RADIO HI-FI TV
Techni-talk
COMPLETE ELECTRONIC SERVICING INFORMATION

Vol. 20, No. 4 Winter, 1968-69

COLOR TELEVISION--NTSC STANDARDS-III

In the last issue the luminosity response of the human eye was discussed. In this issue the development of chrominance signals are described.

As indicated in Figure 2 in the Volume 20, No. 1 issue, the high definition brightness signal that has been constructed is only step one of a two-step process. Step two is the addition of low definition color information. This will result in the "splashing on" of low detail color to the high detail monochrome picture. The necessary voltages for a color reproduction are as shown at the picture tubes in Figure 7, E_r for the red tube, E_g for the green tube and E_b for the blue tube. In other words, for any fluctuation of the voltage out of the red camera that same fluctuation should be applied to the red picture tube. For reasons cited previously, E_y is being applied to all three receiving picture tubes. Therefore, what color signals must be added to E_y to give E_r, E_g, and E_b? Apparently, three different signals are needed. One color signal when added to E_y must give E_r. A second signal added to E_y must result in E_b. Finally, a third signal must be used to give E_g.

The next problem is the exact nature of these three signals. Looking at the signal to be applied to the red tube: Color Signal $+ E_y = E_r$

so Color Signal $= E_r - E_y$

When this is done for the green and blue tubes also, the resulting color signals take the form:

E_r-E_y E_g-E_y E_b-E_y

When these color difference signals as they are called, are applied to their respective picture tubes, the results will be:

$(E_r-E_y) + E_y = E_r$ for the red tube
$(E_g-E_y) + E_y = E_g$ for the green tube
$(E_b-E_y) + E_y = E_b$ for the blue tube

A look at Figure 7 shows what the addition does to the color receiver. First, the signals E_y, E_r-E_y, E_g-E_y, and E_b-E_y are derived from E_r, E_g, and E_b. This is done by applying the outputs of the cameras into a matrix system, which is nothing more than a series of adding and subtracting circuits. The outputs are then fed through cables to the color receiver. The receiver is set up to feed E_y to all three adder circuits equally. In addition the E_r-E_y signal is applied to the red adder, E_g-E_y is applied to the green adder, and E_b-E_y is applied to the blue adder. The outputs which are then fed to the picture tubes are E_r, E_g, and E_b.

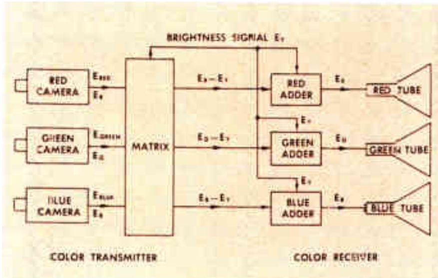

Fig. 7—Simple color transmission system by means of color difference signals.

In order to clarify the exact nature of the brightness signal and the three color difference signals, a look at the make up of the signals for a color-bar pattern (Figure 8) would be advisable. This pattern consists of five vertical bars—White, red, green, blue, and yellow. The last four bars are 100% saturated colors. Figure 8 indicates the waveforms that would be observed with an oscilloscope synchronized at the horizontal scanning frequency. The starting point is the white bar since the initial camera adjustments are made for equal outputs for Illuminant C. Thus, the wave forms for E_r, E_g, and E_b each indicate 1 unit output for white. Because saturated bars are used, notice that there is 1 unit for E_r when scanning the red and yellow bars, the output is zero for the blue and green bars.

In a similar manner, E_g is 1 unit for the green and yellow bars and zero for the blue and red bars.

Also, E_b is one unit for the blue bar only. It is zero for the red, green, and yellow bars.

The next step is the development of the E_y signal.

$$E_y = .30E_r + .59E_g + .11E_b$$

Using the above formula for the white bar, E_y is:

E_y (White) $= (.30 \times 1.0) + (.59 \times 1.0) + (.11 \times 1.0) = 1.0$ units

For the red bar E_y is:

E_y (Red) $= (.30 \times 1.0) + (.59 \times 0) + (.11 \times 0) = .30$ units

For the green bar E_y is:

E_y (Green) $= (.30 \times 0) + (.59 \times 1.0) + (.11 \times 0) = .59$ units

For the blue bar E_y is:

E_y (Blue) $= (.30 \times 0) + (.59 \times 0) + (.11 \times 1.0) = .11$ units

and finally the yellow bar is:

E_y (Yellow) $= (.30 \times 1.0) = (.59 \times 1.0) + (.11 \times 0) = .89$ units

Recalling the purpose of the brightness signal, how would this color-bar pattern show up on a monochrome receiver? The more signal applied to the picture tube grid, the brighter the bar. Therefore, the bars would have different values of brightness. The brightest would be white, then yellow, green, red, and the dimmest, blue. A glance at Figure 4 in the last issue, will show that these various brightness levels are logical since they correspond approximately to the response curve of the eye.

The remaining signals to be developed in Fig. 8 are the color difference signals. These are achieved in simple adding circuits just as the E_y signal was developed. E_y is put through a phase inverter to give $-E_y$ and added to E_r, E_g and E_b. The resulting voltages are E_r-E_y, E_b-E_y and E_g-E_y.

For example, E_r-E_y is formed by taking the waveform E_y, inverting it to give $-E_y$ and adding it to the waveform E_r.

For the white bar $E_r = 1$ unit and $E_y = 1$ unit. E_r-E_y is therefore 0 for white. This is a point worth remembering. There is no color-difference signal for white.

For the red bar $E_r = 1$ unit and $E_y = .30$ units. So, $E_r-E_y = .70$ units.

For the green bar $E_r = 0$ units and $E_y = .59$ units. So, $E_r-E_y = .59$ units for this bar. Notice that, although it is not possible to have negative values of E_r, E_g, E_b or E_y, negative values of color-difference signals do exist and occur quite frequently.

For the blue bar $E_r = 0$ units and $E_y = .11$ units. Therefore, $E_r-E_y = .11$ units for this bar.

The color difference signals, E_g-E_y and E_b-E_y, are formed in the same manner. The results of which can be seen also in Figure 8.

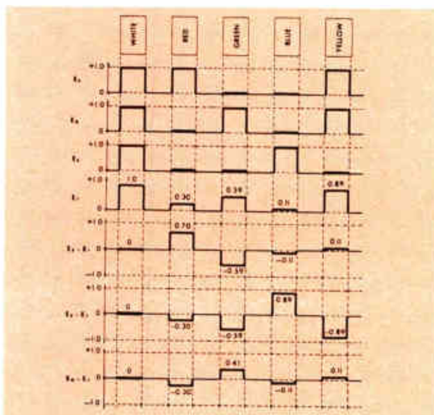

Fig. 8—Waveforms for 100% saturated color bar pattern.

(Continued next issue)

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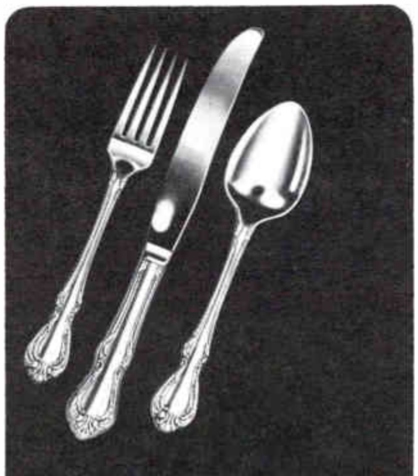

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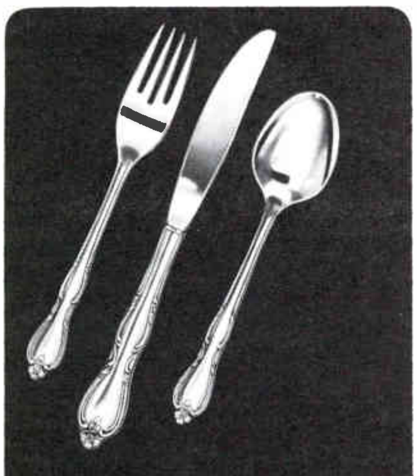

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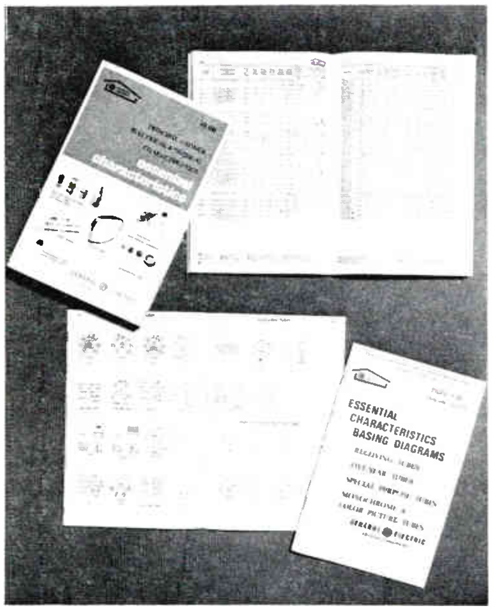

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