Color Television Troubleshooting

EDWARD BANNON

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Preface

With the rapid advance in electronic technology, combined with the marked shift in academic emphasis, particularly in the consumer-electronics area of the junior-college curriculum, the need has become apparent for a color-television guidebook that provides high-level motivation for students in the upper-class division. This text is a teaching tool that presents state-of-the-art color-television servicing information in a functional format that minimizes the prerequisites for effective application. It permits the upper-class student to test, diagnose, and repair many of the common defects and malfunctions that occur in solid-state color-television receivers.

The text treatment assumes that the student has completed a course in radio and television theory, and that he has obtained a working knowledge of the basic electronic servicing instruments. Although no prior instruction in color-TV circuit action is prerequisite, it is desirable that the student carry a concurrent course in color-TV theory. This text is profusely illustrated for minimization of the learner's burden and for optimizing retentivity. General principles of circuit function and malfunction are stressed throughout, with emphasis on logical reasoning from trouble symptom(s) to component defects. Test and measurement techniques are explained and illustrated for each basic subdivision of troubleshooting technology. The final chapter covers specialized digital-logic test

instruments in application to troubleshooting digital-control and display systems in modern color-TV receivers.

This guidebook is the outcome of extensive teaching experience on the part of both the author and his fellow instructors. They have also contributed numerous constructive criticisms and suggestions. It is appropriate that this text be dedicated as a teaching tool to the instructors and students of our junior colleges, vocational schools, and technical institutes.

Edward Bannon

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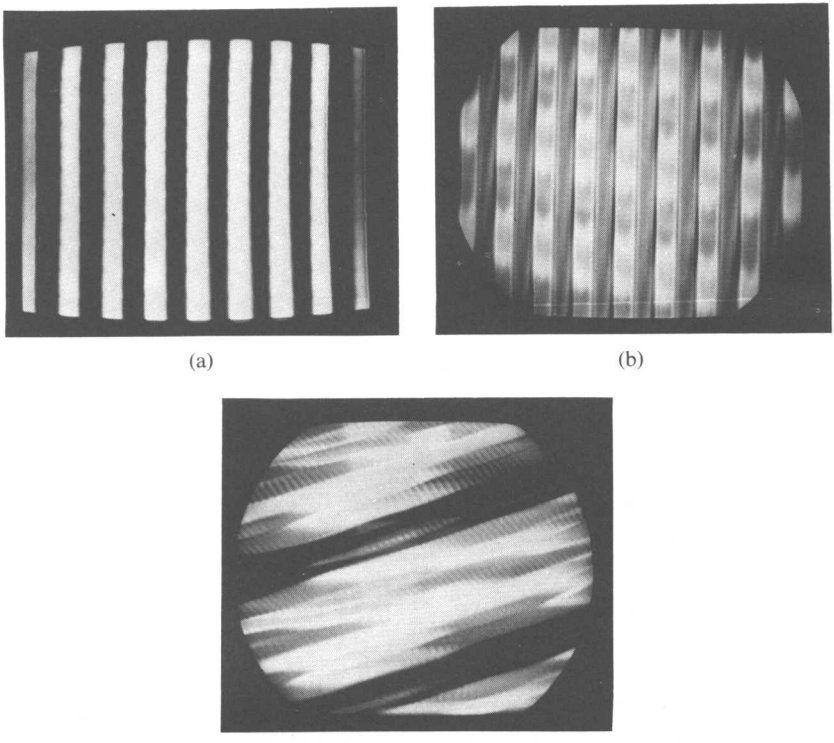
Basic Troubleshooting Approach

1.1 OPERATING AND MAINTENANCE CONTROLS

Color television troubleshooting starts with an analysis of the picture and sound trouble symptoms. As an illustration, a color receiver might display a picture that has lost color synchronization, or a picture that has lost both black-and-white and color synchronization, as shown in Fig. 1–1. In these examples, the sound output is almost always normal. Note that the loss of black-and-white and/or color sync may be caused by a defective component in the synchronizing circuitry of the receiver, or it may be caused by a simple misadjustment of the horizontal locking (hold) control. Therefore, it is essential to have a good understanding of the operating and maintenance controls that are provided in various color-TV receivers. Typical operating controls are shown in Fig. 1–2. These include a channel selector, fine-tuning control, volume control with off-on switch, ultra high frequency (UHF) tuning control, tint, color, and brightness controls, horizontal and vertical hold controls, contrast control, and tone control.

There is no sharp dividing line between operating controls and maintenance controls. As an illustration, the horizontal and vertical hold controls depicted in Fig. 1–2 are included with the maintenance-control group in some receivers. Operating controls



(a) (b)

(c)

Figure 1–1. Examples of color picture trouble symptoms: **(a)** Normal chroma bar pattern; **(b)** Loss of color sync; **(c)** Loss of both color and black-and-white sync.

are located on the front or side (sometimes the top) of the receiver, and are readily accessible to the viewer. On the other hand, maintenance controls are usually mounted on the back of the receiver, or sometimes inside the cabinet. Typical maintenance controls include convergence, height, automatic gain control (AGC), color killer, and peaking controls, as exemplified in Fig. 1–3. Note that the "dots" control is not provided in most color receivers; this control produces a dot pattern on the screen that is used during adjustment of the convergence controls. This topic is detailed subsequently. Note in passing that a tone control is included with the maintenance controls in Fig. 1–3, whereas the tone control is grouped with the operating controls in the example of Fig. 1–2.

Each operating and maintenance control is associated with a

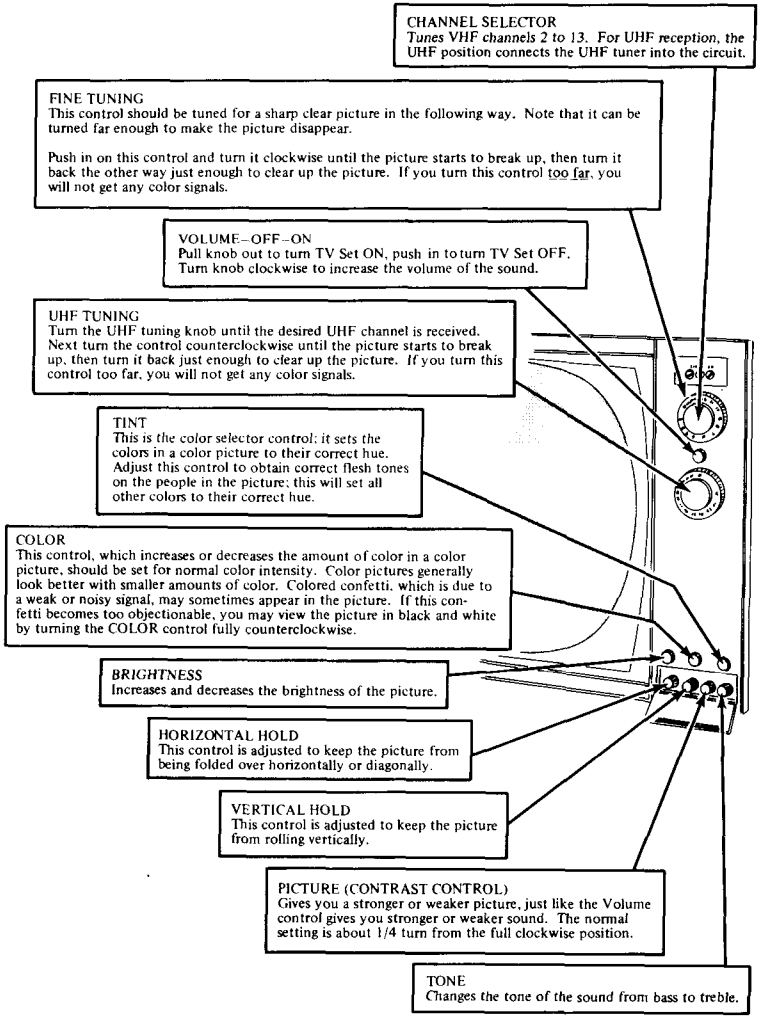


Figure 1–2. Typical operating controls for a color-TV receiver. *(Courtesy of Heath Company)*

particular receiver section, as seen in the block diagram of Fig. 1–4. Each control varies the circuit action of its associated section in some manner. For this reason, a technician checks the responses of certain controls in a preliminary approach to sectionalization of the picture and/or sound trouble symptom(s). It is in-

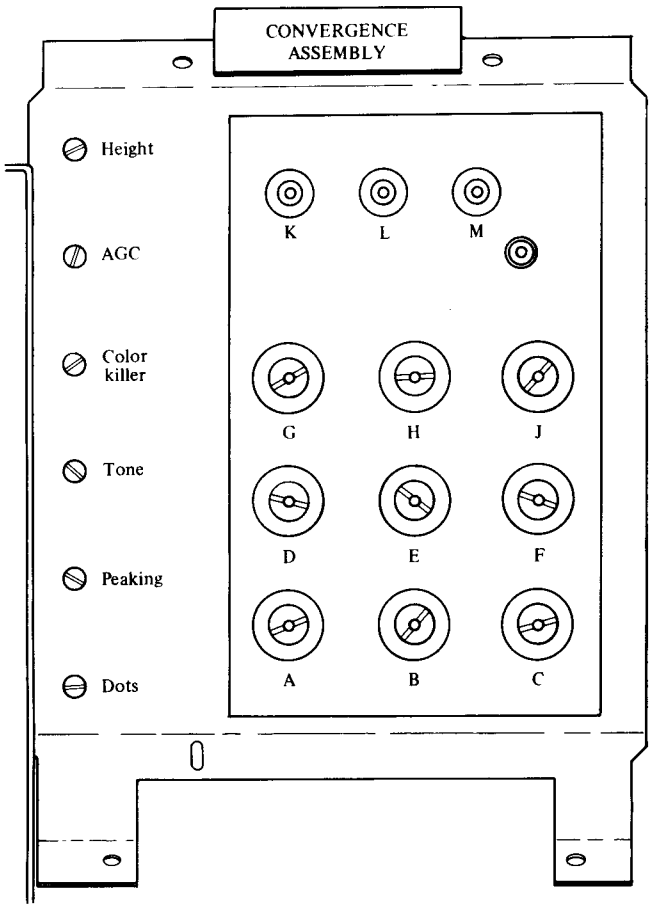


Figure 1–3. A typical group of maintenance controls. *(Courtesy of Heath Company)*

structive briefly to note the function of each shaded block depicted in Fig. 1–4. From the video amplifier, the chroma signal branches off into the chroma bandpass amplifier, where its amplitude is stepped up and the black-and-white signal is rejected. The video signal is applied to the delay line by the video amplifier, where it undergoes a time delay of approximately 1 μs. From the delay line, the video signal is applied to the video-output stage.

The chroma signal branches off into the burst amplifier. In the burst amplifier, the color burst is stepped up in amplitude, and the black-and-white signal is rejected.

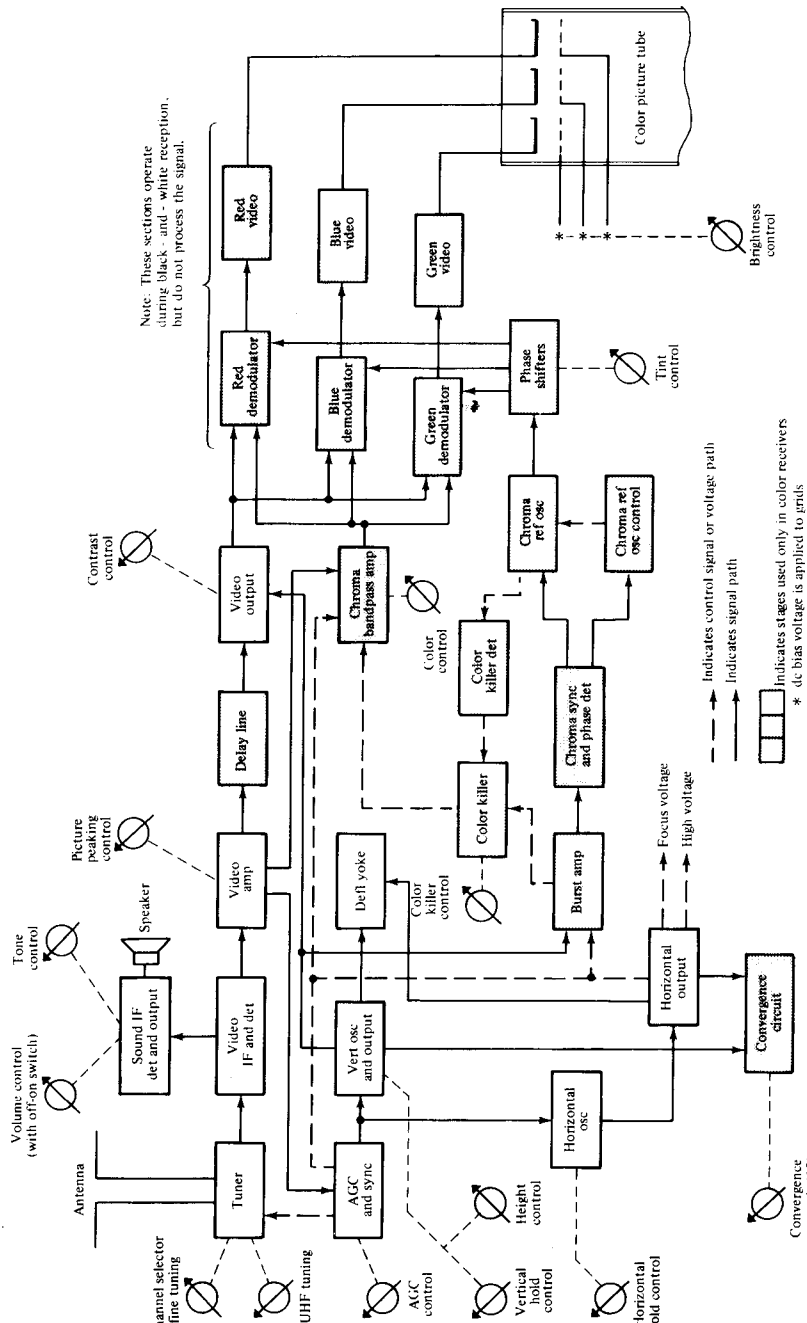


Figure 1–4. Block diagram of color-TV receiver, with operating and maintenance controls.

Next, the chroma signal from the chroma bandpass amplifier in Fig. 1–4 is applied to red, green, and blue demodulators, where it is combined with the reconstituted color subcarrier (3.58-MHz subcarrier) and mixed with the black-and-white signal. The color subcarrier is reconstituted by processing the color-burst signal through the chroma sync and phase-detector section for locking the chroma reference oscillator (subcarrier oscillator). In turn, the output from the chroma oscillator is split into three suitable phases for injection into the three chroma demodulators. From the chroma demodulators, the red video signal, the blue video signal, and the green video signal are stepped up in amplitude by the color video amplifiers, and are then applied to the color picture tube. Note that the color-killer system senses whether a color burst is present, and automatically disables the chroma bandpass amplifier if an incoming color signal is not present. The convergence circuit brings the three electron beams in the color picture tube into proper focus, as detailed subsequently.

1.2 NORMAL AND ABNORMAL CONTROL RESPONSES

Preliminary analysis of a trouble symptom in a color-TV receiver requires a good knowledge of normal and abnormal control responses. As an illustration, if the receiver has lost color sync, as shown in Fig. 1–1(c), it may be possible to correct the trouble by readjusting the horizontal-hold control. On the other hand, if the picture cannot be brought into sync by control adjustment, the control is said to be *out of range*. This condition is caused by some component defect in the horizontal-oscillator section, or in its associated AGC and sync section, pictured in Fig. 1–4. At this point, it is instructive to note that color sync is a subfunction of horizontal sync lock. In other words, it is possible to encounter loss of color sync without loss of horizontal sync, as seen in Fig. 1–1(b). However, if horizontal sync is lost, color sync will also be lost, as shown in Fig. 1–1(c).

When the picture has broken horizontal sync lock, it is sometimes possible to bring the picture into sync by turning the hold control to a critical setting. In such a case, the horizontal-hold control is said to lack normal locking range. This is another trouble symptom that indicates some component defect in the

sync section, or in the horizontal-oscillator section. Although it is less likely, there is also a possibility that critical sync lock is being caused by technical difficulties at the transmitter. To check this possibility, the channel selector may be set to another channel. Occasionally, excessive ripple voltage on the V_{cc} (B+) lines will cause critical sync lock. Spurious AC voltages on the supply line can be quickly investigated with an oscilloscope, such as that illustrated in Fig. 1–5. Spurious AC voltages usually result from an open decoupling capacitor along the supply line, or a defective filter capacitor in the power supply.

Next, it is helpful to consider the normal responses that are observed when the fine-tuning control is adjusted. With reference to Fig. 1–6, the color picture has maximum quality when the fine-tuning control is correctly adjusted. If the fine-tuning control is turned too far left, the color "drops out" of the picture, leaving only a black-and-white image. On the other hand, if the fine-tuning control is turned too far right, both the color image and the

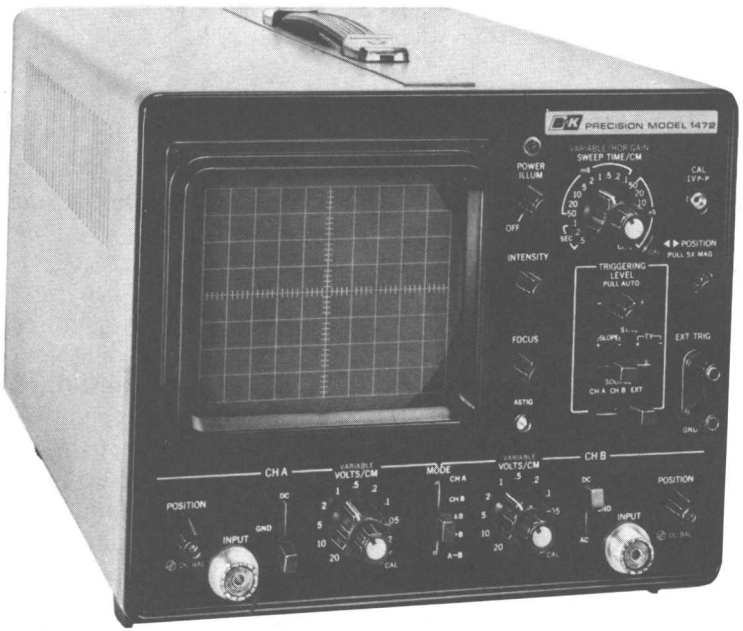


Figure 1–5. A high-performance oscilloscope for color-TV servicing. *(Courtesy of B&K Precision, a branch of Dynascan Corporation)*

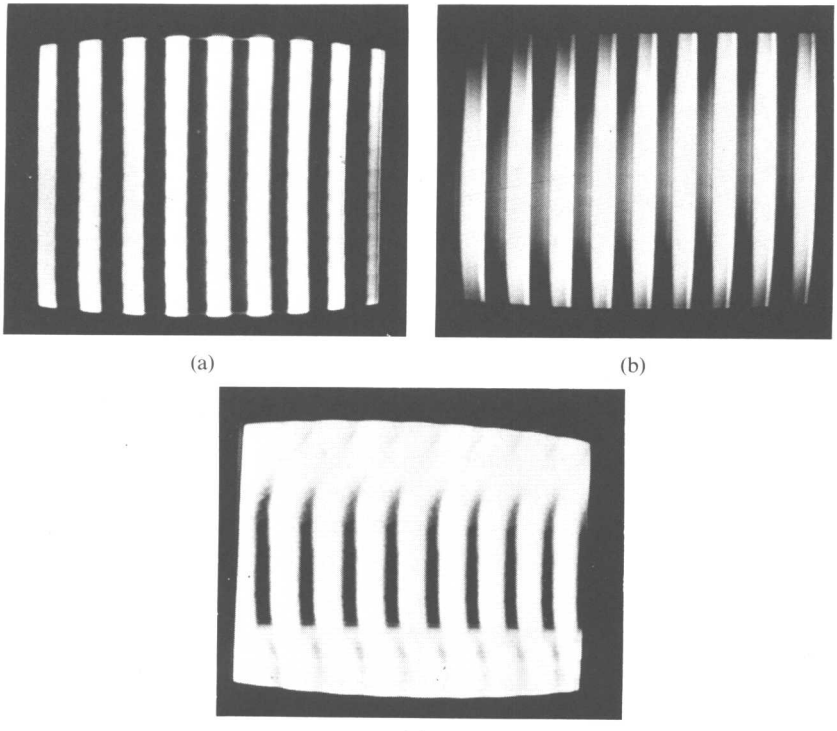


Figure 1–6. Normal effect of fine-tuning control variation: **(a)** Color picture with correct tuning; **(b)** Control turned too far left; color is lost; **(c)** Control turned too far right; both black-and-white and color are lost.

black-and-white image disappear, leaving a random sound-and-noise interference display. These are the responses that are observed in a normally operating receiver. If the color portion of the image is not displayed at any setting of the fine-tuning control, for example, a fault in the color signal channel is indicated. Again, if the best picture is obtained at one setting of the fine-tuning control, but the best sound reproduction is obtained at another setting of the fine-tuning control, another kind of malfunction is indicated in the picture channel. Analysis of these trouble symptoms is detailed subsequently.

Referring to Fig. 1–4, it is instructive to note the normal response to variation in setting of the color control. These responses are illustrated in Fig. 1–7. If normal response is not obtained from

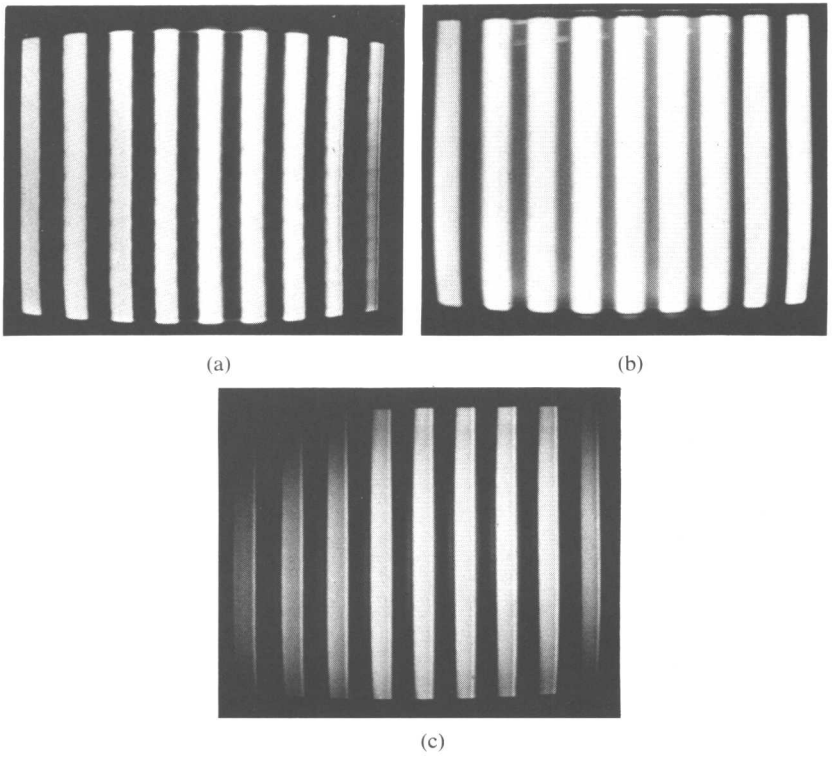


Figure 1–7. Normal responses to adjustment of the color control: **(a)** Control set correctly; **(b)** Control turned too high; **(c)** Control turned too low.

adjustment of the color control, it is indicated that there is a defect in the chroma channel. Although the color control operates in the chroma bandpass amplifier section, the fault may be elsewhere, such as in the video amplifier, or in the chroma oscillator network. Therefore, chroma signal-tracing procedures would be used to localize the difficulty. With reference to Fig. 1–8, correct color reproduction is normally obtained at a particular setting of the tint control, with distorted color reproduction on either side of the correct setting. Inability to obtain correct color reproduction by adjustment of the tint control points to a fault in the phase-shifter section, or in the color demodulator section(s). Accordingly, oscilloscope tests would be made to localize the trouble area.

Adjustment of the color-killer control normally permits color-