the chassis of the bias supply, it can safely be attached to a point other than ground. This feature makes it convenient to obtain positive as well as negative bias potentials from the unit. If one of the negative output leads is connected to the chassis, the other negative lead and the common lead both become positive source points. The voltage obtained at the common lead is then determined by the setting of the control that corresponds to the grounded lead. The voltage at the second negative lead can also be varied (with the other control), but cannot be greater than the voltage established between the common and grounded leads.

The *Align-O-Pak* is strictly a bias supply, so it naturally is not designed to provide enough output current for powering any type of equipment. However, there are plenty of uses for the bias-voltage sources, either singly or both at the same time. The dual-bias feature is often needed in servicing sets with keyed AGC systems, since many test procedures require applying different bias potentials to the RF and IF amplifiers. The second DC source can also come in handy for clamping some auxiliary point suspected of being involved in an AGC-sync problem (such as the grid of a triode-type sync noise inverter) at the same time the AGC line is being clamped. Still another need for two bias voltages at once occurs during alignment of many color TV sets.

Most service work requires values of bias from about –3 to –15 volts DC — well within the output range of the *Align-O-Pak*. Incidentally, while using the BE113 in the lab, I noted that the voltage calibrations on the panel are accurate enough to be relied on for setting up specific values of voltage.

"Mini" Waveformer

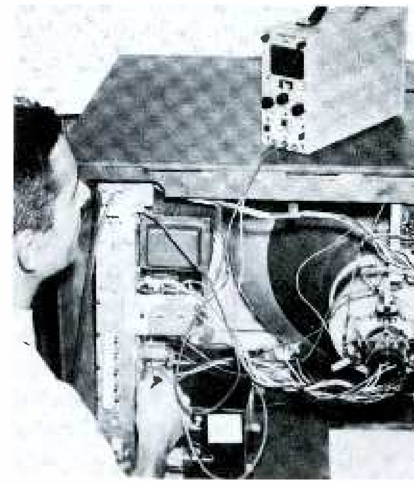


Fig. 2. New Waterman scope is so small that you can carry it in a tube caddy.

If you've been asking for a *really* portable oscilloscope, Waterman Products Co., Inc., of Philadelphia has an answer — the Mark I *Primer-Scope*. Shown perched upon a color TV cabinet in Fig. 2, this "baby" instrument occupies only 1/6 to 1/8 as much space as a conventional service scope; yet it has all the necessary waveform-reproducing features of an "adult" unit.

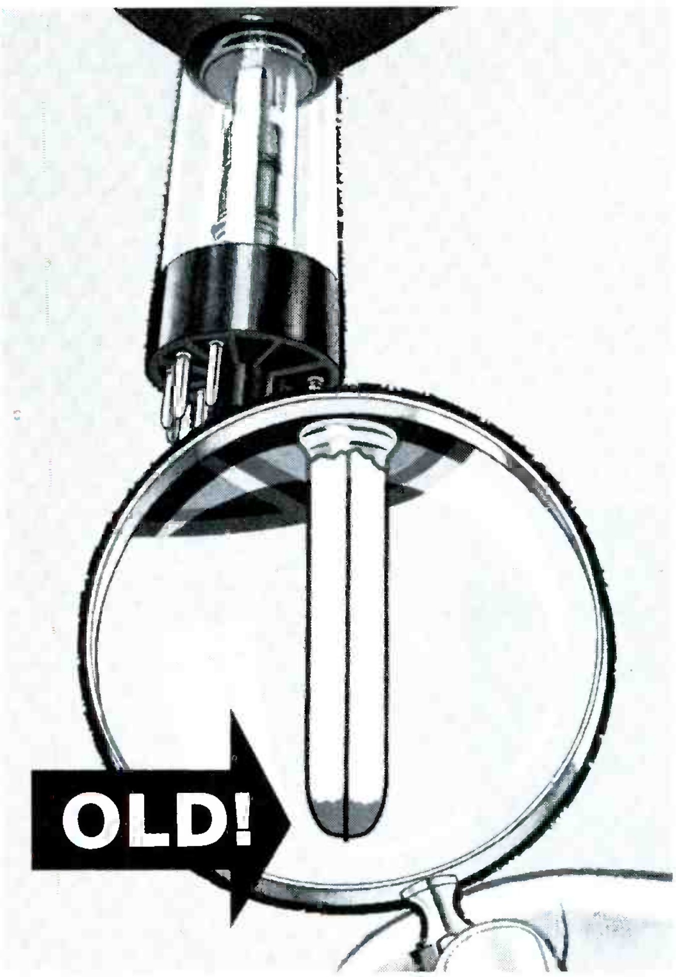
Specifications are:

1. *Power Requirements — 105/125 volts, 60 cps; power consumption 40 watts; instrument isolated from AC line and fused.*
2. *Vertical System — input impedance .5 megohm shunted by 100 mmf; AC-DC switch provided; AC fre-*

Fig. 3. Face of the Mark I has calibrated 3" screen and simplified controls.

New Sylvania Technique eliminates erratic pin soldering

Picture tube callbacks due to "open-pin connections" dramatically reduced

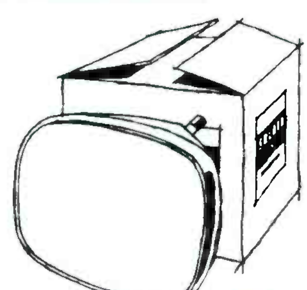


The "old" conventional pin soldering method relied upon contact between pin and wire only at their tips.

New Sylvania pin soldering technique extends solder far up into the pins—provides maximum contact with the wire—assures low electrical resistance and high mechanical strength.

What does the new Sylvania pin soldering technique mean to you? It means the solution of a long-standing, industry-wide pin soldering problem. Callbacks will be reduced—crimping and resoldering will be a thing of the past.

Thousands of service technicians have proven for themselves—in millions of service calls—that Sylvania SILVER SCREEN 85 TV PICTURE TUBES are the surest way to build a better business. You should, too. Electronic Tubes Division, Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.



SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

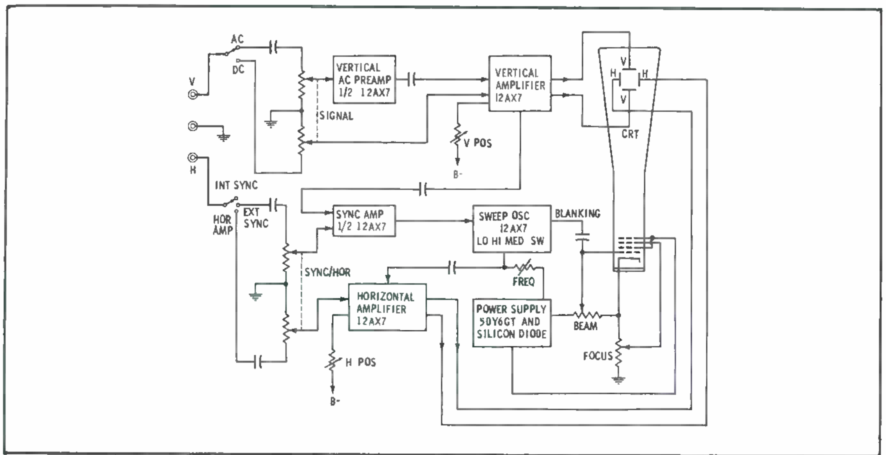


Fig. 4. Functional block diagram of the Waterman *Primer-Scope* Mark I.

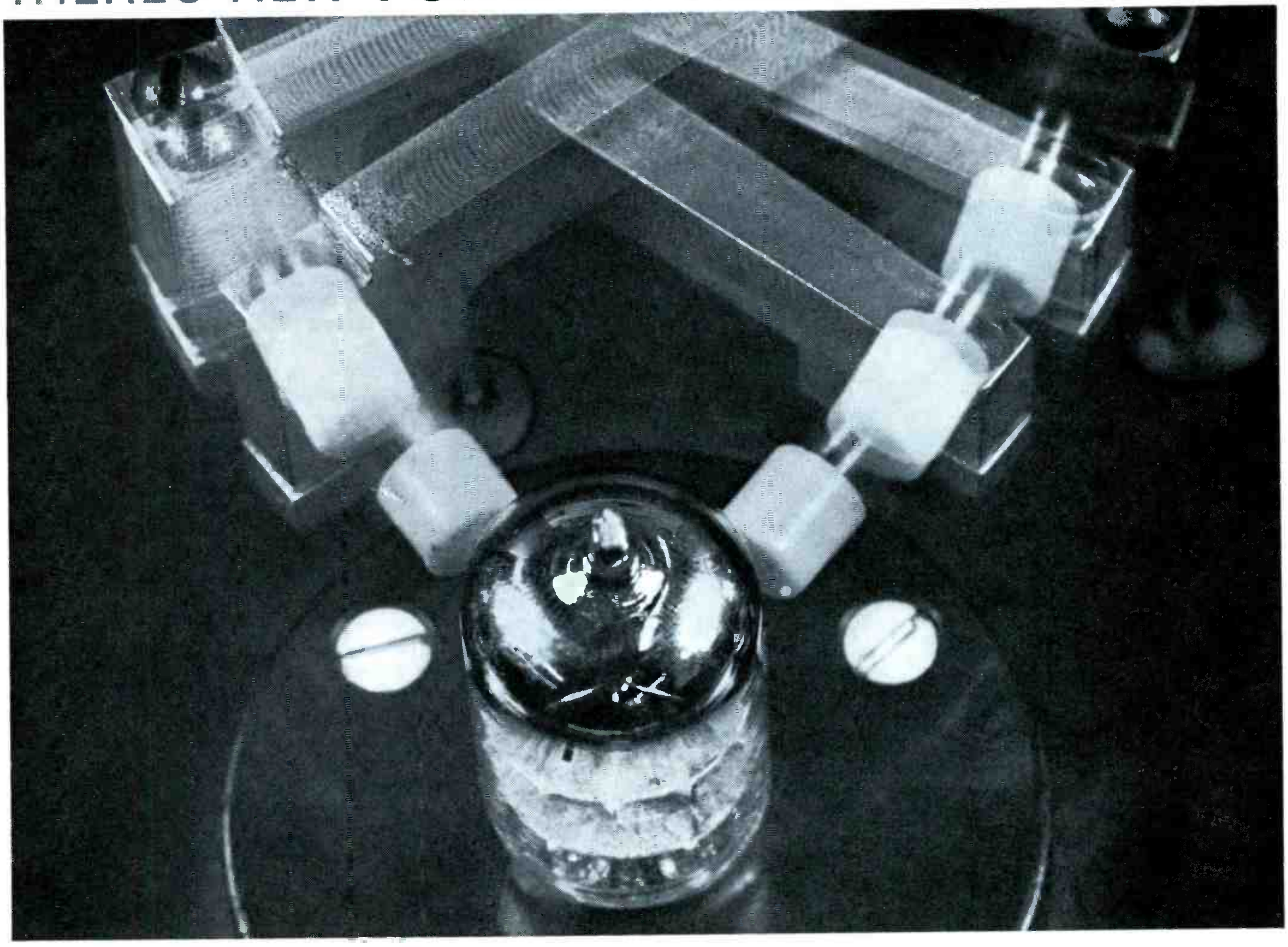
quency response 20 cps to 75 kc, sensitivity 6 mv rms per scale division (1/4"); DC frequency response 0 to 75 kc, sensitivity 250 mv P-P per scale division; pulse rise time 2.5 usec; maximum input 400 volts (AC + DC); input and ground leads supplied.

3. *Horizontal System — input impedance .5 megohm shunted by 100 mmf; frequency response 20 cps to 75 kc; sensitivity 150 mv rms per scale division (1/4"); maximum input 400 volts (AC + DC).*
4. *Sweep System — frequency continuously variable in three overlapping ranges from 20 cps to 20 kc; fixed sweep width; internal retrace blanking provided.*
5. *Synchronization System — panel switch provides internal or external sync; internal requires signal capable of producing peak-to-peak vertical deflection of one scale division, while external requires 150 mv rms (both of positive-going polarity); maximum external-sync input 400 volts (AC + DC).*
6. *Cathode-Ray Tube — flat-face 3" Waterman "Rayonic" VC129P1 with internal magnetic shield; 2-3/8" x 1-3/4" rectangular mask and scaled graticule.*
7. *Size and Weight — 7-1/4" x 3-1/2" x 11-1/4", 5-3/4 lbs.*

A close up of the front panel is presented in Fig. 3. All operating controls have been simplified and clearly marked. The vertical input circuit does not include the usual step attenuator; gain is governed by a single control labeled SIGNAL. The knob in the center of the panel, marked SYNC/HOR, has a dual function. Normally, it controls the amount of sync signal applied to the internal sweep oscillator. During external sweep operation, with the input selector in the HOR AMP position, it governs the amount of driving signal (width).

Internal sweep frequencies are selected by a three-position slide switch (LO-HI-MED), and the control labeled FREQ. The two-position slide switch located in the lower left corner of the panel sets up the instrument for either AC or DC measurements, while the three-position switch in the center selects the mode of sweep and sync desired. Remaining adjustments include both vertical and horizontal positioning controls, focus, and brightness. At the bottom of the panel, the jack on the left is for vertical inputs, the center one is for ground connections, and the one on the right is for external-sync and horizontal inputs.

In the block diagram of Fig. 4, the number of stages, tube types, circuits capacitively coupled, and electrical locations of all panel controls are shown for the Mark I. An unusual thing I noticed about this scope is the fact that the operator has no control over horizontal gain when the sweep is internally generated. However, I found it easy to compensate for this omission by adjusting the FREQ control to change the number of cycles displayed on each sweep. I could always find some setting



at which one or two cycles were clearly presented.

Since it can easily be carried on outside calls, this miniature scope opens up new possibilities for more extensive "on-the-spot" servicing. Many of today's TV sets incorporate printed circuitry with all components exposed on the tube side of the chassis, and this type of receiver can be "scoped" in the cabinet as easily as on the bench. On any set, regardless of chassis design, numerous check points are accessible with just the cabinet back removed. For example, you can check for ripple on AGC and B+ supply lines at tuner connections; check at the picture-tube socket for the composite video signal, hum modulation, and vertical blanking pulses; make horizontal-oscillator waveform adjustments on some sets; test for audio signals across a speaker or at terminals of the volume control or TV-phono switch; check sync and sawtooth waveforms at the socket of an AFC dual diode; look for B+ ripple at a fuse connection, or for boost ripple at the accelerating anode of the CRT; and sample the video signal at the second detector (in sets having the crystal mounted on top of the chassis). Furthermore, by pulling tubes or using a socket adapter, you can view every meaningful waveform in a receiver.

Although its frequency response is limited, I found that the Mark I could reproduce all monochrome TV waveforms, and that it was also useful in signal-tracing many sections of a color receiver. Among the waveforms it can reproduce are the R–Y, B–Y, and G–Y signals applied to the tricolor CRT; grid and plate signals of burst amplifiers; and waveforms associated with sync phase detectors. Of course, since the higher-frequency components of these signals are attenuated somewhat, accurate amplitude measurements are not always possible; however, the results are useful for determining the presence or absence of the signals.

Considering that the instrument is easily portable and well suited for audio work, it offers many opportunities for developing more efficient field-troubleshooting methods for electronic organs, public-address systems, and complex intercom installations.

Tester Updater

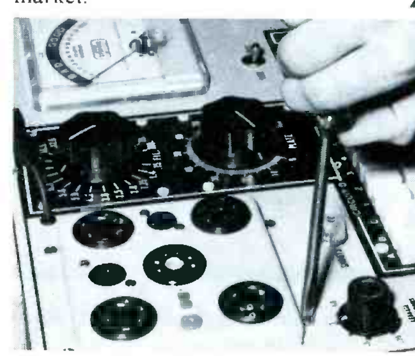
Jackson Electrical Instrument Co. of Dayton, Ohio has recently designed a plug-in Socket Modification Kit that fits all Model 658 and 648R tube testers, equipping them to check *Compactron, novar, nuvistor,* and 10-pin miniature tubes in addition to all conventional types.

A reversible plug-in unit with 14 different tube sockets (seven on each side) replaces the nine-socket fixed panel originally mounted in the Jackson testers. (The new panel is already incorporated in two Jackson testers introduced this year, Models 648S and 658A.) One side includes all the newly-introduced sockets, plus octal and 7-pin miniature types. The 9-pin tubes can be plugged into the 10-pin socket, since the tenth pin is

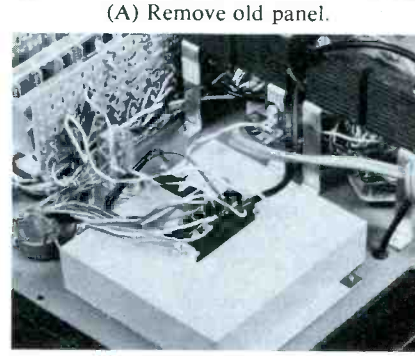
in the center. On the other side are the older 4-, 5-, 6-, and 7-prong sockets, plus two subminiature types. A two-position slide switch labeled NOR./S (for NORMAL-SPECIAL), permits testing certain unusual tubes in a conventional manner.

Connections between the socket unit and the tester are completed through a 12-prong male plug mounted in a "well" (also furnished in the kit). This part is designed to occupy the space vacated by the original panel section.

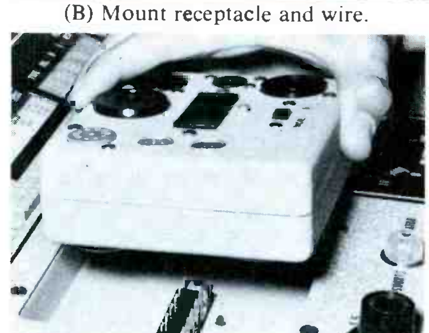
When I installed one of these kits on a Jackson 648R in our lab, I began by removing the entire instrument from its case. Then I took out the original socket unit by unfastening four screws (Fig. 5A), and clipped off all connecting wires close to the socket assembly. Attaching the new receptacle to the panel cutout, I wired the connecting plug (Fig. 5B) according to the instructions packaged in the kit. The wiring job was simplified by the fact that all leads requiring splice connections are identically color-coded. Reinstalling the tester chassis in the case completed the job; by plugging the new socket assembly into the receptacle one way or the other, I could test any tube type now on the market. ▲



(A) Remove old panel.

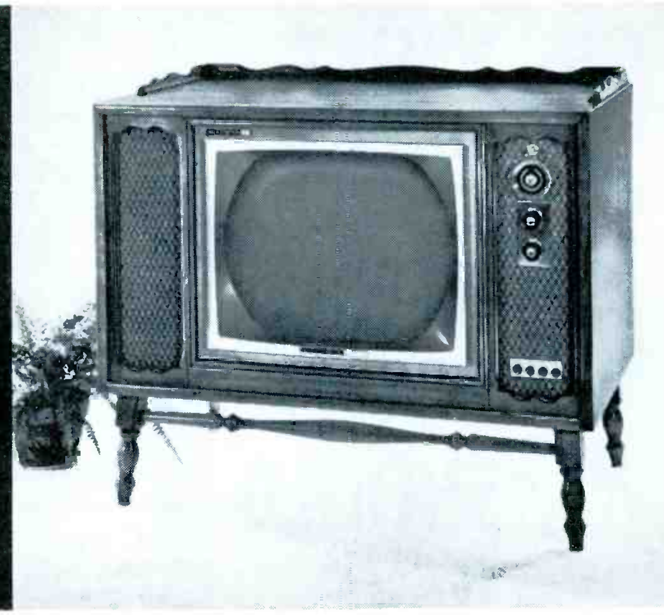


(B) Mount receptacle and wire.



(C) Insert socket unit (either side).

Fig. 5. Steps in installing *Socket Modification Kit* on Jackson 648R tester.



NEW RCA VICTOR COLOR TV!

PROVED IN SERVICE! PROFITABLE TO SERVICE!

New RCA Victor Color TV incorporates more than seven years of refinements based on field and service experience. Experience that tells you why RCA's new High Fidelity picture tube has been accepted as the industry standard. It's the same experience which has proved the greater dependability and serviceability of RCA's "road-mapped" printed circuits.

A proved chassis, with easy-to-find, accessible test points, proved-in-use replacement parts, and proved-in-practice service literature make RCA Victor Color TV *easy and profitable* to service.

Join the growing corps of servicemen who have found new interest and opportunity in Color TV. Ask your RCA Victor Distributor to help you.

SEE WALT DISNEY'S "WONDERFUL WORLD OF COLOR," EVERY SUNDAY, NBC-TV NETWORK

RCA The Most Trusted Name in Television

Tmk(s)®

Color Test Equipment

(Continued from page 31)

bars, but a gradual shading from one hue into the next.

The *keyed rainbow* or *sidelock* generator produces an output at a frequency 15,750 cps above or below the reference-oscillator frequency of the receiver. This gives the effect of a continuously varying phase difference between the generator and oscillator signals. In addition, both signals momentarily coincide in phase 15,750 times each second, thus enabling the receiver to lock into color sync at a definite point corresponding to "burst phase" in a normal transmitted color signal.

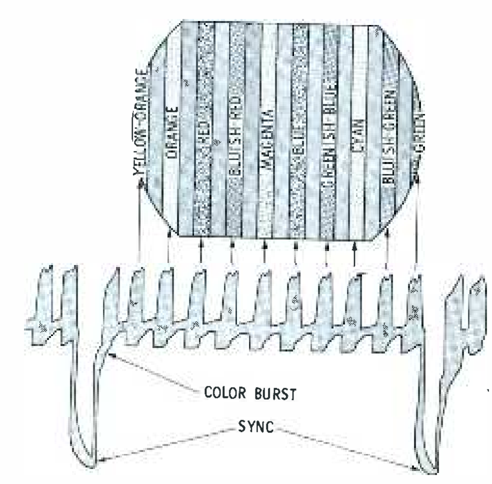
The generator output is keyed alternately on and off to form a series of well defined vertical bars representing 30° chroma-phase intervals. Of the 12 signal pulses generated during each horizontal sweep cycle, only 10 actually show up as bars on the screen. The 11th, at 0°, is utilized as a color burst; the 12th, at 330°, is lost during horizontal retrace time. The vector diagram (Fig. 1) and the drawing (Fig. 2A) indicate the various hues represented by the other phase angles, in the order they appear on the screen. Note that only one of the bars (green) happens to coincide with a pure primary color. Also, since the rainbow-generator output is not amplitude-modulated, the colors are not fully saturated.

The more elaborate NTSC-type bar generator develops a 3.58-mc chroma signal which is accurately amplitude- and phase-modulated to reproduce all three primary colors, and their complementary hues, at 100% saturation. Luminance information is also added to the signal so that all colors will be equally bright. An NTSC signal waveform and bar-sequence drawing are shown in Fig. 2B for comparison with the keyed rainbow signal in Fig. 2A.

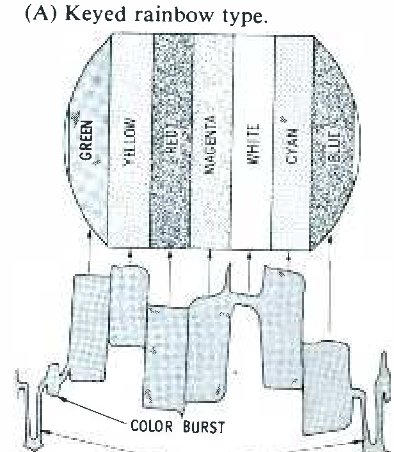
Any bar generator should provide a choice of RF or video outputs, so that the signal can be injected at various points to isolate troubles. These instruments commonly provide their own internal synchronization — a feature which simplifies the test hook-up. However, some units are equipped to accept external sync, which is useful in obtaining a more stable pattern under certain circumstances.

To decide which of the three types of color-bar generators would best suit your needs, first consider the probable extent of your color-TV servicing activities. If you're interested mainly in an easily-portable, low-cost unit to assist you in troubleshooting color defects (especially on home calls), a continuous-type rainbow generator will be satisfactory. It will help you to localize defects involving partial or complete loss of color, and will also show whether or not a receiver can be held in color sync. However, since these units typically provide no specific reference phase (burst signal), they are not adequate as a signal source for making chroma-sync and demodulator-phasing adjustments.

On the other hand, a keyed rainbow generator is excellent for this purpose, because it does offer a substitute burst signal in addition to

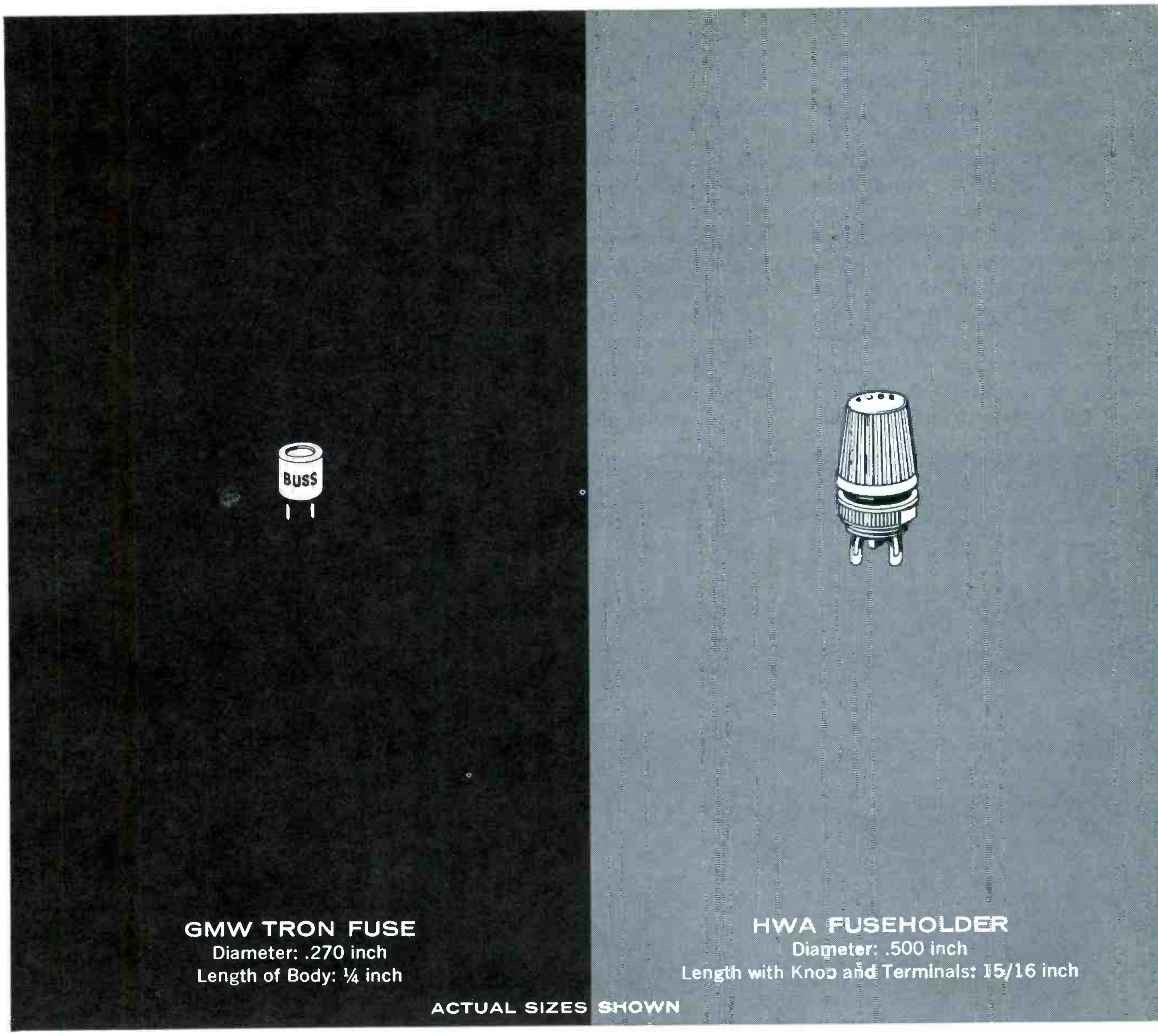


(A) Keyed rainbow type.



(B) NTSC standard type.

Fig. 2. Color-bar generator outputs.



Another BUSS sub-miniature fuse and holder combination

EXTREME RELIABILITY UNDER HIGH SHOCK AND SEVERE ENVIRONMENTAL CONDITIONS.

Rigid construction of fuse and holder assures extraordinary reliability under high shock and vibration conditions. Fully insulated ceramic body isolates fusible element from effect of dust, corrosion, moisture and vapors.

DESIGNED FOR SPACE-TIGHT APPLICATIONS

Panel Mounted. Holder can be mounted on panel by hand. No special tool required to run down holding nut.

Prong type contacts on fuse make it easy to install or replace.

A knob for the holder may be used to make holder water proof from front of panel.

HOLDER CAN BE MOUNTED IN PRINTED CIRCUITS

Terminals of holder can be inserted into holes and soldered on printed circuit board without additional forming.

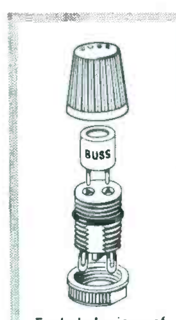
If desired, GMW fuse may be used without holder and mounted directly into printed circuit boards.

AVAILABLE RATINGS FOR GMW FUSES.

Fuses are made in sizes from 1/10 to 5 amperes for use on circuits of 125 volts or less where fault current does not exceed 50 amperes.

Transparent window in end of fuse body permits visual inspection of fusible element.

Before crystallizing your design using sub-miniature fuses be sure to get full data on the Buss GMW fuse and HWA holder combination.



Exploded view of GMW-HWA fuse & holder combination.

IN THE BUSS LINE, you'll find the type and size fuse to fit your every need . . . plus a companion line of clips, blocks and holders.

FUSETRON — TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION — BUSS

McGRAW EDISON

BUSSMANN MFG. DIVISION, *McGraw-Edison Co.,* **UNIVERSITY AT JEFFERSON, ST. LOUIS 7, MO.**

an output of varying phase. Since the keyed rainbow output includes a nearly complete range of hues, it also enables the user to recognize when some colors are missing from the picture or weakly reproduced. However, it is not as versatile as the NTSC generator in trouble-shooting this type of problem, since the saturation and brightness levels of the signal vary at random from hue to hue. Notwithstanding this slight limitation, a keyed rainbow generator can provide the average color-TV serviceman with adequate signals for practically all trouble-shooting and alignment needs. On top of this, it is moderately priced, and also portable enough to be conveniently taken on home calls.

An NTSC unit, the ultimate in color-bar generators, is a lab-type instrument suitable for analyzing the worst "tough-dog" problems ever encountered in color-TV servicing. As this description might lead you to expect, it is also the largest and most expensive type of bar generator. However, it is worth the extra investment when used at the bench in a shop that does a great deal of color work.

Pattern Generators

Color convergence adjustments demand the use of a generator that produces special white patterns on a dark background. Since the latest methods of convergence call for the use of both line and dot patterns, many generators offer a choice of horizontal-line, vertical-line, cross-hatch, or dot displays. Other units produce only dots or lines.

The edges of the dots or lines should change abruptly from white to black, since a sharp transition helps to reveal any color fringing caused by misconvergence. Also, the smaller the dot size, the more readily you can notice convergence errors. However, the dots should not be so small that they are difficult to see clearly. Typical generators produce square or round dots 1/8" to 3/16" across; some models of "dot-only" generators have provisions for varying the dot size.

A pattern generator, like a color-bar generator, should provide both RF and video-frequency outputs; furthermore, it should be possible to synchronize the scanning frequencies of the generator and receiver closely enough to insure a steady, jitter-free pattern.

In addition to a pattern generator's primary function of assisting in color convergence adjustments, it can be used even on black-and-white sets for signal-tracing, linearity adjustments, and approximate video frequency-response checks. (Since the dot or line signals are similar to square waves, low-frequency distortion shows up as smearing, and high-frequency distortion appears as edge-blurring or ringing.)

"I'll call your four 12AU7's and raise another two."

with...

...you can service

COLOR TV

simply...swiftly...profitably!

Color TV is Here . . . Prepare now . . . But, before you invest in color test equipment, get *all* the facts. Plan to attend a HICKOK Color Clinic and write for our free booklet, "Why NTSC?".

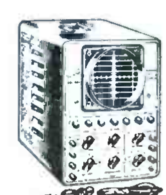
These manufacturers have announced that they will be marketing color television sets this fall.

DUMONT
ADMIRAL
ZENITH
GE
Emerson
Magnavox
Olympic.
PHILCO.

Remember, HICKOK *Color Approved* Test Equipment is built to NTSC standards, recognized and approved by leading TV manufacturers.

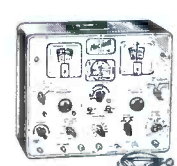
656
NTSC Standard Color Bar Generator

660
White Dot—Bar Generator



675A
Wide Band Oscilloscope

691
Heterodyne Marker-Adder



615
Sweep and Marker Generator

CR33
Color Tube Tester

The HICKOK Electrical Instrument Co.
10566 Dupont Avenue • Cleveland 8, Ohio

Some pattern generators also offer a color-bar output, thus combining the functions of two essential color-TV test instruments in one unit. The advantages for in-home servicing are obvious. However, if you plan to use the equipment for both home and shop jobs, you may find that separate color-bar and pattern generators will provide more desirable features than you can obtain in a combination instrument. Or it may work out better for you to keep a fairly elaborate bar generator at the bench and use a combined dot-crosshatch and continuous-rainbow generator for setting up and troubleshooting color receivers in the home.

CRT Testers

Since a tricolor picture tube costs well over $100 to replace, color-TV owners appreciate prompt and accurate information about the condition of this component. Therefore, an instrument that can check the performance of a three-gun CRT is a definite asset to the serviceman. A conventional type of CRT tester is satisfactory, provided that it includes a color-tube socket and also a three-position switch for selecting the particular gun to be tested. (These features may be either built-in or supplied as part of an accessory adapter.)

The tester should be able to indicate interelement shorts and tube emission. Optional features include a measurement to determine grid-cutoff characteristics, a relative life-expectancy test, and provisions for rejuvenation.

Voltmeters

Trouble in the color circuits can often be localized to specific components by checking voltage and resistance values at tube pins, using the same technique as in radio or monochrome TV servicing. However, some voltage indications may change only slightly when a trouble is present. For example, it's doubtful if mere DC-voltage checks will enable you to determine if color information is reaching a demodulator stage.

A VTVM, because of its high input impedance, should be employed for all grid-circuit measurements and for color-killer or chroma-sync troubleshooting. With an accessory RF probe added, this instrument can also indicate the amplitude of the color signals at various test points such as the secondary of the quadrature transformer. Still another function of the VTVM is as an indicator in chroma-sync alignment.

If you normally carry a 20,000-ohms-per-volt VOM on home calls, you will find it useful for making a fair number of key voltage and resistance checks on a color TV chassis still in the cabinet. When equipped with a high-voltage probe, a VOM is also convenient for measuring CRT focus and high-voltage anode potentials that normally range from 3 to 25 kv.

Voltmeters are not included in the test-equipment availability chart published with this article, because the units you now have will undoubtedly fill the bill very nicely for color-TV servicing.

Oscilloscopes

A wide-band scope is desirable for servicing color circuits. The expression *wide-band* refers primarily to the frequency response of the vertical deflection system. If the amplifiers in this section give equal gain to all frequencies up to approximately 4 mc, the scope can produce both low- and high-frequency components of the composite chroma signal at proper amplitudes. In a narow-band scope, the 3.58-mc color-burst and chroma information can usually pass through the vertical amplifier with sufficient gain to make its presence known; however, since it appears at a greatly reduced amplitude, the scope cannot indicate its peak-to-peak voltage with any degree of accuracy.

The vertical amplifiers of a color-TV scope need not have unusually high gain, since extremely low-level signals are not normally encountered in the color circuits. However, the scope should be capable of relatively high internal sweep frequencies (100 to 500 kc maximum), or should have provisions for expanding the horizontal sweep, so that reasonably well-defined 3.58-mc reference-oscillator and burst signals can be inspected.

Just as in scopes used for black-and-white TV servicing, a built-in system for calibrating waveform amplitudes is an asset. Both low-capacitance and demodulator probes also come in handy. These units should be properly matched to the scope and the attenuation factors accurately evaluated.

new

RCA COLOR TEST JIG

#11A1015

A **must** for any serviceman now servicing or planning to service Color TV receivers ■ Make a one man service call out of a costly two man cabinet pulling job ■ Eliminate possibility of damage to the customer's set when transporting to and from his home ■ Eliminate the need to reconverge the customer's set when the chassis is returned ■ Professional Appearance—Finish matches that of RCA Test Equipment ■ Partial Assembly—Safety glass and kine mask assembled at factory ■ Components Kit furnished with Test Jig includes all necessary components, hardware and Instructions for installation of an RCA Tri-Color Kinescope ■ Convergence control panel supplied provides dynamic as well as static convergence for the CTC-10 and CTC-11 chassis ■ Instructions included with test jig provides data for utilization with CTC-4, 5, 7 and 9 chassis and lists extension cables required ■

act now for the color season

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RCA The Most Trusted Name in Color Television

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You'll find an oscilloscope useful in signal-tracing chroma bandpass and demodulator circuits, checking signals at the output of the burst amplifier, sampling the output of the reference oscillator, and analyzing signals on the chroma phase-detector diodes. The scope also finds many applications in convergence-circuit troubleshooting, alignment, and checking the operation of other color test instruments.

Sweep Generators

An output in the video-frequency range is the most important special requirement for sweep-signal generators used in color-TV servicing, since the mean frequency of the generator output must be approximately 3.58 mc during chroma bandpass alignment. Many conventional TV sweep generators now afford this relatively low band of frequencies, with sweep width adjustable by either a switch or a control. Some units have a built-in marker generator, while others have provisions for adding markers from an external source. Some optional features that add to the convenience of using the generator are retrace blanking, a sweep-reversal switch, and provisions for crystal calibration.

Marker Generators

Marker generators used for color servicing must also have an output in the video-frequency range. Since accuracy and stability are imperative in a generator of this type, the instrument should have facilities for crystal calibration, and its power supply should be well regulated. Among the desirable, though not essential, features found in many generators are provisions for internal or external modulation, and a switch to select either pip or dip marker indications.

An *over-all* chroma-response check of the video-IF and bandpass amplifiers in a color set requires two additional pieces of equipment—a second marker generator (or other very accurate CW signal generator) and an RF modulator unit. The generator provides a 45.75-mc output that serves as a carrier for the video-frequency sweep signal, so that the latter can be fed through the video-IF section of the receiver. Amplitude modulation of the carrier by the video-sweep signal takes place in the modulator; then the output of this device is injected at the mixer, just as in conventional video-IF alignment. The video-frequency marker used during this procedure is coupled into the bandpass amplifier.

Conclusion

Obviously, it takes a fair-sized investment to equip a shop with the proper test equipment for color TV servicing. To offset this expense, however, you can justifiably advertise yourself as being "equipped for *professional* color service" — thus opening the way to a healthy increase in revenue. ▲

"Flashlight batteries."

K-950 ...8″ 2-way coaxial distributed sound loudspeaker....MORE THAN 50% LOWER INSTALLED COST!

NEW

Available with factory installed 70.7 or 25 volt transformers.
KWIKON* instant connectors and tap adjustments are a cost saving feature.

It's simple arithmetic to show that with the full 110 degree coverage angle of the K-950 (compared with 90° or less for conventional types) you can use *half as many speakers, transformers, ceiling baffles . . .* have *less than half* the installation cost, because KWIKON* instant connectors and factory preattached transformers further cut on-the-job time importantly. And amplifier cost goes down, too, due to reduction in the number of speakers plus higher efficiency.

When the K-950 is used with conventional "90 degree" spacing, reproduction quality is substantially improved, and loudness and articulation variations with position are drastically reduced compared with the performance of simple cone speakers.†

So whether you're designing for lowest installed cost or highest quality distributed sound, investigate the advantages of the outstanding K-950. Write for Specification Sheet CSP-102 for complete technical details.

†Results of an impartial test by a world famous firm of acoustical consultants.

NO OTHER DISTRIBUTED SOUND SPEAKER HAS ALL THESE FEATURES

1. Genuine coaxial 2-way system with electrically and acoustically independent tweeter.
2. High fidelity wide range response.
3. High efficiency.
4. Widest high frequency dispersion.
5. Lowest variation of articulation with position.
6. Super-shallow depth . . . will mount in the wall.
7. SYNTOX-6* ceramic magnet (10 oz.).
8. Available with factory mounted 70.7 or 25-volt transformers.
9. Handy 10-pack is economical, easy to handle.
10. KWIKON instant connection and transformer tap adjustments.

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SERVICE DEALER ADVERTISING PROGRAM

Several of these ads reflect a holiday theme that will soon be right in season. Don't delay; before the Christmas rush overtakes you, plan *now* for the ads you're going to use the rest of this year. For a change of pace from holiday greetings and special Christmas-season promotions, try the "TV Neurosis" cartoons included in this month's selections.

Check with your printer to see if you should order newspaper mats ($1.75 per set of 5), reproduction proofs ($1 per set), or both ($2.50). Then, fill in the handy coupon on page 100 to order either this month's selection or the entire program of 60 ads. (With the latter, you receive a comb-bound book of proofs.) To be sure of getting your ads in time for your promotion, mail the request as early as possible.

ES-18 1 7/8" x 3 7/8"

The viewer whose TV set conks out during his favorite TV show is perturbed, to say the least. But he'll recognize himself in this ad, cheer up, and probably call you.

ES-29 1 7/8" x 4 1/8"

Just in time for Christmas, this special get-acquainted offer provides a free toy for each customer's offspring — and some new names for your customer file.

ES-41 1 7/8" x 4 3/8"

This cartoon calls attention to one of the consumer's pet peeves (past-due delivery), and points out that you avoid this pitfall in public relations.

ES-51 3 3/4" x 2 3/4"

It's time to plan your Christmas-season advertising campaign. Here's a Merry Christmas wish that is quickly recognized as yours, since it follows the same pattern as your regular ads.

ES-33 3 3/4" x 3"

About the time your regular and prospective customers are thinking of New Year's resolutions, this gala greeting comes along to suggest they resolve to have their TV work done by you in '62.

G-E ELECTRONICS

ONE G-E 21FLP4 PICTURE TUBE REPLACES 13 TYPES

FILLS 25% OF YOUR REPLACEMENT NEEDS

The General Electric 21FLP4 just released. Here's the only picture tube you need for one out of every four replacements. It replaces 13 tube types. Thirteen replacement tubes you *don't* have to order—pick up—pay for—or carry in stock to meet your customers' requirements. It's almost like getting a 13-tube inventory in one picture tube! Quick availability for more of your replacement needs.

The General Electric 21FLP4 is a low-voltage electrostatic focus tube which does not require an ion trap magnet. Saves time and work on service calls and in the shop. The General Electric high-resolution electron gun and deep-cushion phosphor screen help provide the long-lasting, brighter picture your customers want.

The General Electric 21FLP4 replaces these 13 tube types:

21ALP4	21BAP4	21CBP4B
21ALP4B	21BNP4	21CMP4
21ATP4	21BTP4	21CVP4
21ATP4A	21CBP4	21CWP4
	21CBP4A	

Get full details on this 21-inch 90-degree "universal" replacement picture tube from your General Electric tube distributor. General Electric Company, Distributor Sales, Electronic Components Division, Room 8238B, Owensboro, Kentucky.

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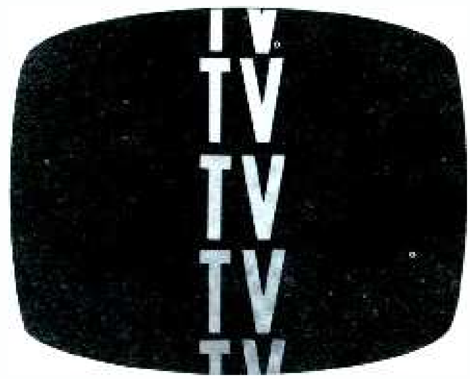


COLOR TROUBLES

These experiences will give you a better understanding of color TV troubles and their solutions.

Talk to anyone who is doing much color TV service, and you'll soon learn that the overwhelming percentage of trouble is in the black-and-white circuits. However, color-section defects claim more that their share of troubleshooting time, simply because service technicians are less familiar with the symptoms and circuits involved. To give you an idea of the special problems found in color sets, we've rounded up a few typical service experiences.

Ghosts in Technicolor

One case we've heard of, although not specifically a color problem, resulted in a service call because the receiver was a color set. The symptom, as understood from the customer's three-paragraph description, was a tunable ghost—one that comes and goes at various settings of the fine-tuning control. Had the receiver been a black-and-white set, there wouldn't have been a call—the customer would have been satisfied with the picture until a more severe trouble developed. However, with a full-color ghost showing up during regular monochrome programs, and the set producing a miserable color picture, it didn't take long for the customer to decide he needed service.

After the home-call man arrived on the scene and viewed the symptom himself, he quickly reasoned that the tunable ghost was due to an RF or IF defect. He therefore substituted the tubes in the tuner and IF section. This failed to solve the problem, so he carefully replaced the original tubes in their appropriate sockets, made an explanation that bench service was required,

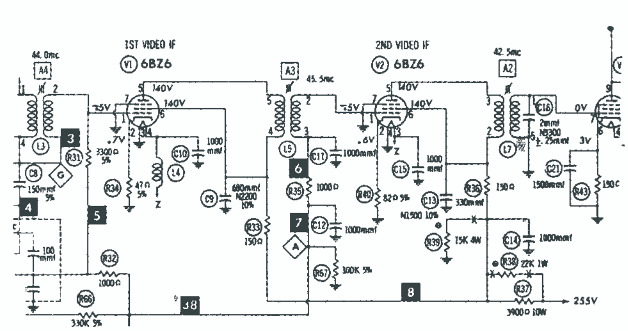


Fig. 1. Tunable ghost was traced to shorted capacitor.

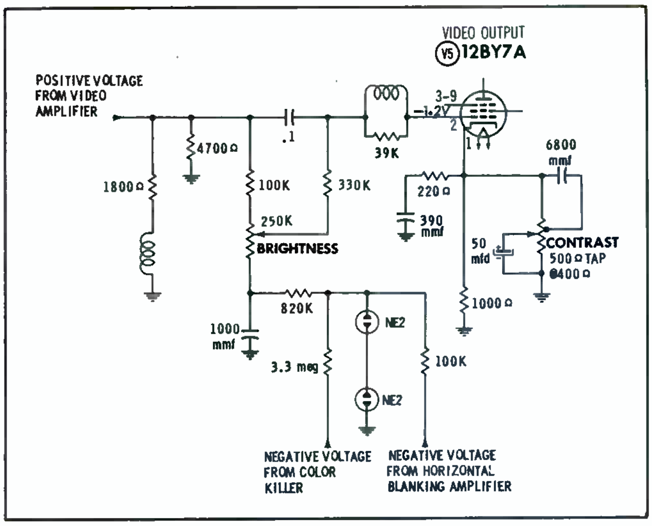


Fig. 2. Neon lamp failed in brightness-control circuit.

and carted the set into the shop.

The first few bench tests revealed regeneration in one of the IF circuits. On close visual inspection of the chassis, a 150-ohm, ½-watt resistor showed signs of overheating. When the set was fired up, a quick check of the voltages in the IF strip revealed low plate and screen voltages on the input IF tube (Fig. 1). A resistance measurement at pin 5 of V1 indicated a short circuit. Since R33 showed evidence of overheating, a shorted screen-bypass capacitor C9 was suspected. Sure enough, when the grounded lead of C9 was clipped, the short disappeared. Both C9 and R33 were replaced, and the set was again fired up. Success! There was no sign of a ghost, regardless of the setting of the fine tuning.

All or Nothing

Another trouble unique to color sets showed up in a newer RCA Chassis CTC10. This set produced a picture only when the brightness control was advanced to maximum. There was always light on the screen no matter where the control was set; however, video information wouldn't appear except at the maximum setting.

What could have been a rather knotty problem was again solved by close visual inspection—after the chassis was fired up on the bench. Two NE2 neon lamps form the ground-return path for the negative bias circuit feeding one side of the brightness control (see Fig. 2). In this chassis, the lamps failed to light. This fault was immediately noted by the serviceman, who is already an "old pro" in color work.

By putting two and two together, the serviceman reasoned that excessive bias was cutting off video output tube V5 except when the brightness control was set to the most positive position. This meant there was either excessive negative voltage at one end of the control, or insufficient positive voltage fed to the other end from the video amplifier stage. Since the NE2's failed to light, excessive negative voltage and a defective lamp seemed to be the mostlikely answer. A quick check with a VTVM confirmed this suspicion. Bridging a new NE2 across each lamp disclosed one defective unit. (The technician had to bridge both of them because he tried the good one first!) After the bad NE2 was replaced, normal operation was restored, and another color trouble bit the dust.

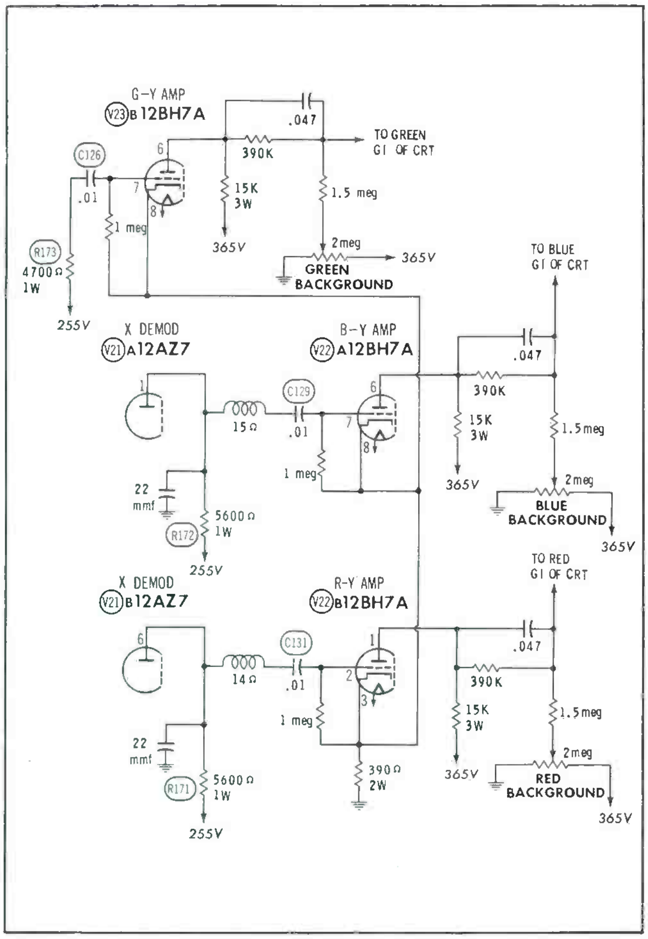


Fig. 3. Red screen was produced by short at R–Y amplifier.

Saw Red

Troubles that produce a solid-color background for any picture are fairly common in color TV work. Although the screen may be tinted with any of the three primary colors, our favorite example of this type of trouble literally caused the customer to see red.

In such circumstances, it doesn't take too much brain power to figure that the problem must be caused by improper gray-scale adjustment (color temperature), a defect in the CRT circuit, or trouble in the R–Y amplifier stage (Fig. 3). Simply adjusting the red screen and background controls in this case proved it wasn't a misadjustment problem. Also, substituting V22 eliminated the possibility that a heater-cathode short or gassy R–Y amplifier might be causing the trouble.

When the VTVM was put to work measuring the voltages at the R–Y amplifier, a healthy positive voltage was found on the control grid. The best bet was that coupling capacitor C131 was shorted. Also, it was probable that increased current had caused R171 to decrease in value. Clipping one lead of C131 reduced the grid voltage to nearly normal—proving it was shorted. Therefore, R171 was checked and, as suspected, it had dropped to a low value.

Replacing the two defective components restored normal operation. However, this didn't conclude the troubleshooting. Experience has shown that two 1600-ohm, 10-watt resistors in the power supply feeding the 280-volt source are often damaged by this sort of trouble. Therefore, they were checked and found to be changed in value. Both resistors were replaced to complete the job.

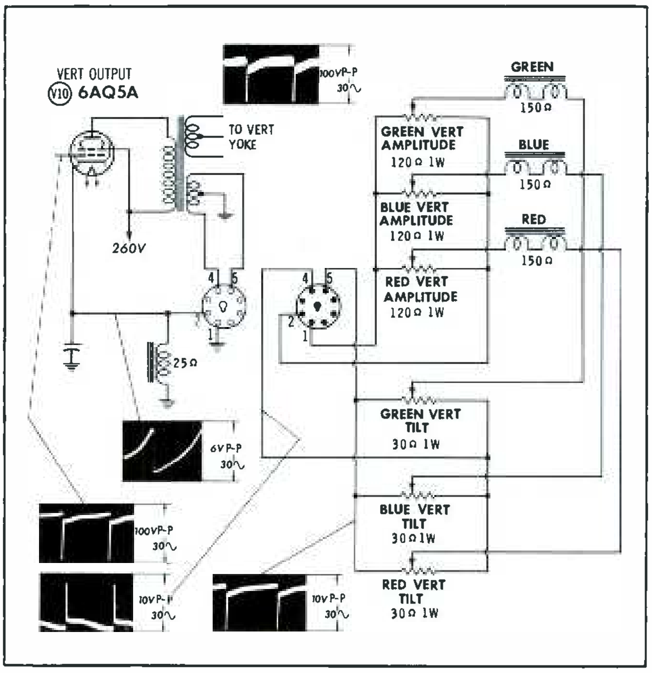


Fig. 4. Faulty 6AQ5A caused intermittent misconvergence.

Whipped Dog

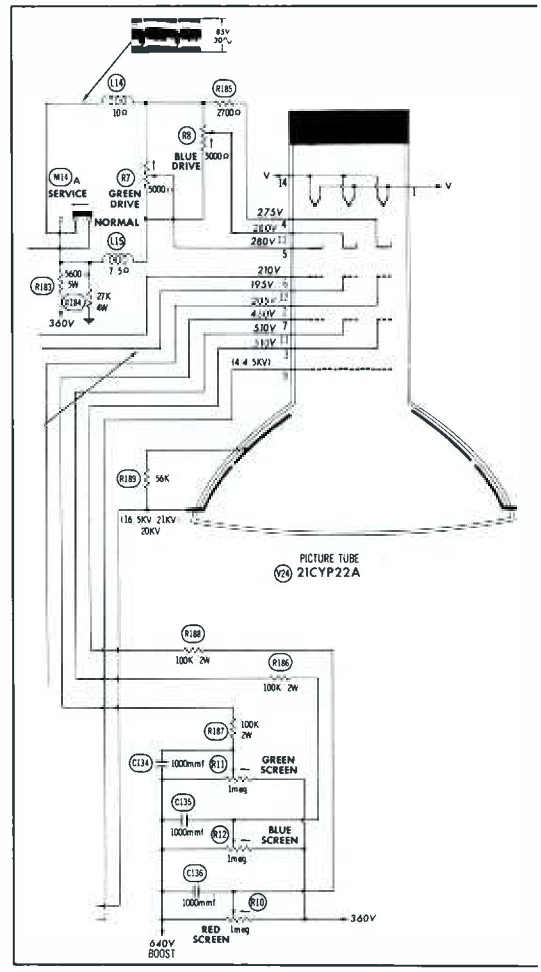
The "doggiest" color problem we've ever heard of involved the convergence adjustments. Contrary to what you may be thinking, the set *would* converge beautifully; but at random intervals, convergence would become terrible. This time interval wasn't consistent; the trouble might show up in an hour or in a week. In fact, the serviceman reconverged the set a couple of times before he was convinced he had anything but "tinker trouble" on his hands.

Because of the erratic nature of the defect, the set was pulled into the shop for bench service. Naturally, everything was perfect when the chassis was put on the bench. However, the serviceman did take advantage of this opportunity to measure and record all voltages, as well as waveform shapes and amplitudes, in the convergence circuits (Fig. 4). Eventually the trouble reappeared, and it was determined that something was wrong in the vertical convergence circuits. Even so, all resistances checked normal, and there was no apparent sign of overheating. Therefore, the set was reconverged, and more extensive measurements and signal amplitudes were recorded—this time all the way back to the grid of the vertical output stage.

Again there came a time of continued "cooking" and waiting for trouble to develop. Two days, later, the set went out of convergence. Waveform tests showed reduced signal amplitudes as far back as the yoke—yet the drive signal at the grid of V10 hadn't changed. Again, resistance measurements didn't show a defect. Therefore, muttering under his breath and hoping against hope, the technician slipped in a new 6AQ5A and fired the chassis up once more. It was necessary to reconverge the set again. However, everything seemed normal after a full week of cooking, so the set was returned. Further checks on the operation of the set showed it to be doing fine. The solution: A tube with erratic operation! The explanation: Just one of those things that makes all of us "love" intermittents. ▲

THE TROUBLESHOOTER

answers your service problems



Color Hash

An RCA CTC4 chassis is giving me a rough time. During color programs, color hash appears as soon as the color control is advanced slightly from the minimum setting. However, there is no hash in black-and-white pictures.

GABRIEL SAND

Jacksonville, Fla.

Take a more critical look at that symptom. Color hash (also referred to as "confetti") is nothing more than colored snow. Therefore, you undoubtedly have a snow problem and should check the antenna, RF, IF, and AGC circuits. Close observation of a black-and-white picture will probably reveal the snow; however it's certain to be more noticeable during a color transmission.

Incidentally, it's almost a sure bet that the killer threshold control is misadjusted, making it necessary to set the color control to minimum during monochrome reception to prevent color contamination. Notice that the bias voltage developed to cut off the bandpass amplifier during black-and-white reception is produced by the conduction of both the color killer and blanking amplifier. This circuit is rather unusual, and operates as follows:

During black - and - white programs, V20A is cut off by a negative voltage developed across R168 at the chroma phase detector. This voltage is produced by the conduction of the lower section (pins 1 and 7) of V21 when a positive pulse is applied to pin 7. The applied signal is a combination of an amplified keying pulse from the killer and a portion of the signal developed in the cathode circuit of the blanking amplifier. The amplitude of the latter depends on the setting of the color control, and that of the former is determined by the setting of the killer theshold control.

When a color signal is received, the burst signal is fed to pin 7 of V21 from the burst amplifier. A negative voltage is then developed across the series combination of R168 and R169, and is fed to the grid of the killer. Here it combines with the positive voltage from the threshold control, and conduction of the killer is reduced or blocked—depending on the control setting. This, then, permits the color control to regulate the bias on the bandpass amplifier by varying the amplitude of the signal fed to pin 7 of V21.

Intermittent Blur

I'm having trouble solving an intermittent focus problem in an RCA CTC10 chassis. The last time it happened, R188 at the red screen grid (pin 11) of the CRT overheated, and I was able to determine that the focusing voltage was quite low. However, the trouble cleared up before I could find the cause.

K. S. JACKSON

Ann Arbor, Mich.

Chances are you have an intermittent short between the red screen grid and focusing anode of the CRT. The next time the trouble appears, pull the picture-tube socket and check voltages again; you'll probably find they will return to normal with the socket removed. If so, the CRT is definitely shorting.

Hot Stuff

I'm having trouble in a Sylvania color TV (Chassis 1-534-1) with arcing from the CRT to the convergence yoke and to the tuner. Also, there is some arcing in one of the 3A2 tubes. I've changed the high-voltage regulator, but it didn't help.

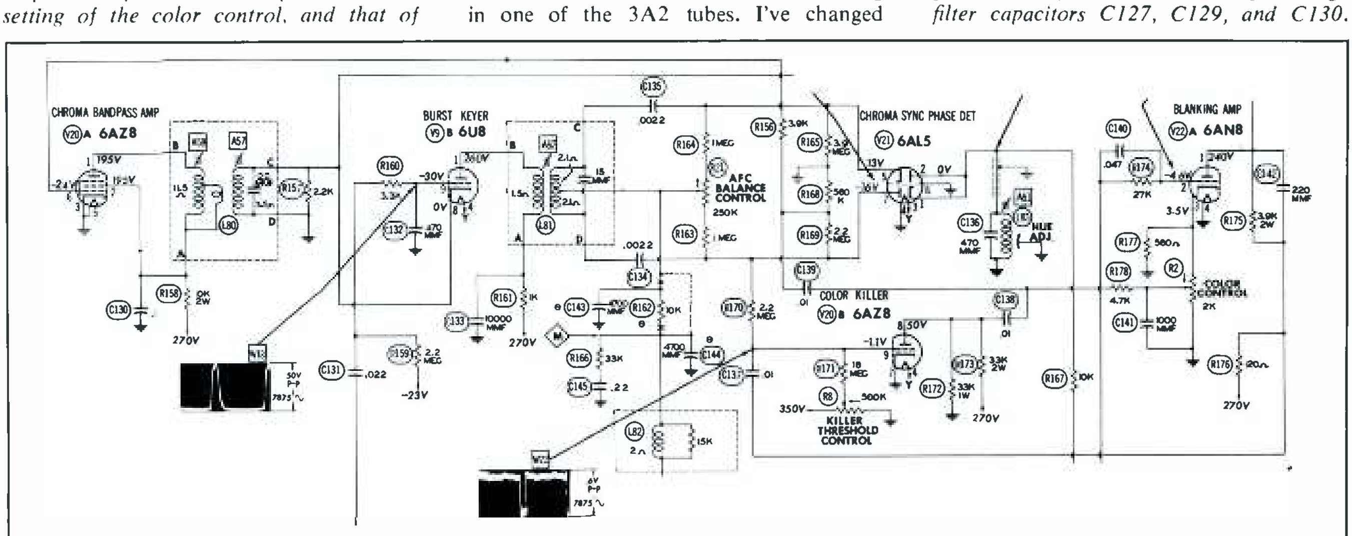
JOHN E. PAVLICK

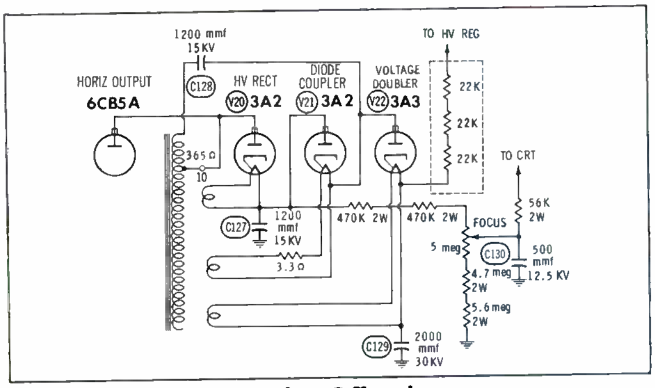
Monroeville, Pa.

When you changed the high-voltage regulator you eliminated the most likely suspect.

A lot of stray RF must be floating around inside the set. Check to make sure the convergence yoke and CRT shield are well grounded. Perhaps a ground strap was left disconnected during a previous service call.

As far as the 3A2 is concerned, be sure the plate leads are dressed away from the glass envelope, and check high-voltage filter capacitors C127, C129, and C130.





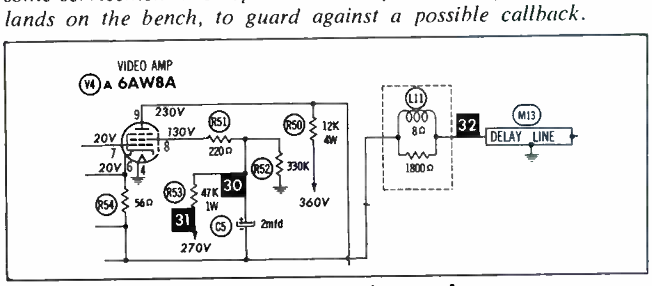
Regular Offender

An RCA CTC10 chassis has a rather weak picture with very touchy vertical hold. The trouble is present on both black-and-white and color programs. All voltages appear to be normal. Any suggestions?

J. G. REESE

Philadelphia, Pa.

The 2-mfd bypass capacitor C5 in the screen circuit of the video amplifier is probably your culprit. This component is a regular offender. When it opens, the unbypassed screen grid causes a loss of video and also sync compression. We know of some servicemen who replace this component every time a chassis lands on the bench, to guard against a possible callback.



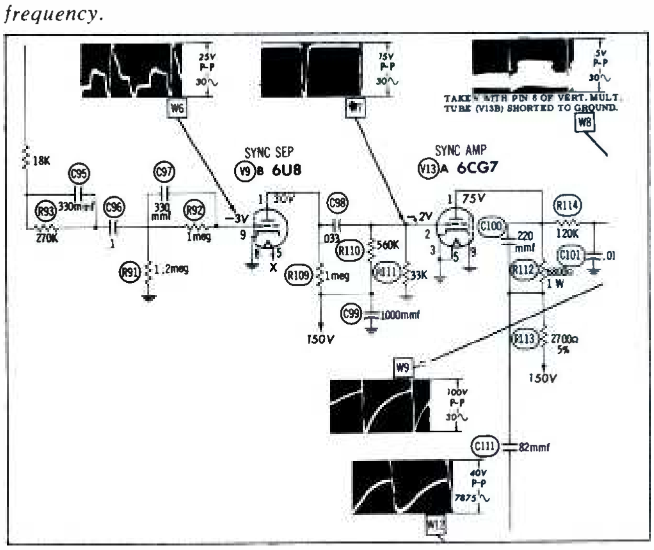
Contrary Horizontal

I'm having trouble pinning down a horizontal hold problem in an RCA CTC5B chassis. The set works fine during color programs, but it loses horizontal hold when a black-and-white show comes on. When the picture is out of sync, the horizontal hold control has no effect.

J. W.

Laurelton, N.J.

This sounds like sync trouble. Apparently the burst signal is adding just enough pulse amplitude during color programming to synchronize the oscillator. Use your scope to trace through the sync circuits until you locate the defective stage. You're most likely to find trouble in the sync separator, since the burst signal could be increasing the bias in this stage and providing better separation. If this is the case, you'll find video information at the output of the separator during black-and-white programs. This of course, could drive the horizontal oscillator far off frequency.



Bandpass & Demodulator

(Continued from page 26)

vided by this arrangement may be used either to permit feeding a signal directly to the bandpass amplifier from the video detector, or to develop the relatively high input-signal amplitude required by some types of chroma demodulators.

Fig. 2 illustrates a two-stage circuit containing many of the same features found in Fig. 1. However, notice that the burst signal is taken from the secondary of the interstage transformer. This means that the horizontal blanking pulses and color-killer bias must be applied only to the second bandpass stage, because the first stage must be left conducting so that the burst signal can reach the input of the color killer.

In the grid circuit of the first bandpass amplifier, the connection marked FROM KILLER DET is a source of automatic chroma control (ACC) bias. The negative voltage at this point, produced in proportion to the strength of the burst signal, assists the AGC system of the receiver in maintaining a steady input-signal level at the chroma demodulators.

Another type of two-stage bandpass amplifier, introduced this year in the new Zenith color sets, is described in "What's New in Color TV?" elsewhere in this issue.

Frequency Response

A correct response curve in the bandpass - amplifier section is extremely important to good color reproduction. When the bandwidth is too great, or the frequency limits of the response curve are incorrect, the luminance (Y) signal enters the bandpass amplifier and causes cross talk. This results in ragged or fluctuating edges on objects in the picture which are much brighter or darker

"You've got to look and think like an ace TV repairman, charm the customer, keep up on the latest technology . . . Oh, skip it!"

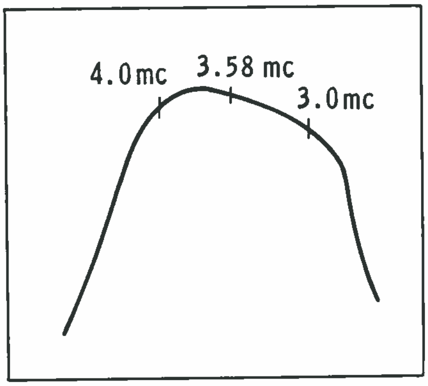


Fig. 3. In many sets, response curve of bandpass amplifier has slight tilt.

than their surroundings. On the other hand, too narrow a bandwidth produces an effect similar to the results of narrow response in black-and-white video amplifiers. Color details are less clearly defined because the chroma sideband frequencies farthest from the carrier (representing the finest picture details) are choked out. The stage gain may also be reduced, thus weakening the chroma signal and causing poor color contrast. If there is severe misalignment, the chroma signal may be badly distorted; typical results are a smeared, muddy-looking picture or incorrect hues.

In addition to the exacting bandwidth requirements of the bandpass response curve, its slope is also fairly critical. The bandpass amplifiers of most receivers are tuned for slight peaking toward the high-frequency end of the curve, somewhat as shown in Fig. 3, rather than for a flat-topped response. This is the reverse of the video-IF curve, which gradually falls off at frequencies 3 to 4 mc away from the picture carrier. Therefore, the overall frequency response of the signal path from the mixer-oscillator stage to the chroma demodulator is substantially flat between approximately 3 and 4 mc.

A video-frequency sweep generator and certain other special facilities are necessary for checking chroma-bandpass response. (See "Test Equipment for Color TV" in this issue.) However, shops that are serious about color TV work find it advantageous to have this equipment and use it frequently in maintaining top-notch color-picture quality.

Common Circuit Troubles

Next to tube failures, capacitor defects are the greatest source of difficulty in bandpass amplifiers.

Leaky capacitors may shift bias voltages in either a positive or negative direction, depending on the circuit arrangement and the location of the defective capacitor. Thus, accurate circuit analysis and careful voltage checks are particularly important in localizing bandpass-circuit capacitor troubles.

Too much negative bias voltage on the bandpass amplifier produces symptoms similar to those of a weak tube. The stage gain is reduced, and color contrast (saturation) becomes poor. Color sync is also likely to become unstable if the burst signal passes through the affected stage. A very negative voltage may cut the bandpass amplifier stage completely off, resulting in no color. The opposite trouble — bias voltage not negative enough — may cause a bandpass stage to become overloaded and produce smeared or false colors in the picture. Bias troubles usually originate in the color killer or ACC (automatic chroma control) circuits, but a defective cathode - bypass capacitor could result in the same trouble.

Marginal or defective filter capacitors in the B+ supply sometimes interfere with good color reproduction by placing colored hum bars in the picture. However, the ripple voltage to the bandpass amplifier must usually become quite large before any indication of breakdown actually shows up. Another trouble which may originate in the B+ system is low plate or screen voltage on a bandpass amplifier, which reduces stage gain and results in compression or clipping of the chroma signal. The symptom is usually very weak color, or in some cases, a complete loss of color.

A defective horizontal blanking amplifier, or a damaged blanking-pulse winding on the horizontal output transformer, is not an uncommon occurrence. Either of these troubles permits a burst signal to pass through the bandpass amplifier to the color demodulators, possibly producing the yellowish interference mentioned earlier.

Saturation controls are often troublesome. A dirty or noisy control can cause everything from drifting color reception to jumpy or intermittent color.

Sound traps in the bandpass amplifier are another trouble spot in older color sets. In many cases, they drift off frequency, distorting the bandpass - amplifier response curve and letting sound interference appear in the picture. A shorted parallel trap produces symptoms very similar to an off-frequency trap, but is often difficult to pinpoint. A shorted series trap circuit means an inoperative amplifier.

Various makes and models of color receivers tend to develop their own characteristic circuit troubles. For example, service technicians in the field constantly report two specific breakdowns in the RCA Chassis CTC4 which caused weak color or complete loss of color. One is a high-resistance short between the primary and secondary windings of the bandpass transformer, resulting in lower plate and screen voltage on the bandpass amplifier. The other common trouble is an increase in the resistance of a 560-ohm, 1-watt plate-decoupling resistor in the demodulator-driver circuit. The change is apparently caused by an intermittent short in a 10,000-mmf bypass capacitor, which results in excessive current through the resistor.

Chroma Demodulators

The combined phase and amplitude modulation in the bandpass-amplifier output signal is detected by the chroma demodulators. These circuits come in pairs, since proper demodulation requires the use of two separate 3.58-mc reference-oscillator signals at different phase angles with respect to the color-burst reference phase. The demodulators are designated by letters to indicate the phase angles or *axes* used. R–Y and B–Y axes (or a slight variation, X and Z) are exclusively used in today's sets; however, some past models have used other pairs of axes such as I and Q or R–Y and G–Y.

A quick review of how the color signal is transmitted will help to explain what these letters mean. When the brightness-level information (also called luminance or Y signal) is removed from the outputs of the red, blue, and green color cameras, the remaining portions are the *color-difference signals* (R–Y, B–Y, and G–Y, respectively). These are the signals which eventually reach the grids of the tricolor CRT. For broadcasting purposes, however, they are combined in specific proportions to form I (in-phase) and Q (quadrature or 90° out of phase) signals. These permit transmitting the maximum practical amount of color-picture detail in a limited bandwidth.

All the transmitted information can be recovered by the receiver if the two reference-oscillator signals used in demodulation are phased to the I and Q signals at the transmitter. However, the outputs of the demodulators must then be put through a relatively complicated matrix, requiring positive and negative polarities of both I and Q, to recover the original color-difference signals. To minimize this extra circuitry, the demodulator phasing can be adjusted so that the demodulators will directly produce two of the three color-difference signals. The third is then obtained by a combination of the first two. This simplification reduces the usual bandwidth of the chroma signal, but only enough to lose a slight amount of color in small areas of the screen.

The R–Y and B–Y axes are customarily used for demodulation, although a combination of B–Y and G–Y have been employed on occasion. Fig. 4 shows a typical modern circuit. The "X" and "Z" labels on the demodulators simply refer to reference-oscillator phases that correspond to R–Y and B–Y outputs. Each demodulator is biased so that it conducts only on the negative

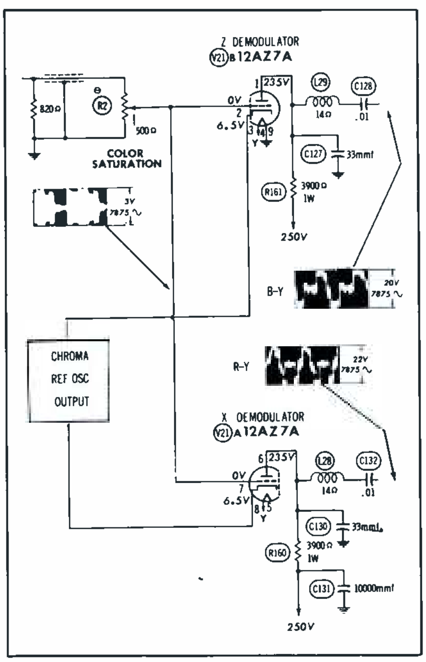


Fig. 4. Chroma demodulator circuit and waveforms of NTSC color-bar signal.

peaks of the 3.58-mc reference signal fed to its cathode. At this "sampling" time, the strength of tube conduction is determined by the instantaneous amplitude of the chroma signal on the grid. If the phase of the reference signal is accurately adjusted, this process results in a pure R–Y or B–Y signal at the plate. (A 3.58-mc signal component is also present, but this is filtered out by coils L28 and L29 in conjunction with bypass capacitors C127 and C130.) The signal is amplified as well as demodulated; however, the plate signals are still not strong enough to be fed directly to the control grids of the CRT. Therefore, R–Y and B–Y amplifiers (not shown in schematic) follow the demodulators. A G–Y signal is developed across the common cathode resistor of these stages and used to drive another amplifier that feeds the green CRT grid.

A different type of R–Y and B–Y circuit, introduced by Zenith this year, is more fully described in "What's New in Color TV?" elsewhere in this issue. Using sheet-beam tubes, it produces high-amplitude outputs of both positive and negative polarities. The circuit contains no additional color-difference amplifiers—just a resistive matrix to adjust the relative signal amplitudes and obtain G–Y.

Common Circuit Troubles

A defective filter coil or oscillator-plate transformer is a particularly troublesome service problem in chroma demodulators. An open or shorted primary winding in the transformer removes the reference signal from the demodulators, while a defect in the secondary circuit usually shows up as a phasing error which results in incorrect reproduction of hues. An open coil in the output of a chroma demodulator kills one of the color-difference signals. In addition, it sometimes upsets the DC voltage distribution in the chroma circuits, producing color tinting in the raster. A shorted coil allows the subcarrier signal to reach the picture tube; this generally results in overloading and produces a smeared picture. Shorted turns also produce the same effect. A careful ohmmeter check will sometimes uncover this trouble, but it is far better to substitute for suspected components.

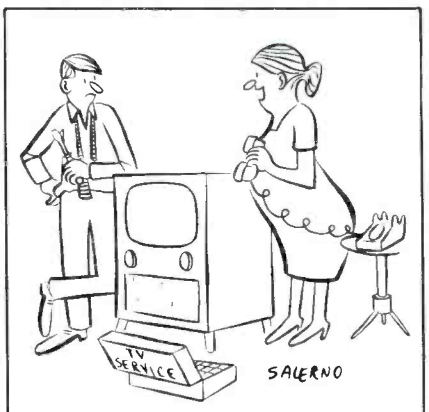
Hum in chroma demodulators, usually attributable to heater-cathode leakage, is a very common occurrence. This fault produces horizontal hum bars in the picture. Different colors are generated in different types of demodulators, as follows:

COLOR	AXIS
Orange and Cyan:	I
Green and Magenta:	Q
Red and Blue-green:	R–Y
Blue and Yellow-green:	B–Y
Green and Blue-red:	G–Y

It should be pointed out that hum in the demodulator will mix with the test signal from a color-bar generator and produce incorrect colors; that is, the hues will change from the top to the bottom of the picture-tube display.

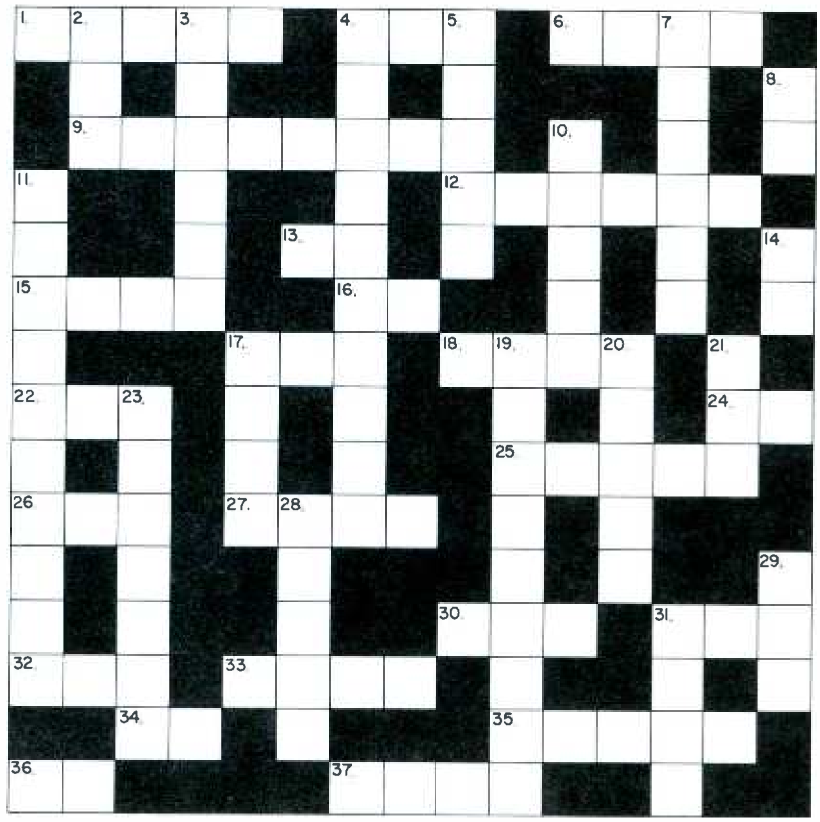
Supposed demodulator faults often originate in other circuits — particularly the 3.58-mc oscillator. Since the output signal of the oscillator is used in the demodulation process, failure of this circuit for any reason results in an inoperative chroma demodulator and a loss of color. Lesser defects in the oscillator also affect the demodulators and produce intermittent or weak color. Incorrect hues are also sometimes produced by a weak subcarrier-injection signal.

An absence of output from the demodulator can also be caused by partial or complete loss of the chroma signal from the bandpass amplifier. Therefore, in isolating the cause of apparent demodulator failure, be sure to check both chroma and reference waveforms entering the stage—paying special attention to their amplitudes. ▲



"It's my husband, he says be sure to check the horizontal syncopation, see that the audio harmonics are adjusted, and he wants you to file the tuner."

COLOR TV CROSSWORD



Are you familiar with the many words and terms used in color TV? Test your color TV vocabulary by working this challenging crossword.

Watch out—Many of the clues are tricky just to throw you off the track! After you have filled in all the empty blocks, check your solution against the diagram on page 95.

ACROSS:

1. Another name for a matrixing amplifier.
4. The color burst is a sample of the 3.58-mc ______ carrier.
6. The purpose of the burst signal is to ______ the reference oscillator on the correct frequency and phase.
9. Term applied when all three rasters of the color CRT are superimposed on each other.
12. This word, in conjunction with item 31 down, describes a device mounted inside a tricolor picture tube.
13. Voltage output of the red camera tube at the transmitter (abbr.).
15. In late-model color sets, proper dynamic convergence on the right side of the screen is obtained by making ______ adjustments.
16. The type of modulation placed on the chroma subcarrier to determine saturation of colors (abbr.).
17. A color-TV signal-generator pattern used in adjusting convergence.
18. For accurate color reproduction, the over-all frequency response from the antenna to the chroma demodulator must be ______ from approximately 3 to 4 mc.
22. If there are no shades of green in the color picture, check to see if the G—Y amplifier tube is ______.
24. In color TV, "break-______" is an effect caused by rapid subject motion.
25. Watery color picture pattern resulting from interference beats.
26. Two of the ______ chromatic coefficients describe a color by its position in a chromaticity diagram.
27. ______ing in the color picture may result from a defective delay line.
30. The CW driver transformer in a color set resembles a typical video IF ______.
31. In the ______rix circuitry, the three primary color signals are recovered from the demodulated chroma signals.
32. Pastels are ______saturated colors.
33. Many stations transmit a color stripe as a ______ signal.
34. The resultant of —I and —Q is ______ – ______ (supply missing letters).
35. In a properly-converged tricolor CRT, the paths of the electron beams from the three guns ______ at the shadow mask.
36. The resultant of +I and +Q is ______ – ______ (supply missing letters).
37. The color represented by the B—Y color-difference signal.

DOWN:

2. One of the primary TV colors spelled backwards.
3. Spurious colors at borders of different-colored areas in the color picture.
4. The characteristic of a color that expresses the relative freedom from dilution by white light.
5. The 3.58-mc color sync signal.
7. The section of a color receiver which is inactive during black-and-white reception.
8. The color difference signal produced by combining —I and +Q chrominance signals is ______ – ______ (supply missing letters).
10. Coefficient defining the relationship between the luminance of the color picture and the CRT drive voltage.
11. Generally speaking, the ______ of color information in the picture is not as good as that of the black-and-white information.
14. Voltage representing the brightness component of the color TV signal (abbr.).
17. In most color sets, the high-voltage regulator tube can be reached through the______of the high-voltage cage.
19. The part of the color TV signal which can also be utilized as a black-and-white video signal.
20. Group of three primary color phosphor dots.
21. The identification or "name" of a color.
23. Hangover of luminous spots on TV screen.
28. The color TV term______leaving denotes the transmission of both color and monochrome signals within the same range of video frequencies.
29. Color television (abbr.).
31. See clue 12 across.

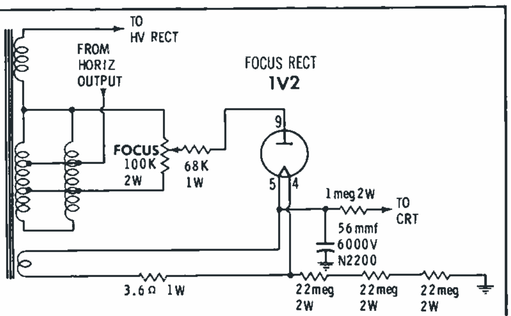
What's New in Color

(Continued from page 35)

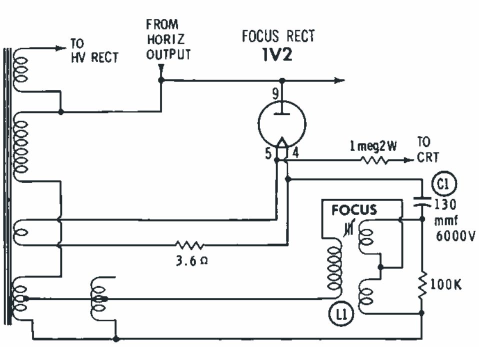
former L2 contains relatively equal proportions of all chroma-signal components within the range from 3 to 4 mc. This signal is tapped off at the desired level by the color control.

Two signals from the blanking amplifier are coupled to the grid and cathode of the bandpass amplifier to cut it off during horizontal-sync time, thus preventing the 3.58-mc burst signal from reaching the demodulator circuits.

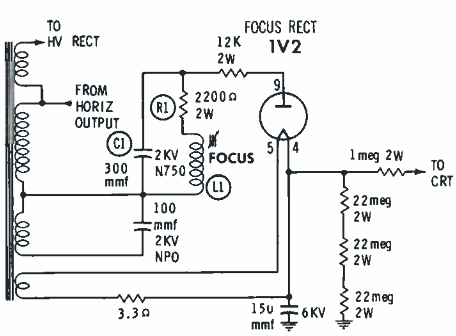
Some '62 receivers use a two-stage variation of the above circuit, as described in "Chroma Bandpass and Demodulator Circuits" elsewhere in this issue. It is important to recognize this variation when you are troubleshooting color problems, since an extra stage of amplification means another possible trouble spot.



(A) Potentiometer control.



(B) Opposing-pulse control.



(C) Phased sine-wave control.

Fig. 5. Typical focus circuits.

The third style of bandpass amplifier circuit also incorporates two stages of amplification. However, it uses a different method of interstage coupling, and the input signal is obtained from the video detector rather than from the video amplifier. This system, used by Zenith, is shown in Fig. 4. Like the other two-stage circuit, it includes the added feature of *Automatic Color Control* (ACC). This is similar in action to AGC, acting on the control grid of the first bandpass amplifier to regulate amplification of the chroma signal.

A 3.58-mc signal from the burst amplifier is fed to the ACC-killer phase detector, where it is compared to a reference-oscillator signal taken from the in-phase secondary of the quadrature transformer. Since the reference oscillator maintains a constant output, the conduction of the ACC-killer phase detector is regulated by the strength of the burst signal. Obviously, since the amplitude of the burst signal varies as reception fluctuates, ACC phase-detector conduction will vary and automatically adjust the bias on the bandpass amplifier to maintain a constant color-signal level.

Incidentally, coil L1 in Fig. 4 serves the conventional chroma-sync phase detector as well as the ACC-killer phase detector. This design feature is one of several minor variations in chroma-sync circuitry found among the '62 sets. For a more detailed explanation of how these circuits function, see "Understanding Chroma Sync" in this issue.

Picture Tubes

An increase in light output has been obtained in the new 21FBP22 and 21FJP22 picture tubes through the use of more efficient sulfide phosphors. These CRT's, found in most of the '62 sets, are also available for direct replacement of different types used in older color receivers.

Changing over to a sulfide-type tube presents one slight problem: The new blue, green, and red phosphors are more nearly equal in efficiency than those formerly used. Whereas the red phosphor always used to be considerably less efficient than the other two, it is now possible for it to be even more efficient than the blue phosphor.

The light-output balance among the three phosphors is not the same

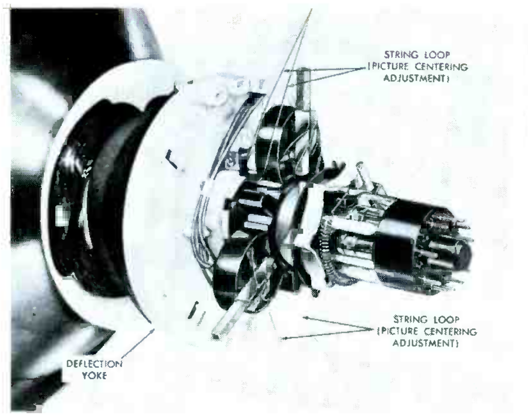


Fig. 6. Centering rings in one new set are manipulated by means of strings.

for every individual tube; thus, most new sets provide a means of compensating for differences in efficiency by rearranging the cathode circuits of the three CRT guns. Two cathodes are returned to the center arms of the CRT-drive controls, while the third cathode is connected directly to the video amplifier circuit. This direct connection is usually made to the red gun, since the red phosphor is generally the least efficient. However, with the circuit wired in this way, it is sometimes impossible to set the drive controls for a white raster. In such cases, the cathode circuits must be reconnected.

When a sulfide tube is installed, it is impossible to determine in advance which phosphor will be the least efficient; a trial setup procedure must be performed to obtain this information. An over-all magenta tint in the raster means that the direct connection should be transferred to the green gun; an over-all yellowish background means that the blue gun should be direct-connected.

Focus Circuits

The methods used to obtain variable focus voltages in the new color sets also reduce to only three basic configurations, as shown in Fig. 5. In A, the voltage applied to the plate of the focus rectifier is varied by a potentiometer connected across a portion of the secondary winding on the flyback.

In the most widely used circuit (shown in B), L1 develops a rather low-amplitude pulse of positive polarity which is coupled to the filament of the rectifier through C1. As the focus coil is adjusted to produce a higher pulse amplitude, the potential between plate and filament is reduced, the tube conducts less, and the focus voltage is reduced. If a higher focus voltage is required, the amplitude of the feedback pulse can be lowered in order to increase tube conduction.

In Fig. 8C, on the other hand, the amplitude of the pulse applied to the plate is varied. Components L1, C1, and R1 form a ringing circuit that produces a sine wave measuring 2000 volts peak-to-peak. Adjusting L1 varies the phase of the sine wave in relation to the pulse. In this manner, the algebraic sum of the two signals can be modified to increase or decrease plate voltage, in turn adjusting the output.

Picture Centering

For the first time in the history of color TV, centering rings similar to those used in monochrome receivers have been put to use. The rings are mounted inside the yoke assembly and can be adjusted by means of a pair of string loops (Fig. 6).

The above arrangement is found only in Zenith sets. All other color receivers employ electrical centering circuits which control the direct current flowing through the vertical and

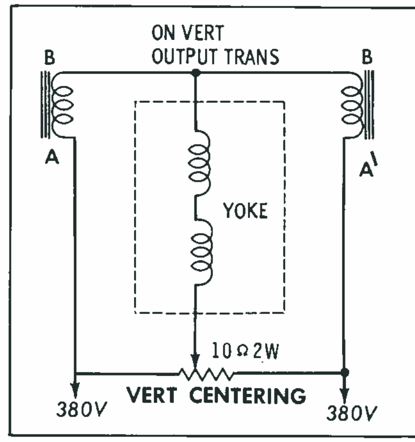


Fig. 7. Basic arrangement of vertical centering circuit now widely used.

horizontal deflection windings. The control arrangement forms a balanced bridge, as shown in Fig. 7 (a simplified schematic of a typical vertical-centering circuit). Windings AB and A'B are sections of the tapped, bifilar-wound secondary of the vertical output transformer; identical yoke-drive signals appear across both sections. When the potentiometer between points A and A' is set to the middle of its range, no DC (positioning) current flows in the yoke. At any other setting, the bridge is unbalanced; thus, the yoke is fed a positioning current which moves the raster up or down. Horizontal centering is accomplished in a similar manner. (*Caution:* Never center the raster on a color receiver unless you are prepared to perform the entire convergence procedure.)

Summary

Increased variety in chassis design, a natural result of keener competition among color-TV manufacturers, is already evident in the '62 sets. However, developments are following a conservative path of gradual evolution, and this is encouraging news to servicemen who are striving to gain experience in color TV. ▲

"Come Back Again! . . . in 10 years"

Isolating Chroma

(Continued from page 29)

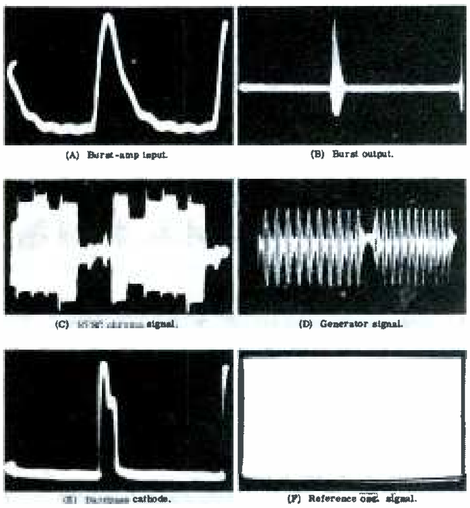


Fig. 2. Normal waveforms found at the key test points in the chroma section.

overlook it.

The "teardrop" pattern in Fig. 2B is the burst signal which is passed along to the phase detector from the burst amplifier.

Fig. 2C shows the waveform which should be present at the grids of the chroma bandpass amplifier and demodulator stages when a standard NTSC color-bar signal is fed to the receiver. (A similar signal is shown on PHOTOFACT schematics.) On the other hand, the type of chroma signal in Fig. 2D is produced by a keyed rainbow generator. Therefore, you'll find this waveform along the chroma path instead of the one in Fig. 2C if you are using this type of generator.

Fig. 2E is a horizontal blanking pulse such as you'll often find at the bandpass amplifier. Many circuits employ a positive pulse of this sort at the cathode to cut the tube off during burst-signal time. Therefore, you'll normally find the burst signal (center pulse) lacking in Fig. 2D beyond the bandpass amplifier.

Fig. 2F is the signal produced by the reference oscillator. You should find this waveform not only at the oscillator, but also at both demodulators and the sync phase detector. While there is a phase difference in the three signals, this characteristic cannot be discerned from an analysis of scope waveforms.

If you have trouble identifying the waveforms in Fig. 2, practice on them until you know what to expect at various points in the chroma circuits. Learning these basic troubleshooting patterns will not only eliminate the need for constantly referring to pictures in service data, but will also increase your understanding of what's going on in the circuits and will thus speed your servicing.

Where to Check

Once you know the paths of various signals in the chroma section, and learn what the signals look like,

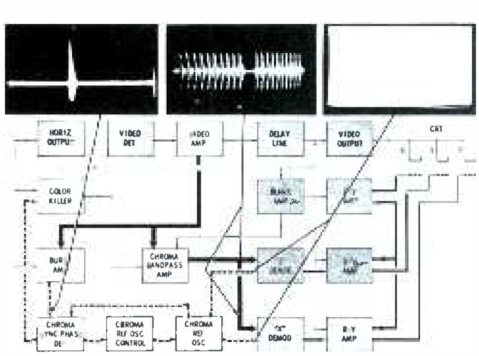


Fig. 3. Key waveforms and test points for troubleshooting a loss of color.

isolating a specific chroma trouble becomes a simple matter of deduction. Remember that we said chroma trouble falls into four categories? Let's see how a troubleshooting procedure is developed for each symptom.

Loss of Color

Complete loss of color can be caused by many things. However, when preliminary tests have shown the trouble is in the chroma section, it can be centered in any of the stages shown as unshaded blocks in Fig. 3. This illustration also shows the normal waveforms you'd expect to find at the key check points.

The best place to start checking is at either demodulator stage. Since there is a complete loss of color, it is obvious that either the chroma input signal (center waveform) or the reference-oscillator signal (right waveform) is missing. If both signals were present at either demodulator, some sort of color would appear.

Suppose your check shows that the reference-oscillator signals are present, but the chroma signal is absent. Under such circumstances, you'll want to go back along the chroma path (heavy line) to see where the signal is being interrupted. So, the logical place to check will be the bandpass amplifier. The center waveform should appear at both the grid and the plate. If the signal is absent at the plate, but does appear on the grid, check the plate, screen, and grid voltages. You'll undoubtedly find either a severe drop in plate and screen voltages, or excessive bias at the control grid. In the latter case, the trouble is probably being caused by a malfunction in the color killer.

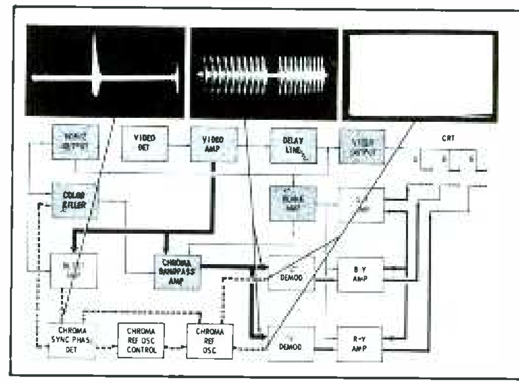


Fig. 4. Key waveforms and test points for localizing cause of wrong colors.

When a color signal is being received, the color killer tube is normally cut off by a negative voltage on its grid. This voltage is developed in the chroma sync phase detector whenever a burst signal (left waveform) is present. Therefore, if the killer is not cut off, you'll want to trace through the phase detector and burst amplifier stages to find out why not.

If your preliminary scope checks show that loss of color is caused by an inoperative reference oscillator, you can troubleshoot this section just as you would a conventional horizontal oscillator and AFC stage.

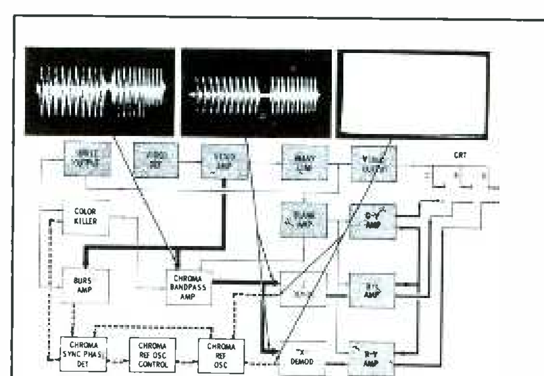


Fig. 5. Key waveforms and test points for analyzing problem of weak colors.

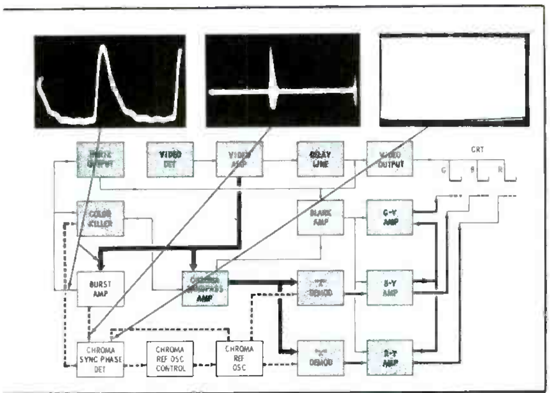


Fig. 6. Key waveforms and test points for pinpointing a loss of color sync.

Wrong Colors

In its broadest sense, the term *wrong colors* could apply to many visual symptoms. However, in this discussion, we shall consider only two basic types of faults. A good example of the first type is a picture which has all colors present, but everything appears in the wrong hue. The second type of symptom involves a complete absence of one primary color in the picture.

Hues are what most people have in mind when they speak of "different colors," such as red, blue, green, yellow, etc. In a color set, hue is determined by comparing the phase of the incoming chroma signal with two signals generated by the reference oscillator. This comparison is, of course, made in the demodulator stages.

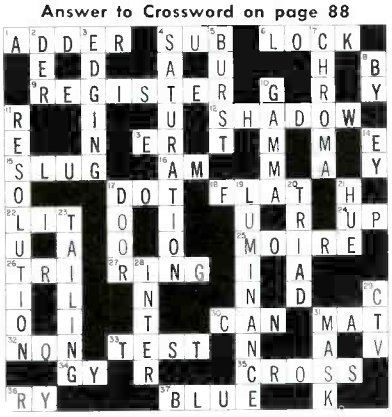
The sections of the receiver associated with wrong-color troubles are shown as unshaded blocks in Fig. 4. Notice that the key waveforms for troubleshooting this sort of problem are the same ones used in checking for complete loss of color. When you notice certain colors missing from the picture, you should promptly make the quick waveform checks shown in Fig. 4. If the input signals appear to be correct, move the scope to the output of the demodulators to see if they are functioning. Incorrect outputs mean you should follow the chroma - alignment procedures outlined in the service manual for the receiver; correct outputs point to trouble in the color-amplifier or picture-tube circuits.

Washed-Out Colors

When color bars appear as pastels instead of fully-saturated colors, the reason is improper signal amplitude. To explain this point more fully, saturation depends on the amplitude ratio of the luminance and chroma signals. Since it has previously been determined that the luminance signal is okay (black-and-white operation is normal), it becomes obvious that the outputs of all the color amplifiers must be low in amplitude. Therefore, the washed-out colors must be the result of insufficient output of either the chroma bandpass amplifier or the reference oscillator.

As shown in Fig. 5, the input signals to the demodulators provide key troubleshooting information. However, the main emphasis must

Answer to Crossword on page 88



be placed on signal amplitudes rather than waveshapes or mere presence of the signals. Of course, the amplitude of the chroma signal can be regulated by a control often referred to as the color saturation control. In normally-operating receivers, this control should provide a signal of the required amplitude when set at its midpoint. If the control must be advanced beyond its normal setting, the signal feeding the chroma bandpass amplifier, and the voltages of this circuit, should be checked in order to localize the trouble. Don't forget, the bias on the bandpass amplifier can be altered by a malfunction in the color-killer circuit. Therefore, it may be necessary to troubleshoot the stages associated with the killer.

Color-Sync Troubles

As shown in Fig. 6, color-sync problems are associated with only a few of the chroma circuits. Troubleshooting these sections becomes a familiar process if you relate it to the experience you've gained from servicing horizontal oscillator and AFC circuits. Making rapid checks of the waveforms shown in Fig. 6 will normally direct your attention to the defective stage. For example, if your check for the burst signal at the phase detector (center waveform) shows the presence of chroma information, you can be reasonably sure the trouble is being caused by improper bias on the burst amplifier, and you can direct your attention to that stage. If, on the other hand, the amplitude of the reference-oscillator signal happens to be considerably different from the value shown in the service data, you can concentrate on the oscillator and control circuits.

Summary

For faster and more accurate troubleshooting in the chroma stages:

1. Determine that the trouble is definitely in the chroma section, by injecting a color-bar generator signal at the grid of the video amplifier.
2. Learn the paths of the various signals through the chroma circuits, and follow the troubleshooting sequence outlined in Chart I.
3. Become thoroughly familiar with the signals at key check points as they are produced by your color test equipment.
4. Relate the visual symptoms to specific sections of the chroma circuits. ▲

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((Signed) MAL PARKS, JR., Bus. Mgr.
Sworn to and subscribed before me
this 28th day of September, 1961
(Seal) Marian F. Newman, Notary Public

A Bout With a Color Set

(Continued from page 33)

opened up between the oscillator plate and B+; if there had been a short serious enough to reduce the plate voltage to only 5 volts, I surely would have smelled smoke by now.

Looking again at Fig. 2, note that the only possible open component besides L30 is R156, a half-watt, 1000-ohm resistor that is very vulnerable to excess current damage which might result from a shorted tube or bypass capacitor. When I checked this little resistor, I found it just about wide open.

Remembering the several flashes of the neon short indicator when I had checked V19, I got out another 6U8A, checked it too, and substituted it for the old tube. Then I tested dual capacitor C104 and discovered leakage in both sections. After replacing this unit with two individual ceramic capacitors (.01 mfd each), I fired up the set and looked once more at the oscillator and control-tube outputs. There was a modulated waveform of 25 volts peak to peak at the plate of the control tube (Fig. 7), and the oscillator signal (Fig. 8) was a normal sine wave of adequate amplitude.

Color Adjustments

It was almost a sure bet that my repairs to this receiver had affected the chroma sync and demodulator alignment, so I made a point of re-adjusting the set before returning it to the owner. Since I had the set in the shop, with my scope handy, I carried out the complete sequence of adjustments. Since these are pretty well spelled out in the service data, there's no point in talking about them here. However, while we're on this subject, I'd like to tell you of a simpler *in-home* adjustment procedure for RCA's CTC7, -9, -10, and -11 series of sets, using only a color-bar generator and VTVM. Though not as precise as the "full-dress" adjustment method, the in-home system is entirely satisfactory for the peaking and phasing adjustments made necessary by tube replacement or other minor servicing.

In later models, you don't even have to remove the chassis from the cabinet. If you have any CTC7A's in your care, a little foresight will also enable you to adjust these in the home without the need for disassembly. Just remember to bring along a few socket adapters for 9-pin miniature tubes; also, on some occasion when you have the set in the shop, install a test-point extension lead running above the chassis from the junction of phase-detector resistors R164 and R165 (see "Quicker Servicing" in this issue). Another special requirement for adjusting the CTC7A and -AA chassis is an alignment tool with a slim shaft, which will allow you to adjust both the top and bottom slugs of the double-tuned oscillator-plate transformer from the top side.

The following step-by-step procedure applies specifically to the CTC7A: Insert an adapter in the socket of V21, and connect a VTVM to the plate terminal of the killer-detector section (pin 7). This output test point is used for all chroma-sync adjustments. Begin by peaking both slugs of oscillator-plate transformer L30 (designated A16 and A17 in Fig. 2) for a maximum negative DC reading on the meter. Next, ground the lead running from

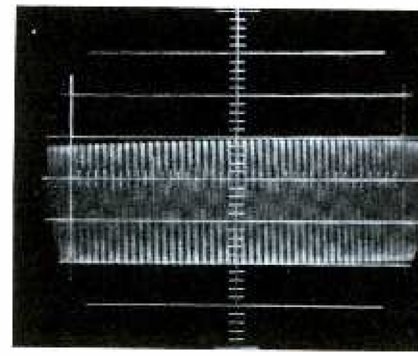


Fig. 5. Plate signal of 3.58-mc control tube looks good, but is incorrect.

between R164 and R165, in order to remove the DC correction-voltage input from the oscillator-control tube, and turn the control-tube plate adjustment A19 to stop the rapid movement of color bars on the face of the CRT. (This step is comparable to adjusting a horizontal-frequency slug with the horizontal AFC disabled.) As a final touch, install adapters in the sockets of V17 and V18; ground both pin 7 of V18A (the burst-amplifier grid) and pin 9 of V17A (the color-killer grid); and adjust the oscillator-transformer trimmer C111 for zero volts on the VTVM.

This completes the chroma-sync adjustments, and you can move on to the demodulator-phasing adjustments. Remove the tube adapters from the receiver, and disconnect the VTVM; you'll be using the picture tube itself as an indicator during the rest of the procedure. In each step, the object will be to disable two of the three guns in the tricolor CRT, and adjust the receiver so that the portion of the color-bar pattern contributed by the third gun appears to be correctly presented. Any gun can be disabled by temporarily connecting the control grid to ground through a 100K-ohm resistor. The different grids can be identified by the appropriately color-coded leads running from

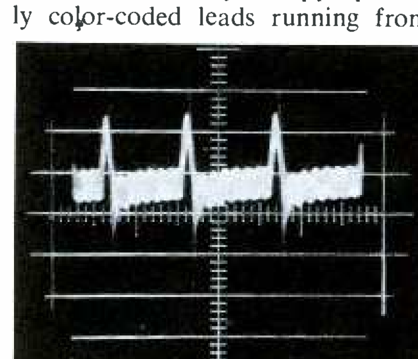


Fig. 6. Weak, deformed signal at the oscillator plate pointed to trouble.

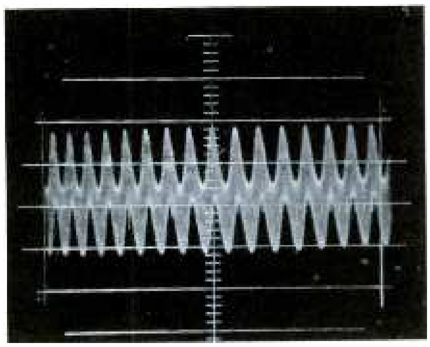


Fig. 7. Correct signal at plate of control tube after completion of repair.

the chroma section to the picture-tube socket.

Using a conventional keyed rainbow generator as a signal source, and with the tint control set at midrange, your results should turn out as follows:

With the blue and green CRT guns disabled, the third bar from the left should appear solid red, and nearly all of the other 10 bars should show some red color. However, the sixth bar (which is normally bluish) should be practically invisible. This shade of blue is produced by chroma-signal modulation 90° out of phase with the signal that produces red. (See the vector diagram in "Test Equipment for Color TV," elsewhere in this issue.) Therefore, the red gun normally contributes nothing toward producing the sixth bar. If this bar can be seen, try adjusting slug A18 in burst transformer L28, to blend the bar into the background as completely as possible.

The second step is to disable the red and green guns—leaving the blue gun active—and check for the absence of the third and ninth bars in the rainbow (normally red and bluish-green). If these bars are visible, try touching up the top adjustment A16 of the oscillator-plate transformer for more complete fade-out of both bars.

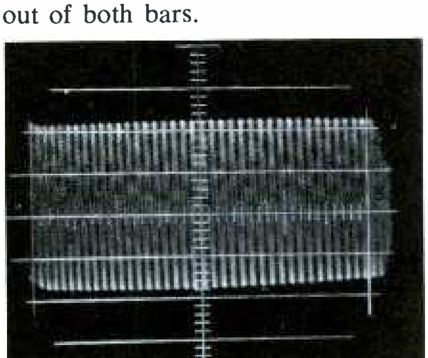


Fig. 8. Normal waveshape of output signal generated by 3.58-mc oscillator.

Also check the operation of the green gun with no output from the blue and red guns. If there is more than a trace of illumination in the first and seventh bars (normally yellow-orange and greenish-blue), it is advisable to recheck the previous adjustments for possible improvement. However, avoid unnecessarily readjusting A17, the lower slug of L30, since this usually requires further retouching of upper slug A16.

The last step in the procedure is a check of tint-control range. With the blue and green guns again disabled, the sixth bar should become illuminated and the seventh bar should fade into the background as you turn the control to its clockwise extreme. Toward the full counterclockwise setting, the fifth bar should fade out. This action indicates that the control is able to introduce a 30° oscillator phase shift in either direction from the normal setting.

If these adjustments cannot be made as described, you may find that a previously unsuspected defect is still present in the chroma sync, oscillator, demodulator, or matrix circuits.

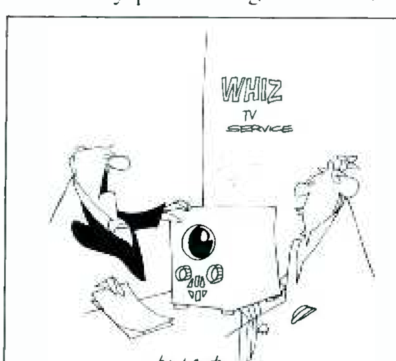
Adjustments for Newer Models

The in-home chroma-circuit adjustments have been revised and simplified for receivers introduced since the CTC7A. None of the later sets have a killer detector; thus, the grid of the color killer is the proper VTVM test point for chroma-sync alignment. In addition, the CTC9 and all subsequent chassis have only a single-tuned 3.58-mc oscillator-plate transformer with no trimmer across it, eliminating two of the adjustments which were necessary in the earlier models. Thus, the adjustment boils down to the following three-point routine:

1. Peak the burst transformer and 3.58-mc transformer for a maximum DC reading at the color-killer grid, with a color-bar input injected into the chroma section.
2. Short the phase detector-control tube connection to ground (at the test point above the chassis), and adjust the control-tube plate coil to zero-beat the oscillator and color-bar signals.
3. Check for proper colors in the bars on the CRT, with the tint control set at midrange; if these are incorrect, retune the burst transformer until the correct color sequence appears.

Now, As I Was Saying

The complete chroma-adjustment procedure for the CTC7A on my bench wasn't quite as easy as the touch-up I have just described; however, it went off without a hitch. I reassembled the set, had it delivered, went out to the customer's home for a final check of purity and convergence, and left him with an excellently-performing color set. ▲



". . . Good news, we couldn't fix it, but the Smithsonian offered to buy it . . ."

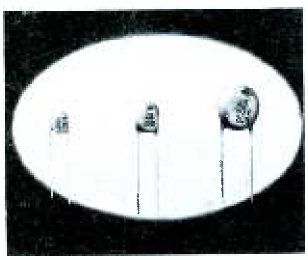
PRODUCT report

For further information on any of the following items, circle the associated number on the Catalog & Literature Card.

Bonded Color CRT (36H)

A new 21FJP22 color-TV picture tube, with a "glareproof" window bonded to the face, has been made available to the replacement market by **RCA Electronic Tube Div.** This type, which eliminates the need for a separate safety glass, is almost identical electrically to the recently-announced 21FBP22. Both tubes have new, high-efficiency sulfide phosphors that give a number of advantages, including a marked increase in both brightness and contrast.

Transistor-Circuit Capacitors (37H)

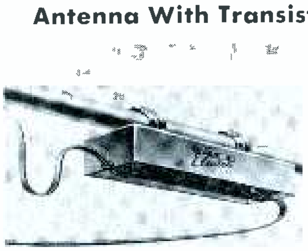


High-capacitance, low-voltage ceramic disc capacitors, **Centralab** Type CK, have many applications in transistor circuitry. Units with a working-voltage rating of 50V DC are manufactured in values from 5000 to 100,000 mmf, with a capacitance tolerance of ±20%. All are 5/32" thick; diameters range from ⅜" to ⅝", depending on capacitance value.

Sweep-Circuit Test Instrument (38H)

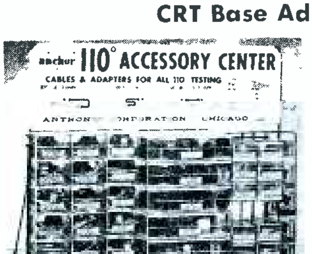
Numerous signal-injection and component-substitution tests can be performed with the **Sencore** Model SS117 "TV Sweep-Circuit Analyzer." Checks of the horizontal oscillator, horizontal output, flyback, both pairs of yoke windings, and anode voltage can be made. In addition, a built-in meter has 300- and 1000-volt ranges on DC (for checking B+ and boost) and peak-to-peak AC (for checking sync and oscillator outputs), plus a 300-ma range for checking current through the sweep fuse. Dealer net price is $82.50.

Antenna With Transistorized Amplifier (39H)



An antenna-mounted, transistorized amplifier gives the **TACO** "T-Bird Electra" a ten-fold increase in gain over previous "T-Bird" models, while retaining the sharp directivity of the latter. The amplifier system obtains power from the 117-volt AC line, and includes a built-in TV/FM two-set coupler. Three models are available for different signal conditions.

CRT Base Adapters (40H)



The **Anchor** "110° Accessory Center" display holds an assortment of extension cables and adapters for 110° CRT's, packaged in reusable plastic boxes. One item, the RK-320 kit, contains a complete set of accessories for interconnecting various types of 110° tubes and sockets. In other boxes are single connectors designed for specific purposes, such as adapting a standard 8-pin socket to accommodate the special base connections of a 23EP4 tube.

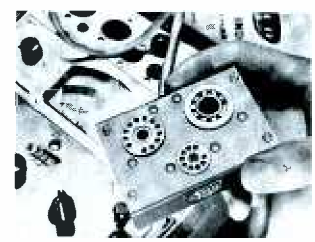
Pocket Portable Radio (41H)

A six-transistor AM radio about as large as a pack of king-size cigarettes, the **Sampson** Model S640 "Little Sampson 6," is packaged in a book-shaped gift box including a leather case, accessory earphone, and battery. Suggested retail price is $19.95. A five-tube superhet table radio, Model ST61, has also been introduced.

Record-Cleaning Kit (42H)

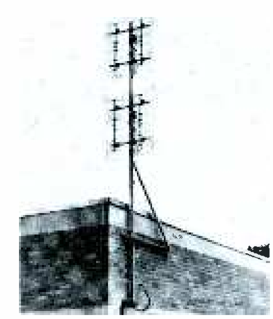
For cleaning all types of phonograph records, **Duotone** supplies a kit including a bottle of antistatic detergent and a deep-pile wiping pad for sweeping dust and dirt out of record grooves. The kit, packed in a vinyl bag, also contains a needle-cleaning brush. Price is $1.50. Another new feature in the company's product line is "bubble - packaging" for diamond needles. Units are displayed in individual clear plastic boxes with identifying tabs.

Socket Adapter (43H)



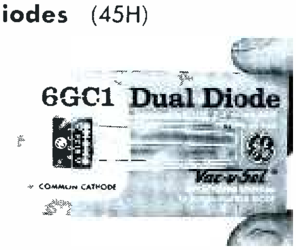
Fitting into the cord compartment of the **Seco** Model 107 tube tester, the new No. 1171 adapter contains test sockets for "novar," 10-pin, and "Compactron" tubes. Case dimensions are 3½" long x 2⅜" wide x ¾" high. The unit is supplied with a 12-wire, 22" cable, ready for installation, at a dealer net price of $4.95.

UHF Antenna Line (44H)



Several models of **JFD** antennas are available for UHF reception. The following three types are designed to receive translator and airborne educational broadcasts on channels 70-83: 12-bay Model MPAT-1212 (shown stacked vertically), 6-bay Model MPAT-1206, and 4-bay Model MPAT-1204. Types for receiving conventional UHF station signals are the MPAT-410 corner reflector (for fringe areas) and MPAT-600 (for strong signals).

Dual Selenium Diodes (45H)

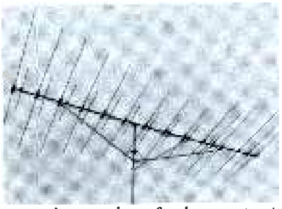


The three types of "Vac-U-Sel" dual selenium diodes supplied by **General Electric** are intended for use in horizontal AFC and other low-power circuits. The diodes are packaged on wall cards which are color-coded as follows: Type 6GC1 (common cathode), orange; 6GD1 (series-connected), black; and 6GX1 (common anode), gold. On the back of the card is a chart listing the original manufacturers' part numbers for units which the new component will replace. List price is $1.40 each

Stero FM Coils (46H)

A set of five inductors required in constructing stereo FM adapters is available from **J. W. Miller Co.** All units — a low-pass filter, two bandpass filter elements, a 19-kc locked-oscillator coil, and a 38-kc output transformer — are shielded, and measure ¾" square x 1 7/32" high. Included with each coil is a circuit diagram and parts list for a complete adapter, plus useful facts about stereo FM.

High-Gain Antennas (47H)

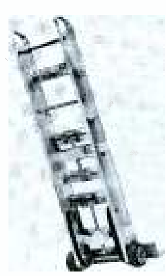


The multiple driven elements of **Channel Master** "Crossfire" antennas gradually decrease in impedance from the front feed point to the rear of the array, giving an effect of "proportional energy absorption." The conductors of the feed line are transposed between each successive pair of elements to produce a wave-cancelling effect—thus increasing the front-to-back ratio. No reflector is used, but a "director group" is mounted at the front to increase gain. A short parasitic element in front of each dipole gives more efficient harmonic-mode operation on high VHF channels. Six models are available.

CB Transceiver Kits (48H)

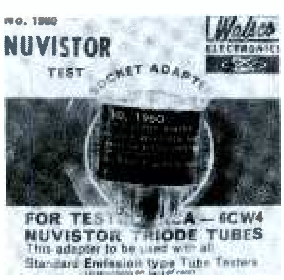
Special features of **EICO** "770 Deluxe Series" Citizens band transceiver kits (not included in the standard kit series) are an adjustable squelch circuit, a "press-to-talk" relay, and crystal-controlled receiver operation on one of the four channel-switch positions. Model 770 (kit, $69.95; wired, $99.95) has a power transformer and silicon-rectifier voltage-doubler supply for 117V AC operation. Models 771 and 772 (kit, $79.95; wired, $109.95) also include vibrator-type supplies for 6V and 12V DC, respectively.

TV-Appliance Dolly (49H)



Equipped with an extra strap and ratchet assembly near the bottom of the frame, the **Yeats** Model 14 dolly is a deluxe version of the No. 7 type. Like the No. 7, the 14 has aluminum I-beam construction with curved cross members, conveniently placed side and top handles, roller-bearing wheels, permanently-lubricated step-guide belts, and heavy felt padding on the face. Weight is 40 lbs; price is $79.50.

Nuvistor Test Adapter (50H)



The **Walsco** "Nuvistor Socket Adapter" (Cat. No. 1960), which permits testing of 6CW4 "nuvistor" tubes at the same test settings as the 6BQ6 or 6CU6, is designed for use with any emission-type tube tester. It is simply plugged into the octal socket of the tester. Dealer net price of this accessory is $1.95.

Deflection Yokes (51H)

A number of exact-replacement yokes have been added to the **Merit** line. For 110° sets, Types MDF-112 and MDF-118 replace Packard-Bell part nos. 29645C and 29696; MDF-122 replaces Westinghouse and Airline part 490V007H01; and MDF-131 replaces Wells-Gardner and Airline part 9A2476. For 90° and 92° sweep, MDF-109 substitutes for Westinghouse part no. 490V004M01; MDF-121 is a replacement for Coronado and Wells-Gardner part 9A2458B; and MDF-124 replaces Zenith no. 95-1768.

Tubes for Mobile Communications (52H)

New "A" versions of three popular tubes for mobile radio transmitters have been announced by **Sylvania.** They feature more stable power output at heater voltages about 15% below normal, thus affording better performance when radios are operated with the vehicle engine idling or turned off. The 6146A, 6883A, and 6159A (with 6.3-, 12.6, and 26.5-volt heaters, respectively) are all beam-power pentodes with identical basing arrangements. Maximum power output is 70 watts in class-C telegraphy under ICAS-specified conditions.

INDEX TO ADVERTISERS

November, 1961

Latest Jackson Tube Test Data

MODEL 648

Tube Type	Fil.	D.	E	Plate Test
2FS5	2.5	A234	AC156	53 V
3GK5	3.0	A234	A57	22 YZ
6FD7	6.3	A127	A89	27 WX
	"	126	A45	31 VW
6JH8	6.3	1289	AB347	35 XZ
	"	"	AB356	35 XZ
11JE8	10.5	A129	67B*	22 XZ
	"	A124	A35	28 XZ

SUPPLEMENTS LATEST ROLL CHART 648-25

MODEL 598

Tube Type	A.	B.	C	Fil. Cont.	D.	E.	F.	G.
2FS5	2.5	3Y	7	4	5	1	6	54
3GK5	3.0	3YZ	7	4	5	2		48
6FD7	6.3	4		5	6	7		59
	"	4	2		1	3		34
6JH8	6.3	4Z		5	9	2	3	95
	"	4Z			8	1	3	95
11JE8	10.5	4Y		5	9	7	8	29
	"	4Y			3	2		60

SUPPLEMENTS LATEST ROLL CHART 598-3

MODEL 658

Tube Type	Sec.	Heater	Circuit H-K	Circuit P-G	Plate	Grid Test	Heater Current
2FS5	P	2.5M	124	ac356	62R	5WY*	A10.6J Z600
3GK5	T	3.0J	123	a57	21R	5WY*	A8.5F Z450
6FD7	T	6.4L	127	a89	83Q	10WY*	
	T	"	126	a45	18R	60VY*	
6JH8	B	6.4J	12459	c368	16Q	25WY*	
	B	"	"	c378	"	25WY*	
11JE8	T	10.6L	128	679	23R	15WY*	A18.6G Z450
	T	"	124	a35	68R	10WY*	

SUPPLEMENTS LATEST ROLL CHART 658-5

"For further information, see Tube Test Data in PHOTOFACT Folder No. 536"

CATALOG AND LITERATURE SERVICE

ANTENNAS AND ACCESSORIES

1H. *ALL CHANNEL PRODUCTS* — Brochure on *Rembrandt, Embassy,* and *Rembrandt X-9* indoor antennas; also covers *Atlas* and *Riviera* outdoor antennas with 12-position switch for electronically rotating the pickup pattern.

2H. *INTEC*—Data sheet on fully transistorized broadband amplifiers (frequency range 53-100 mc) for TV-FM antenna distribution systems. Models ABB-11 and -12 are both housed in weatherproof enclosures.

3H. *JFD*—New 1961 *Exact-Replacement Antenna Guide Wallchart for Portable and Toteable TV Sets.* Gives TV-receiver model number, manufacturer's antenna part number, and model number of corresponding JFD exact-replacement antenna. Also Form 940 dealer catalog illustrating and describing 1961 line of TV antennas, *Transis-Tennas,* mounts, masts, *Mardi Gras* TV tables, accessories. *See ad page 15.*

4H. *WINEGARD*—Literature on new *Tenna Boost* transistorized amplifier (list price $34.95) which mounts on any antenna. *See ads pages 18-19, 21, 23.*

AUDIO AND HI-FI

5H. *OAKTRON*—Complete listing of *Melody Blue* line of general-replacement, public-address, and high-fidelity speakers, plus enclosures and wall baffles—in 8-page catalog which is punched to fit easily into any reference notebook or file.

6H. *ROBINS*—16-page Catalog No. 15 of audio accessories for tape-recorder and phonograph users; pocket reference guide of M/M tape-recorder heads.

7H. *SONOTONE*—4-page brochure SAC-23 with specifications and performance features of *Velocitone* stereo ceramic cartridges.

8H. *SWITCHCRAFT*—New Product Bulletin 114, describing new miniature audio equalizer which adapts output of ceramic cartridge to RIAA response so it can be connected to "magnetic" input of amplifier without modification.

COMMUNICATIONS RADIO

9H. *GENERAL ELECTRIC* — Publication ECR-904 (24 pages), entitled *Two-Way Mobile Radio;* describes vacuum-tube and transistorized types with power outputs from 10 to 100 watts.

10H. *HALLICRAFTERS*—Booklet, "12 Field-Tested Tips on Selling Citizens Band," describing important techniques now being used by service dealers to promote CB sales. Available to established, qualified firms interested in becoming Hallicrafters-authorized CB dealers.

COMPONENTS

11H. *AEROVOX*—Compact catalog of Type AFH twist-prong electrolytic capacitors; engineering data and catalog covering AC motor-start and motor-run capacitors.

12H. *BUSSMANN*—Bulletin EFA on two new fuse assortments including practically all types needed for TV sets and other electronic equipment. Each assortment comes in metal display stand with special inventory feature; stand can be hung on wall or stood on bench. *See ad page 67.*

13H. *CLAROSTAT*—Leaflet explaining *RTV* replacement program for TV controls, built around ready-to-install exact replacements for many special applications —even in little-known brands of TV sets.

14H. *CORNELL-DUBILIER — Service Selector,* a 40-page quick-reference catalog of capacitors, vibrators, power supplies, antenna rotators, and test instruments, prepared especially for radio and TV service technicians. *See ad page 27.*

15H. *LITTELFUSE*—Illustrated price sheet showing complete line of fuses and fuse holders, with list price of each product. *See ad 4th cover.*

16H. *SPRAGUE*—Catalog C-457 of capacitors, printed circuit components, and wire-wound resistors (designed to hang on wall). *See ad page 11.*

17H. *VIDAIRE* — Catalog sheet on silicon-rectifier voltage-doubler assemblies for snap-in or one-screw mounting, used as replacement in Philco, DuMont, General Electric, Hotpoint, and Sylvania TV sets. *See ad page 96.*

SERVICE AIDS

18H. *ATR*—Literature on Model 250 *Electronic Tube Protector,* which protects all TV tubes including CRT, as well as hi-fi tubes. *See ad page 14.*

19H. *ANTRONIC CORP.* — Catalog of CRT test equipment, brighteners, adapters, switches, and other service aids.

20H. *BERNS*—Data on 3-in-1 picture-tube repair tool, on *Audio Pin-Plug Crimper* that lets you make pin-plug and ground connections for shielded cable without soldering, and on ION adjustable beam bender. *See ad page 86.*

21H. *CASTLE*—Leaflet describing fast overhauling service on television tuners of all makes and models. *See ad page 72.*

22H. *PRECISION TUNER* — Information on repair and alignment service available for any TV tuner. *See ad page 50.*

23H. *RCA*—Instructions and parts list for No. 11A1015 *Color Test Jig* for bench servicing of color TV chassis—includes cabinet, CRT mount, deflection components, and convergence assembly. *See ad page 71.*

24H. *SWING-O-LITE* — Illustrated flyer on *Inspector* swing-arm bench lamps with fluorescent tubes and built-in 5" or 7" glass magnifiers. *See ad page 86.*

25H. *YEATS*—Literature describing *Appliance Dolly* and padded delivery covers. *See ad page 102.*

SPECIAL EQUIPMENT

26H. *SCHOBER* — Descriptive literature on OT-1 *Organ Tester* for signal-tracing and troubleshooting electronic organs, and on AT-1 *Autotuner* for stroboscopic tuning of organs that utilize electronic oscillators.

27H. *UTAH* — Brochure describing new *Quartz-Glow* infrared heating equipment for a variety of industrial applications. *See ad page 40.*

TECHNICAL PUBLICATIONS

28H. *HOWARD W. SAMS*—Literature describing all current publications on radio, TV, communications audio and hi-fi, and industrial electronics servicing. *See ads pages 42, 63, 86.*

TEST EQUIPMENT

29H. *B & K*—Catalog AP18-R, giving data and information on Model 960 *Transistor Radio Analyst,* Model 1076 *Television Analyst, Dynamatic* 375 VTVM, *V O Matic* 360, Models 700 and 600 *Dyna-Quik* tube testers, Models 440 and 420 CRT Cathode Rejuvenator Testers, Model 160 Transistor Tester, Model 1070 *Dyna-Sweep* Circuit Analyzer, and B & K Service Shop. *See ads pages 47, 49, 51, 52.*

30H. *EICO* — New 32-page catalog of test equipment, kits and wired equipment for stereo and monophonic hi-fi, Citizens band transceivers, ham gear, and transistor radios. Also, "Stereo Hi-Fi Guide," and "Short Course for Novice License." *See ad page 56.*

31H. *HICKOK* — Literature on Model 656 NTSC-standard color-bar generator and other color television test equipment; also brochure, "Why NTSC?" *See ad page 69.*

32H. *RCA*—Folder 1Q1017 giving full details on WR-64A Color-Bar/Dot/Crosshatch generator. *See ad page 91.*

33H. *SECO* — Literature on test equipment, featuring complete Model 107 tube tester which meets specifications for Federal Stock Classification; also, booklet, "Selling and Servicing Citizens Band Equipment." *See ad page 97.*

34H. *SENCORE*—New booklet, *How to Use the SS105 Sweep Circuit Troubleshooter,* plus brochure on complete line of *time-saver* instruments. *See ads pages 37, 39, 41, 78.*

TUBES

35H. *SAMPSON Hitachi* receiving-tube manual, giving extensive specifications, basing diagrams, and outlines for complete tube line; also catalog sheet with color photos and descriptions of *Hitachi* broadcast-band and two-band transistor radios. *See ad page 87.*

SELL THE POPULAR RCA SILVERAMA PICTURE TUBE

To Increase Your Business and Build Customer Confidence

Before any RCA Silverama Picture Tube goes into its carton for shipment to your distributor, it has been through one of the most exhaustive series of quality tests in the picture-tube industry.

Every Silverama undergoes the same electrical tests as RCA's original equipment picture tubes. Even the Silverama envelope has been thoroughly cleaned, tested and inspected before re-use. Only then is the famous RCA high-quality phosphor screen added.

Such tests—plus uncompromising quality control at every step of manufacture, assure you that RCA Silverama is the finest replacement TV-picture tube modern science and technology can produce.

But most important to your business: this superior tube is priced to compete with other name brand picture tubes. Thus for no extra cost you can provide the business-building extras of assured quality performance, fewer complaints, callbacks and in-warranty failures—plus the brand-name your customers want and trust, RCA Silverama. See your authorized RCA Tube distributor today!

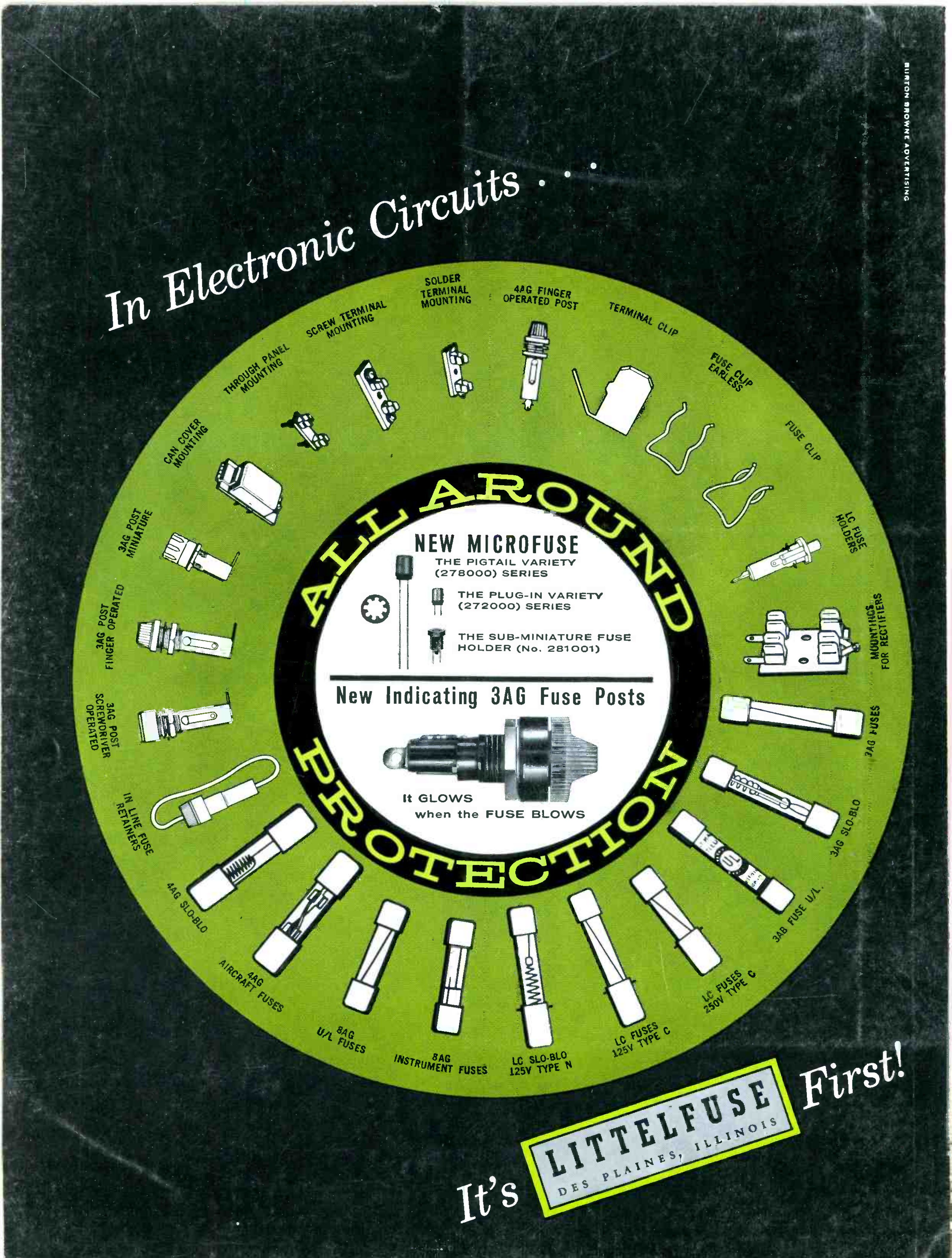
Automatic testing. 26 different tests for major characteristics are performed on this automatic test unit. A tube failing a single test is automatically rejected.

Final checkout. At the end of the production line, just prior to packaging, sample batches of Silverama picture tubes receive a focus check for additional assurance of quality.

RCA ELECTRON TUBE DIVISION, HARRISON, N. J.

RCA® The Most Trusted Name in Television

27F-54—RCA Tube Division
Prepared by Al Paul Lefton Co., Inc.



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