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GE Electronic TUBES

Techni-talk on AM, FM, TV Servicing

COLOR TV-VII

In the last issue it was shown how two sine waves could be combined. The vector addition of two sine waves was also illustrated for waves equal in amplitude as well as unequal in amplitude. In this issue it will be shown how the two color signals are combined to produce changes in both hue and saturation.

It will be recalled that different color bars produce specific E_Y, $E_R - E_Y$ and $E_B - E_Y$ voltages. Since the $E_R - E_Y$ and $E_B - E_Y$ voltages are applied to the balanced modulators in the transmitter and produce the quadrature modulated color signal, it is important to understand how the resultant signal is produced. Fig. 1 shows the voltages, E_R, E_G and E_B produced by the red, green and blue cameras. It will be recalled that specific percentages (30% red, 59% green and 11% blue) of these three voltages are used to produce the E_Y or brightness signal. The E_R and E_B voltages are subtracted from the E_Y signal to produce the $E_R - E_Y$ and $E_B - E_Y$ color signals.

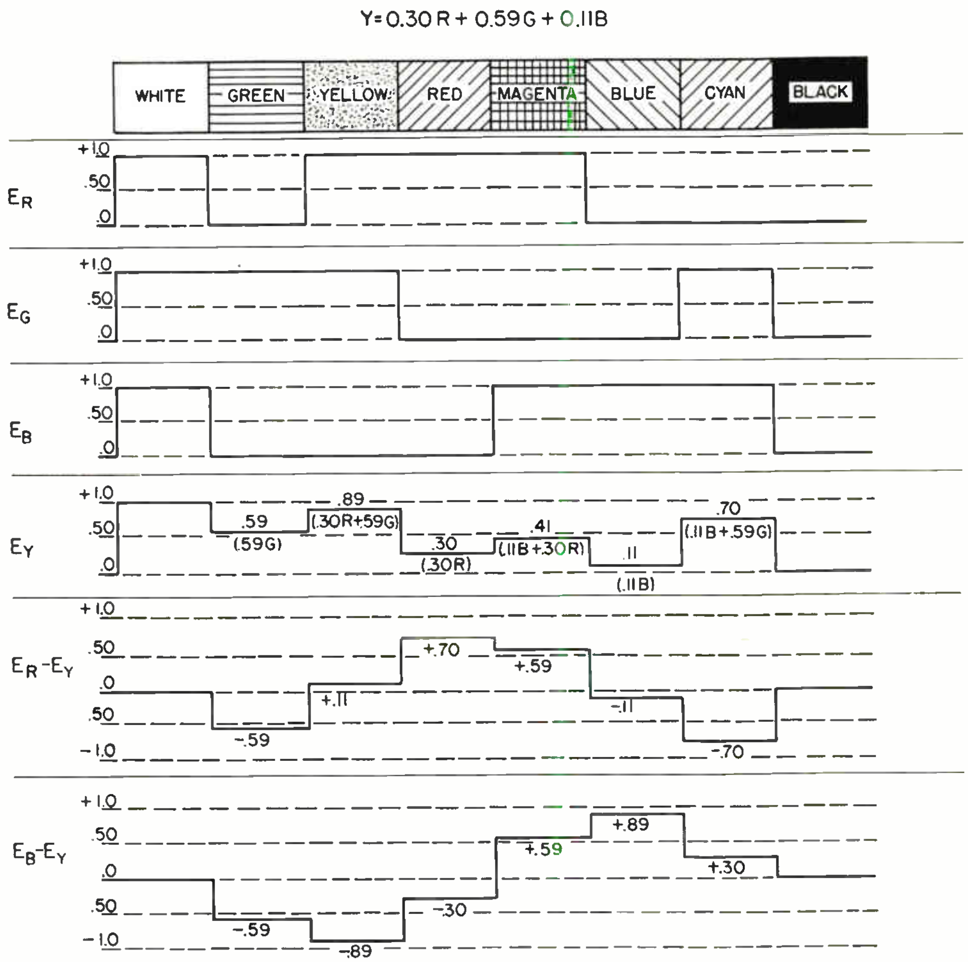

Fig. 1. Signal voltages developed as a result of scanning various colors.

COLOR VECTOR DEVELOPMENT

The $E_R - E_Y$ and the $E_B - E_Y$ color signals shown in Fig. 1 represent either positive or negative voltages. Since the R − Y ($E_R - E_Y$) signal and the B − Y ($E_B - E_Y$) signal are ninety degrees out of phase with each other, they can be shown as two straight lines ninety degrees apart as illustrated in Figs. 2A and 2B. The R − Y voltage is shown as a vertical line with the positive voltage at the top and the negative voltage at the bottom as indicated in Fig. 2A. The B − Y voltage is shown as a horizontal line with the positive voltage at the right and the negative voltage at the left as illustrated in Fig. 2B. When these two are superimposed, the point of intersection represents zero voltage as shown in Fig. 2C. If Fig. 2C is placed within a circle which has the 0° point at +1.0 volt $E_B - E_Y$, the −1.0 volt $E_B - E_Y$ will be at the 180° point. The +1.0 volt $E_R - E_Y$ and the −1.0 volt $E_R - E_Y$ will be at the 90° and 270° points respectively as shown in Fig. 2D. If a straight line is drawn connecting any point within this circle with the center or zero voltage point, this line will have two components. One will be the voltage component and the other will be the phase component. The voltage component will be indicated by the distance away from the center which is the zero voltage point. The phase component will be indicated by the counterclockwise position away from the 0° point. The voltage component will determine the degree of saturation and the phase component will determine the hue.

If the $E_R - E_Y$ voltage developed by the color green in Fig. 1 is plotted on Fig. 2A, it

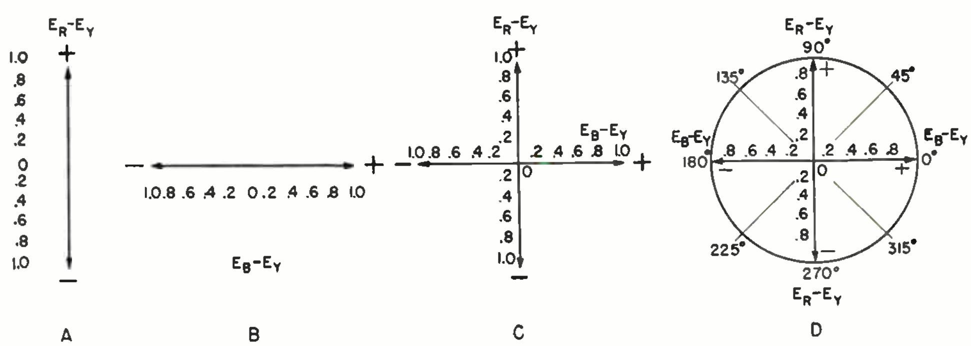

Fig. 2. $E_R - E_Y$ and $E_B - E_Y$ voltages shown as straight lines on which positive and negative voltages have been plotted. When superimposed and enclosed in a circle, phase as well as voltage may be determined.

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will fall below the center and very close to the −.6 point since it has a value of −0.59 volts. The $E_B - E_Y$ voltage for green will fall left of center on Fig. 2B and also very close to the −.6 point since this voltage is also −.59. Fig. 3A shows these two points plotted on a drawing similar to Fig. 2C. If a parallelogram is drawn from the −.59 points, the vector sum of these two voltages is represented by the length of the diagonal vector and the counterclockwise position of the diagonal vector represents the phase angle.

Since yellow is the next color which appears on Fig. 1, the $E_R - E_Y$ voltage of +.11 and the $E_B - E_Y$ voltage of −.89 have been plotted on Fig. 3B. The red, magenta, blue and cyan voltages have also been plotted in the same manner on Figs. 3C, D, E and F. It is evident that a parallelogram can be made from any two voltages whether plus or minus and that the phase angle of the vector changes as the hue changes. Various hues will produce various camera output voltages and, therefore, various $E_R - E_Y$ and $E_B - E_Y$ voltages. These voltages will then produce a wave form which has both an amplitude and a phase characteristic. Fig. 1 shows that neither white nor black produce any $E_R - E_Y$ or $E_B - E_Y$ voltages. Therefore, the phase angle as well as the voltage for black and white will be zero.

COLOR AXES

If Figs. 3A, B, C, D, E, and F are superimposed on a single drawing (Fig. 4) it will be noticed that the green and magenta vectors are equal in length and 180° removed from each other. This is called the green-magenta axis. It will also be noticed that two other axes are formed by the yellow and blue vectors and the red and cyan vectors. Since the two colors on any one axis are equal in length, the vector amplitude of any color shown in Fig. 4 can be determined by drawing three circles as shown. The point where each circle crosses the calibrated $E_R - E_Y$ or $E_B - E_Y$ axes indicates the voltage amplitude of two colors. The amplitude of the red and cyan vectors would be .76 volts because these vectors touch the inner circle. The green and magenta vectors terminate at the next circle and would, therefore, have an amplitude of .83 volts. The blue and yellow vectors would be .90 volts since they terminate at the outside circle. If the axes shown in Fig. 4 are rotated approximately 220 degrees and placed upon the chromaticity diagram the vector for each color will fall in the correct color area as indicated in Fig. 5.

The amplitudes shown in Fig. 4 represent the maximum voltages which can be produced by these six colors because they are one-hundred-percent saturated hues. A lesser

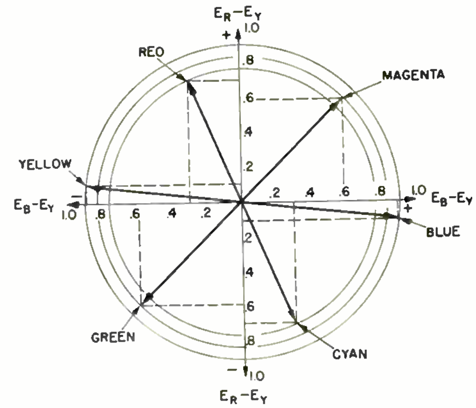

Fig. 4. Combination of the vectors shown in Fig. 3. The three axes, phase relationship and amplitude of the color signals can be seen.

degree of saturation will produce vectors proportionately lower in amplitude. As an example of this, Fig. 6 represents the voltages developed by 50% saturated green, red and blue bars. If the $E_R - E_Y$ and $E_B - E_Y$ voltages are compared with those shown on Fig. 1, it will be noticed that they are just one half the amplitude. If the red voltages shown on Fig. 6 were plotted on Fig. 3C, the phase angle would remain the same because both the $E_R - E_Y$ and the $E_B - E_Y$ voltages would be reduced in the same proportion. The length of the voltage vector, however, would be reduced by 50%. Therefore, the length of the voltage vector will vary in proportion to the saturation for any hue. This is illustrated in Fig. 7 which has the $E_R - E_Y$ and $E_B - E_Y$ voltages plotted for 25, 50, 75 and

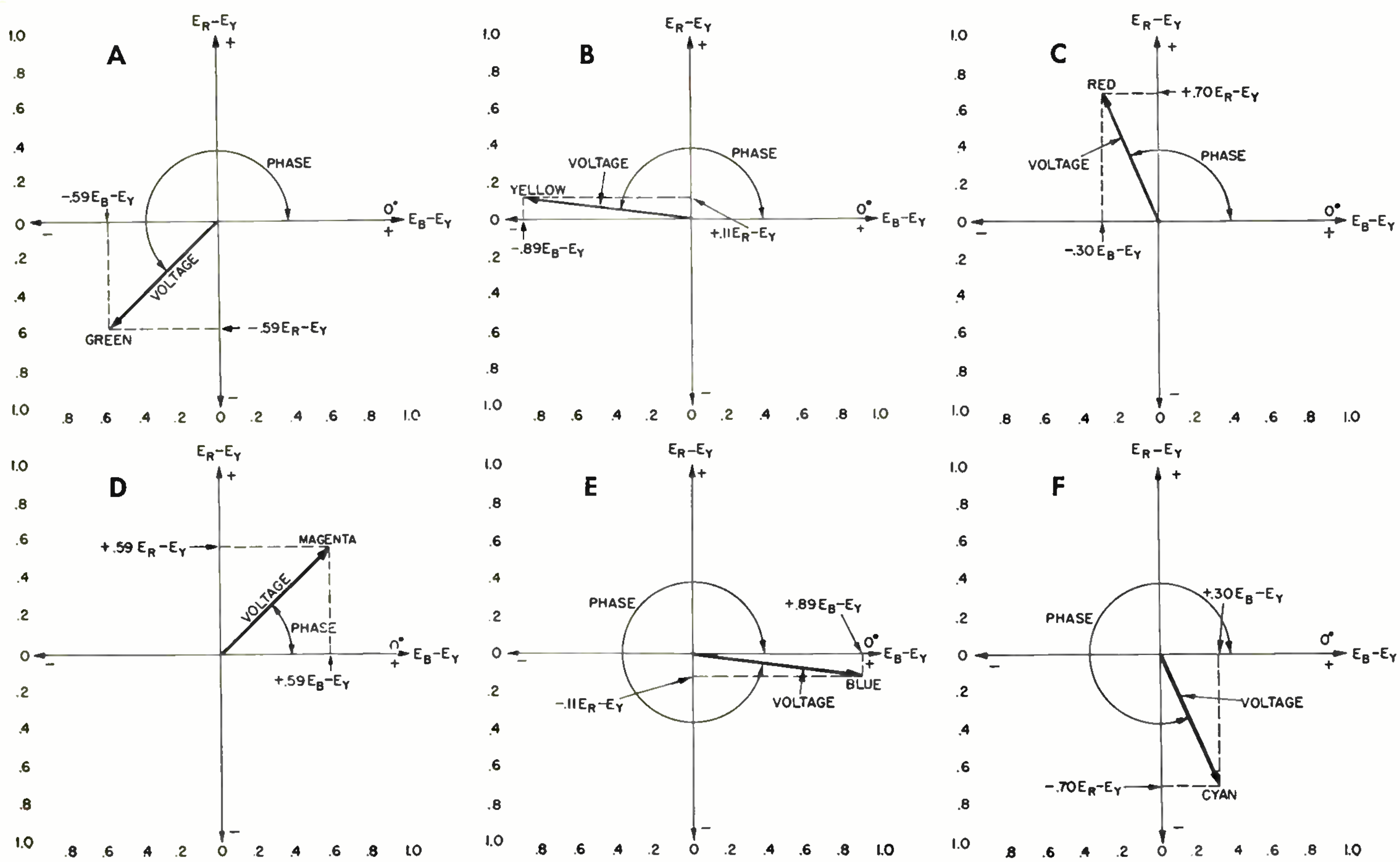

Fig. 3. Vectors produced by the $E_R - E_Y$ and $E_B - E_Y$ signal voltages shown in Fig. 1.

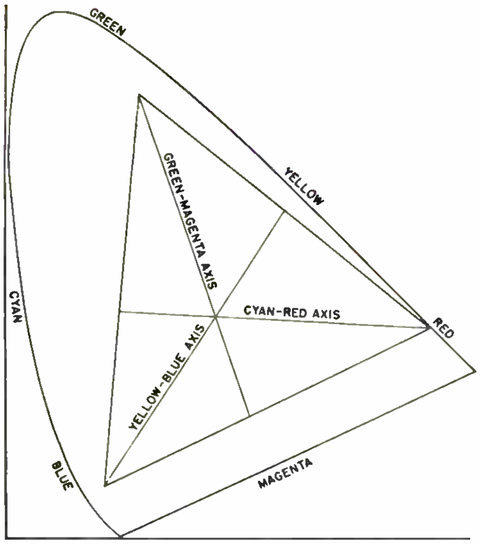

Fig. 5. If the color axes shown in Fig. 4. are superimposed on the chromaticity diagram each color axis will fall in the correct color area.

100% saturation. The red hue determined by the phase angle of the diagonal vector can be visualized as changing from a deep fully saturated red through the various shades of pink to white at the center as the length of the voltage vector is decreased. The amplitude or length of the vector for *any* hue will, therefore, become proportionately smaller as its saturation is decreased.

OVERMODULATION OF VIDEO CARRIER

It was previously stated that the amplitude of any vector indicates saturation. Therefore, a saturated red or cyan will produce a voltage vector of .76 volts, green or magenta will produce .83 volts and blue or yellow .90 volts. This means that the color subcarrier will be amplitude modulated by these voltages. If color signals of these amplitudes are added to the brightness signal, overmodulation of the video carrier will result. Fig. 8 shows the various signal voltages which will be produced. The composite signal is the combination of E_Y and the chrominance subcarrier. It will be noticed that every color signal modulates the carrier over the one-volt (100%) level. This overmodulation could cause the chrominance signal for green, yellow and cyan to be distorted or squashed. Since the amplitude of the chrominance signal determines the saturation of a color, overmodulation could cause these colors to be undersaturated. If the chrominance modulation extends too far into the white level, it may cause video carrier cutoff and produce audio buzz in intercarrier receivers. If it extends too far into the black or blanking level this modulation may affect the horizontal and/or vertical sync. circuits.

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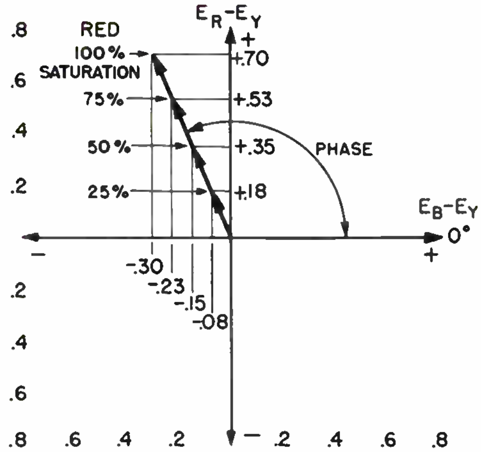


Fig. 7. Various voltages produced by 25, 50, 75 and 100% saturated red.

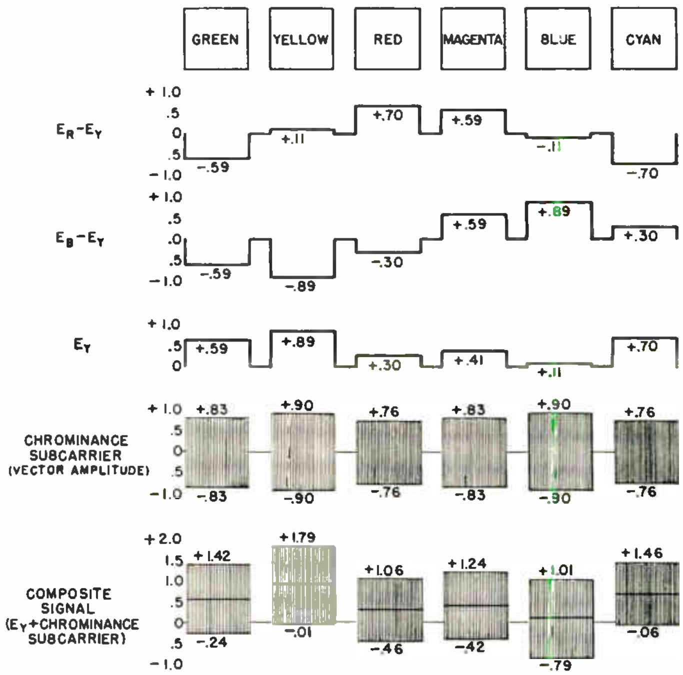


Fig. 8. Signal voltage amplitude resulting from the combination of the chrominance subcarrier and the brightness signal.

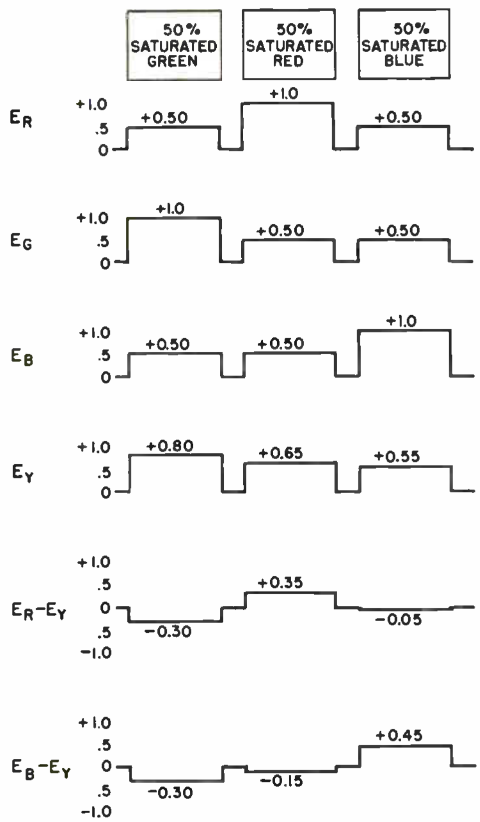
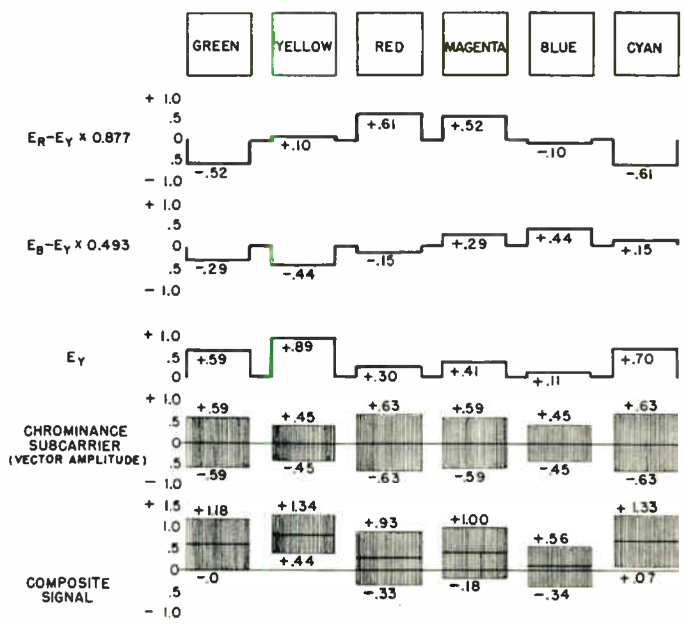


Fig. 6. Signal voltages developed as a result of scanning 50% saturated colors.

Fig. 9. The same signals shown in Fig. 8 attenuated to reduce overmodulation.



BENCH NOTES

Contributions to this column are solicited. For each question, short-cut or chronic-trouble note selected for publication, you will receive $10.00 worth of electronic tubes. In the event of duplicate or similar items, selection will be made by the editor and his decision will be final. The Company shall have the right without obligation beyond the above to publish and use any suggestion submitted to this column. Send contributions to The Editor, Techni-talk, Tube Department, General Electric Company, Schenectady 5, New York.

AMATEUR INTERFERENCE—RADIO

Just recently there has been increased amateur radio activity in our locality. This raises the problem of broadcast interference. Quite a few customers have brought in their radios complaining that they are hearing dots and dashes mixed in with their audio. Most of these complaints came from customers that have cheap radios such as those in the $18.00 to $25.00 range.

99% of these interference problems are cured with the insertion of a 330 mmfd. by-pass condenser from the triode grid of the detector-first audio tube (12SQ7, 12AT6, etc.) to ground. This by-passes the RF that has pushed its way through the IF strip due to its power.

Louis Kurkjian, Service Manager
Associated Radio & Appliance Co.
4162 Beverly Boulevard
Los Angeles 4, California

REDUCED A-C DUE TO LINE CORD

A G-E set which worked perfectly in the shop would not function well in the customer's home. It showed every evidence of low line voltage in spite of the fact that the line voltage was measured and found satisfactory. The mystery was solved when it was noted that the customer was using a line cord from an electric razor as a replacement for the TV line cord. The wire size in the razor cord was not heavy enough to carry the amperage of the TV set. Unfortunately the female member of these razor line cords fits the TV receptacle perfectly.

Frank E. Miller
455 Grove Street
Reading, Mass.

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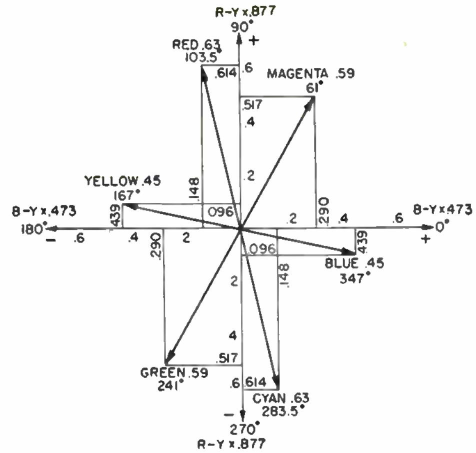


Fig. 10. Vectors produced by the corrected $E_R - E_Y$ and $E_B - E_Y$ voltages shown in Fig. 9.

CORRECTION FOR OVERMODULATION

It was found that satisfactory results could be achieved if the $E_R - E_Y$ and $E_B - E_Y$ signals were attenuated to insure a maximum of 34% overmodulation. The $E_R - E_Y$ signal was, therefore, multiplied by a factor of 0.877 and the $E_B - E_Y$ signal by 0.493. The result of attenuating these two color signals is shown in Fig. 9. It should be kept in mind that signal voltages shown in both Figs. 8 and 9 result from scanning 100% saturated colors. Colors with this degree of saturation are not ordinarily seen or used; therefore, the maximum modulation level of 134% shown in Fig. 9 for 100% saturated yellow will rarely occur in an actual color telecast.

The reason for attenuating the $E_R - E_Y$ and $E_B - E_Y$ signals was to reduce the amplitude of the color modulation. As previously explained this amplitude resulted from adding the two color signal voltages vectorily. Therefore, the attenuated color signals will produce vectors slightly different in both amplitude and phase than those originally shown in Fig. 1. The new values which are actually used are shown in Fig. 10.

What's new! 6AU8

TRIODE-PENTODE

The 6AU8 is a general-purpose miniature tube which contains a sharp-cutoff pentode and a medium-mu triode in one envelope. Each section has a separate cathode and is electrically independent.

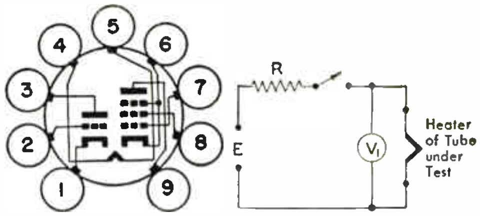
The 6AU8, as a result of its controlled heater warm-up characteristic, is especially suited for use in television receivers which employ series-connected heaters. When the tube is used in conjunction with other 600-milliampere types which exhibit essentially the same heater warm-up characteristic, heater voltage surges across the individual tubes are minimized during the warm-up period.

Heater Voltage, AC or DC	6.3 Volts
Heater Current	0.6 Amperes
Heater Warm-up Time*	10.5 Seconds

MAXIMUM RATINGS

DESIGN-CENTER VALUES	Pentode Section	Triode Section	
Plate Voltage	300	300	Volts
Screen-Supply Voltage	300	. .	Volts
Positive DC Grid-Number 1 Voltage	0	0	Volts
Plate Dissipation	3.0	2.5	Watts
Screen Dissipation	0.6	. .	Watts
Heater-Cathode Voltage			
Heater Positive with Respect to Cathode			
DC Component	100	100	Volts
Total DC and Peak	200	200	Volts
Heater Negative with Respect to Cathode			
Total DC and Peak	200	200	Volts
Grid-Number 1 Circuit Resistance			
With Fixed Bias	0.25	0.5	Megohms
With Cathode Bias	1.0	1.0	Megohms

* Heater warm-up time is defined as the time required in the circuit shown at the right for the voltage across the heater terminals to increase from zero to the heater test voltage (V_1). For this type, E = 25 volts (RMS or DC), V_1 = 5.0 volts (RMS or DC), and R = 31.5 ohms.



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