DECEMBER—JANUARY 1955
Vol. 6 No. 6

COLOR TV-VI

GE Electronic TUBES
Techni-talk on AM, FM, TV Servicing

The material covered so far in this series of articles included color reproduction, which could be demonstrated with an easily constructed "color box." The portion of the NTSC system which covered the development of the brightness signal as well as the R-Y and B-Y signals was also discussed. It was shown that the reproduction of a color picture requires three components: brightness, hue and saturation. The brightness component or "Y" signal was derived from a combination of specific proportions of the output from three color cameras. The R-Y and B-Y signals were also derived from the color camera outputs and were applied to balanced modulator circuits which suppressed the subcarrier frequency. In the next two issues the way in which these two color signals are combined to produce the hue and saturation components will be described.

HUE AND SATURATION

It has been shown that the output of the balanced modulator circuits was combined and the resultant signal represented the subcarrier frequency, quadrature modulated by the two color signals. This signal represents the hue and saturation components necessary for color reproduction. The saturation component is represented by the amplitude of the modulation and the hue is represented by the phase of the modulation. It will be recalled that the subcarrier frequency applied to the R-Y balanced modulator circuit was ninety degrees out of phase with the subcarrier frequency applied to the B-Y balanced modulator circuit. Therefore, these two signals will *always* be ninety degrees apart.

VECTORS

If two sine waves ("A" and "B" in Fig. 1) equal in amplitude but ninety degrees out of phase are combined, the resultant ("C" in Fig. 1) will appear as indicated. One method of determining the amplitude of "C" is through the use of vectors. It will be recalled that vectors may be added by drawing a parallelogram such as illustrated in Fig. 2. Since "A" and "B" are always ninety degrees apart, the parallelogram will be rectangular in shape. The diagonal lines marked "C" in the three parallelograms in Fig. 2 represent the vector sum of "A" plus "B." If "A" and "B" are unequal in amplitude the parallelogram will be rectangular as illustrated in Fig. 2. If "A" and "B" are equal in amplitude the parallelogram will be square as shown in Fig. 2.

Fig. 3 is an illustration of adding vectorily two sine waves of equal amplitude. Since both waves "A" and "B" are equal in amplitude and ninety degrees out of phase, the parallelogram will be square. The resultant voltage is determined by the point where the end of vector line "C" appears in relation to the zero line. This is illustrated in Fig. 3. When sine wave "A" is at the zero degree point, "B" is at its maximum negative point and "C," therefore, has the same negative amplitude as "B." Vector drawings at the right of Fig. 3 represent the three voltages at the 0°, 45°, 90°, 135°, and 180° points. The amplitude of vector voltage "C" can be determined at any other point by plotting the "A" and "B" voltages and then drawing a parallelogram.

Fig. 4 illustrates the vector addition when voltages "A" and "B" are not equal. It should be kept in mind that the vector addition illustrated in Figs. 3 and 4 is made electronically and therefore, almost instantaneously in the color transmitter and receiver. The next issue will show how the R-Y and B-Y signals are used to produce vectors which are the hue and saturation components of the color signal.

(to be continued)

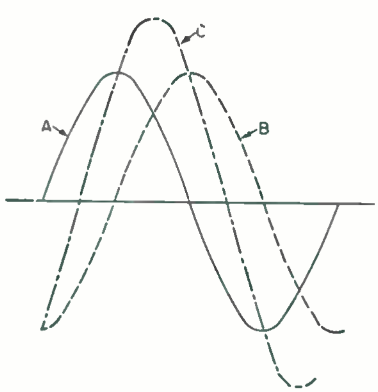


Fig. 1. Combination of two sine waves of equal amplitude and the resultant wave.

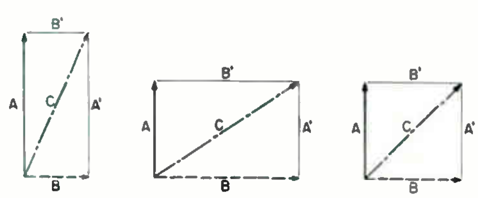


Fig. 2. Parallelogram illustrating the vector addition of unequal and equal forces ninety degrees apart.

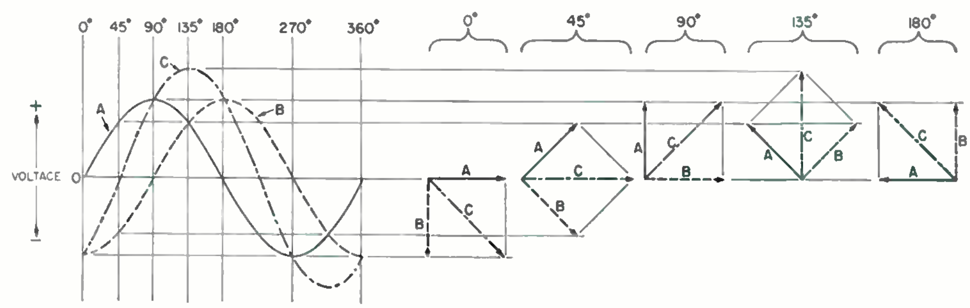


Fig. 3. Illustration of the vector addition of sine waves equal in amplitude.

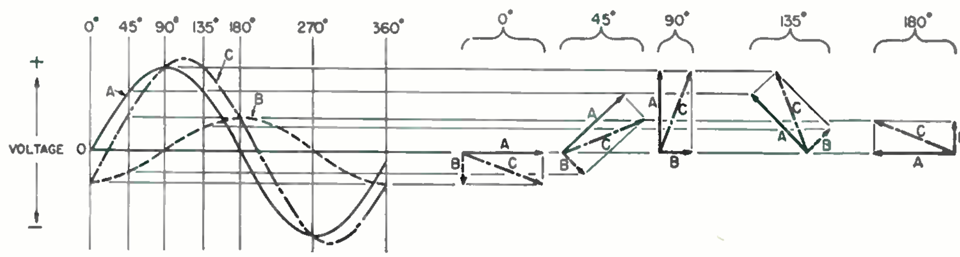


Fig. 4. Illustration of the vector addition of sine waves unequal in amplitude.

"TV SERVICE MONTH"

Sponsored by General Electric to

Electronic TUBES

HELPS IDENTIFY YOU AS A SOURCE FOR G-E TUBES. GIGANTIC CELEBRATION WILL FEATURE:

$25,000 in cash prizes for your customers.

Mammoth G-E ad in LOOK that builds recognition for your efforts. Your name and address can be listed.

Big kit of unique promotion items for your own TV Service Month.

DON'T DELAY! SEE YOUR G-E TUBE DISTRIBUTOR TODAY!

STARTS APRIL 19TH!

improve service business everywhere!

YOU will get the full benefit of TV Service Month! For 30 days new customers will visit your shop to get their entry blanks for the big G-E $25,000 contest. $10,000 first prize . . . plus 816 other cash prizes!

And here's sensational news! *Your name and address* can appear in G. E.'s announcement in LOOK—in subscribers' hands and on the newsstands April 19. You can be part of the industry's greatest public-relations program to date. 20,000,000 people see LOOK. It's read in homes all through your neighborhood.

See your G-E tube distributor immediately so your name may be included! In order to spark sales still more, your G-E distributor has ready for you a big kit of unique promotion items—each new, different, a winner. Read about some of them at right . . . then see or phone your distributor today! *Tube Department, General Electric Company, Schenectady 5, New York.*

You too can display this colorful window emblem! Pinpoints your shop as Contest and TV Service Month headquarters.

Large window streamer. Use it to announce a special attractive TV Service offer that will turn callers into buyers.

Footprints—plastic, self-stick—for sidewalk before your door. They invite customers in!

Talking postcard . . . brand-new, it's a record that actually plays on TV owners' phonographs! Also, regular advertising postcard. Both tell story of prize contest—help you promote TV Service Month profitably.

GENERAL ELECTRIC

161-1A3

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.

SERVICE HINTS

DUMONT R A 164-165
Poor reception; some channels appear overloaded; loud buzz in sound. Trouble—video det. crystal 1N64 was wired in reverse, causing AGC circuit to be inoperative. Reversed connections. Set performs perfectly. This crystal is mounted in can on top of chassis.

RCA—All models using Antenna matching unit attached to side of tuner
1. Snow—smear pix—weak crackle in sound.
2. Six dark vertical bars, left side of raster, more prevalent when on unused channel.
3. Poor picture or sound.
4. Interference lines across picture.
5. No picture or sound or both very weak.
6. Intermittent troubles of above nature.
7. Two rippled lines left side of picture when on the channel.

Check entire antenna matching unit for loose, unsoldered or shorted connections.

PHILCO 51 T 1607
No raster or intermittent raster, arcing hiss heard in set, caused by open 2-meg. resistor in high-voltage cage. Arcing occurs across this resistor when it opens.

PHILCO 51 T 2136
No raster. Open resistor R103 in deflection chassis.

PHILCO All models using 6BQ7 tubes in tuners
Intermittent, weak sound, snowy picture, or no picture or sound. Check C530 150 MMF in tuner for leakage or short. R507 gets hot.

PHILCO 51 T 1836, Code 123
No sound or picture.
Check C401 for short. Check pin 1 12AU7. First sound IF plate voltage may be low or absent.

PHILCO RF Chassis 94
No picture.
Check C305 for open.

PHILCO 51 T 2138
Raster intermittent or no raster.
Check R643 12K resistor in screen circuit of 6CD6-G horizontal output. This resistor intermittently changes its value.

ADMIRAL 21D1 Chassis
No raster, no high voltage.
Check pin 5 horizontal oscillator should be 165 volts. If not, replace R436 a 150K-ohm resistor. I have found it to increase to 800K in a few sets in for repair.

FREED EISMAN 1620C
Intermittent buzz in sound.
Check for brass filings in sound discriminator coil, shorting out coil.

GENERAL ELECTRIC 20C105
Intermittent sound and picture.
Check C379A 10 MFD 450 volt in sync separator plate circuit.

WESTINGHOUSE H710T2
6BQ6-GT plate glows.
Check R438 which is a 33K-ohm resistor plate load. You may find it missing from the circuit.

EMERSON 120169F Chassis
Popping sound, then a vertical roll.
Remedy—Place 100-ohm ½-watt resistor between plate and screen of 6W6-GT vertical output tube.

STROMBERG CARLSON 321 or 324
Picture bending on top.
Increase the value of R194 cathode circuit of 6SN7-GT horizontal oscillator from 1500-ohm to 2000-ohm ½-watt resistor.

George B. Meserole
Meserole Radio & Television
647 88 Street
Brooklyn 9, N. Y.

PENNY WISE

A very simple solution for adjusting the mechanical focus slug when you have misplaced your one and only nonmagnetic screwdriver is to use a copper penny. Simple but sure.

H. Blue
377 Front St.
Hartford, Conn.

What's new! 5AU4

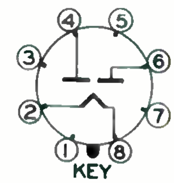
FULL-WAVE POWER RECTIFIER

The 5AU4 is a filamentary full-wave high-vacuum rectifier designed for use in the power supply of television receivers and other equipments which have high output current requirements. In full-wave operation with a supply voltage of 300 volts RMS, the 5AU4 is capable of delivering a d-c output current of 350 milliamperes.

Filament Voltage, AC or DC	5.0 Volts
Filament Current	4.5 Amperes

FULL-WAVE RECTIFIER WITH CAPACITOR-INPUT FILTER

AC Plate-supply Voltage per Plate, RMS	300	400 Volts
Filter Input Capacitor	40	40 Microfarads
Total Plate-supply Resistance per Plate	30	50 Ohms
DC Output Current	350	325 Milliamperes
DC Output Voltage at Filter Input	275	395 Volts



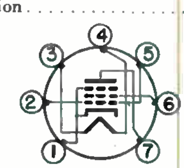
6CA5—12CA5
BEAM PENTODE
FOR AF POWER AMPLIFIER APPLICATIONS

The 6CA5 is a miniature beam pentode designed primarily for use in the audio-frequency power output stage of television and radio receivers. The tube features high power sensitivity at relatively low plate and screen voltages.

Heater Current	1.2	0.6 Amperes
Heater Voltage, AC or DC	6.3	12.6 Volts

MAXIMUM RATINGS
DESIGN-CENTER VALUES

Plate Voltage	130 Volts
Screen Voltage	130 Volts
Positive DC Grid-Number 1 Voltage	0 Volts
Plate Dissipation	5.0 Watts
Screen Dissipation	1.4 Watts



TUBE DEPARTMENT
GENERAL ELECTRIC
Schenectady 5, N. Y.

Form 3547 Requested.

FEBRUARY—MARCH 1955
Vol. 7, No. 1

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.

$Y = 0.30R + 0.59G + 0.11B$

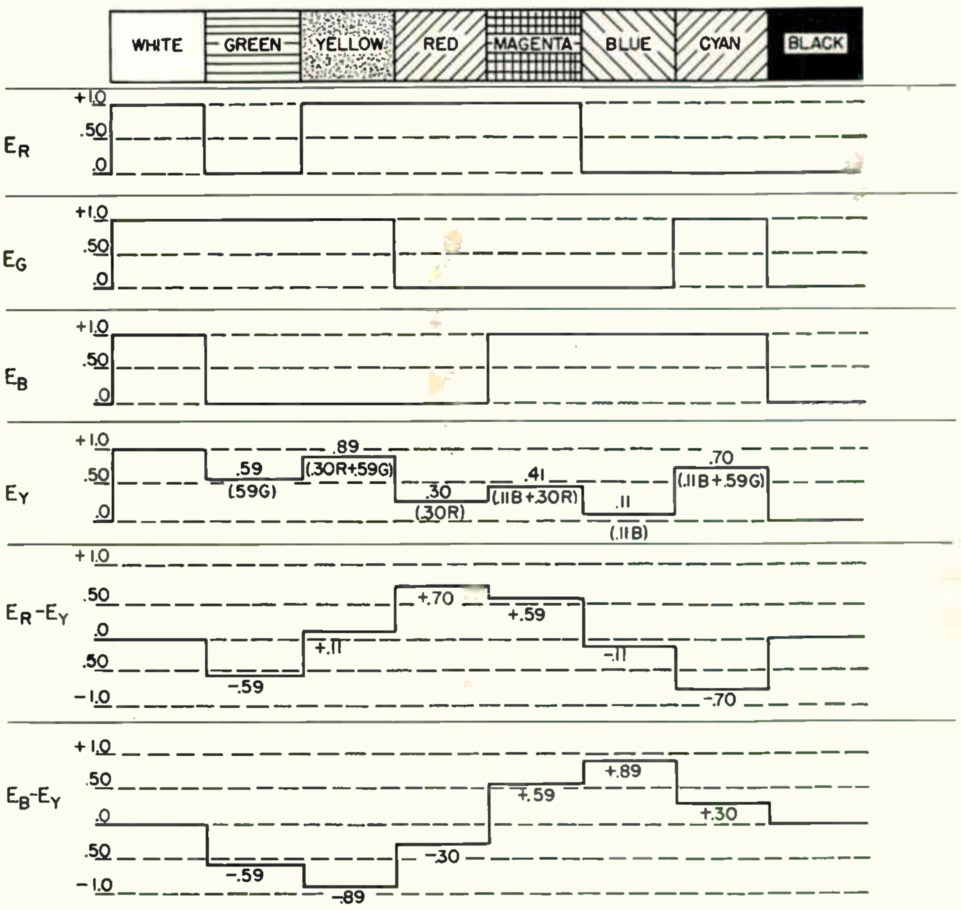


Fig. 1. Signal voltages developed as a result of scanning various colors.

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

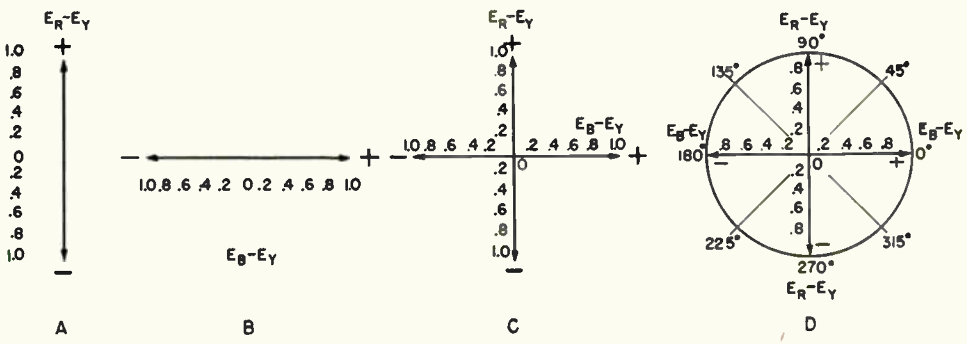


Fig. 2. E_R-E_Y and E_B-E_Y voltages shown as straight lines on which positive and negative voltages have been plotted. When superimposed and enclosed in a circle, phase as well as voltage may be determined.

Vol. 7 No. 1

TECHNI-TALK

on AM, FM, TV Servicing

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R. G. KEMPTON, Editor

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 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

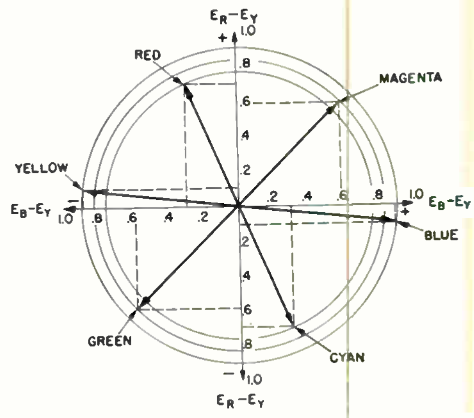


Fig. 4. Combination of the vectors shown in Fig. 3. The three axes, phase relationship and amplitude of the color signals can be seen.

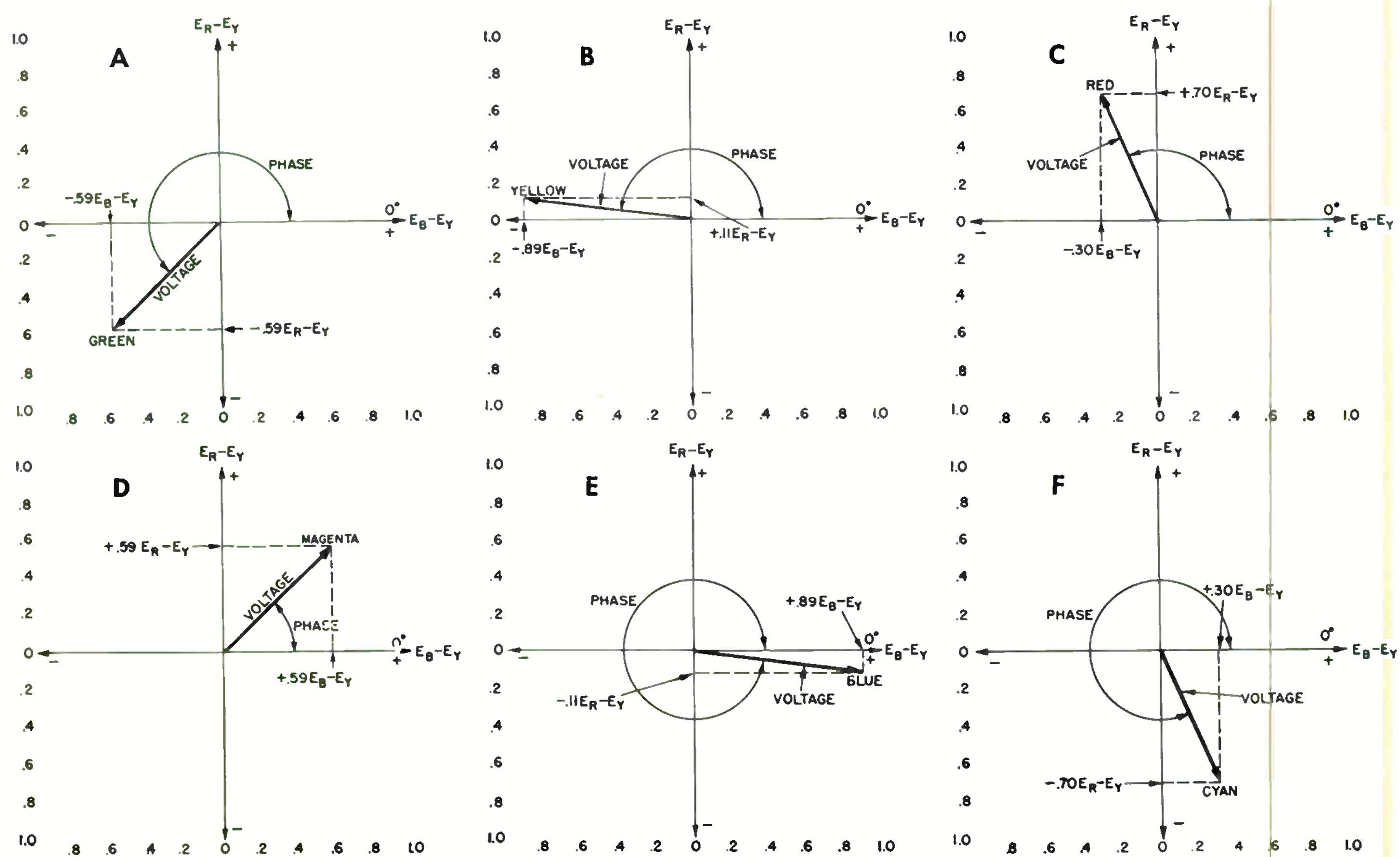


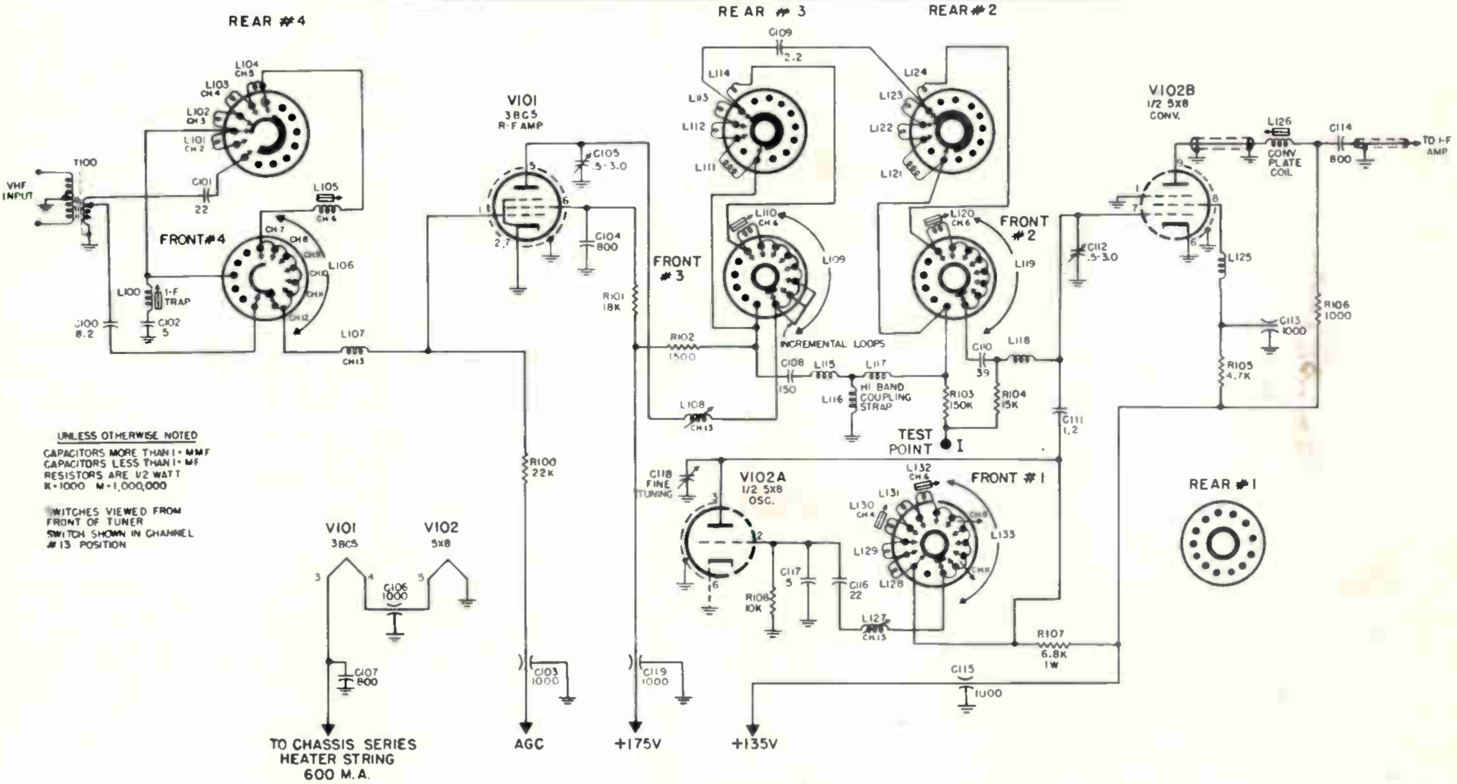
Fig. 3. Vectors produced by the $E_R - E_Y$ and $E_B - E_Y$ signal voltages shown in Fig. 1.

Tele-Clues

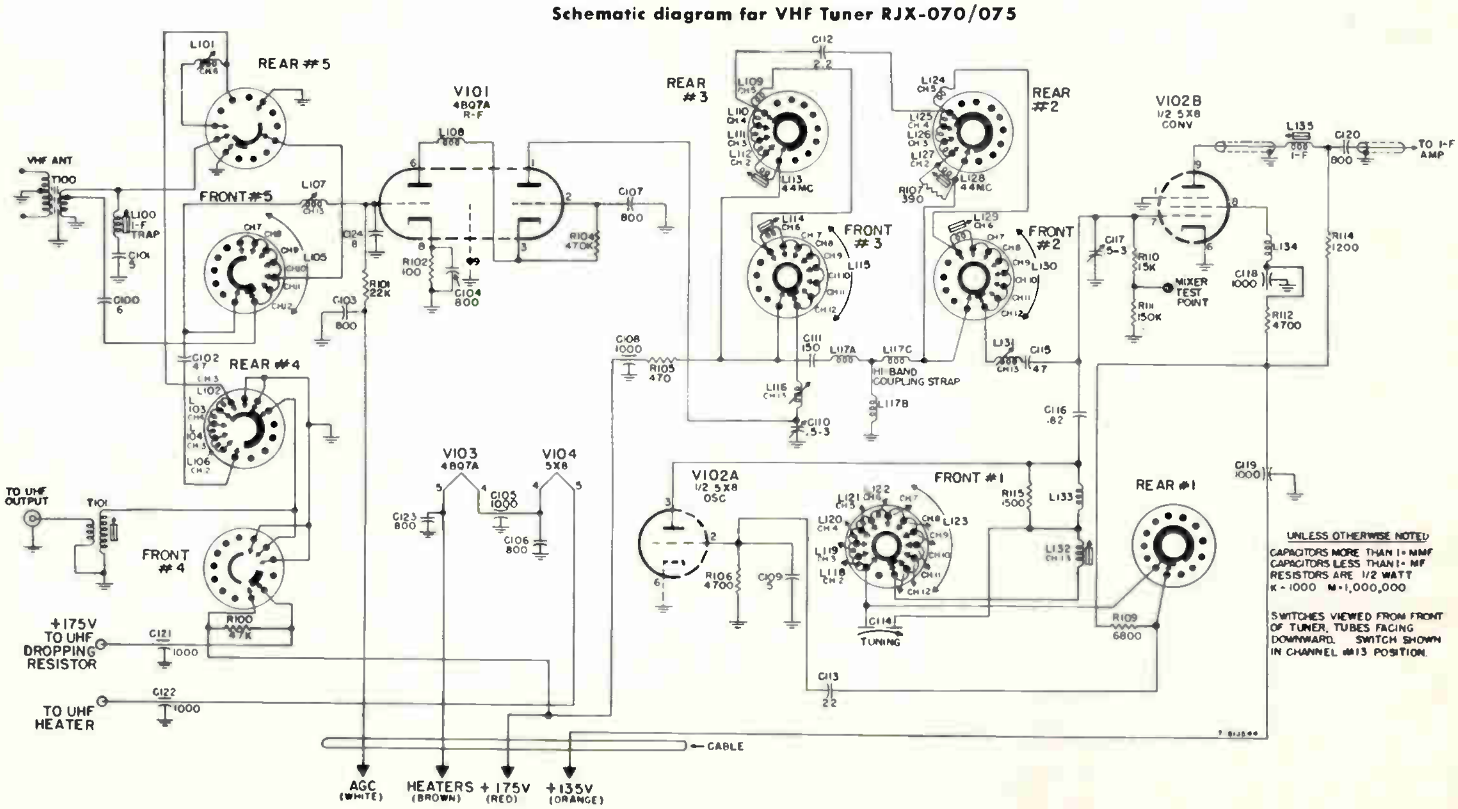
FILE THIS SHEET IN YOUR TELE-CLUE BINDER

TELE-CLUE SCHEMATIC

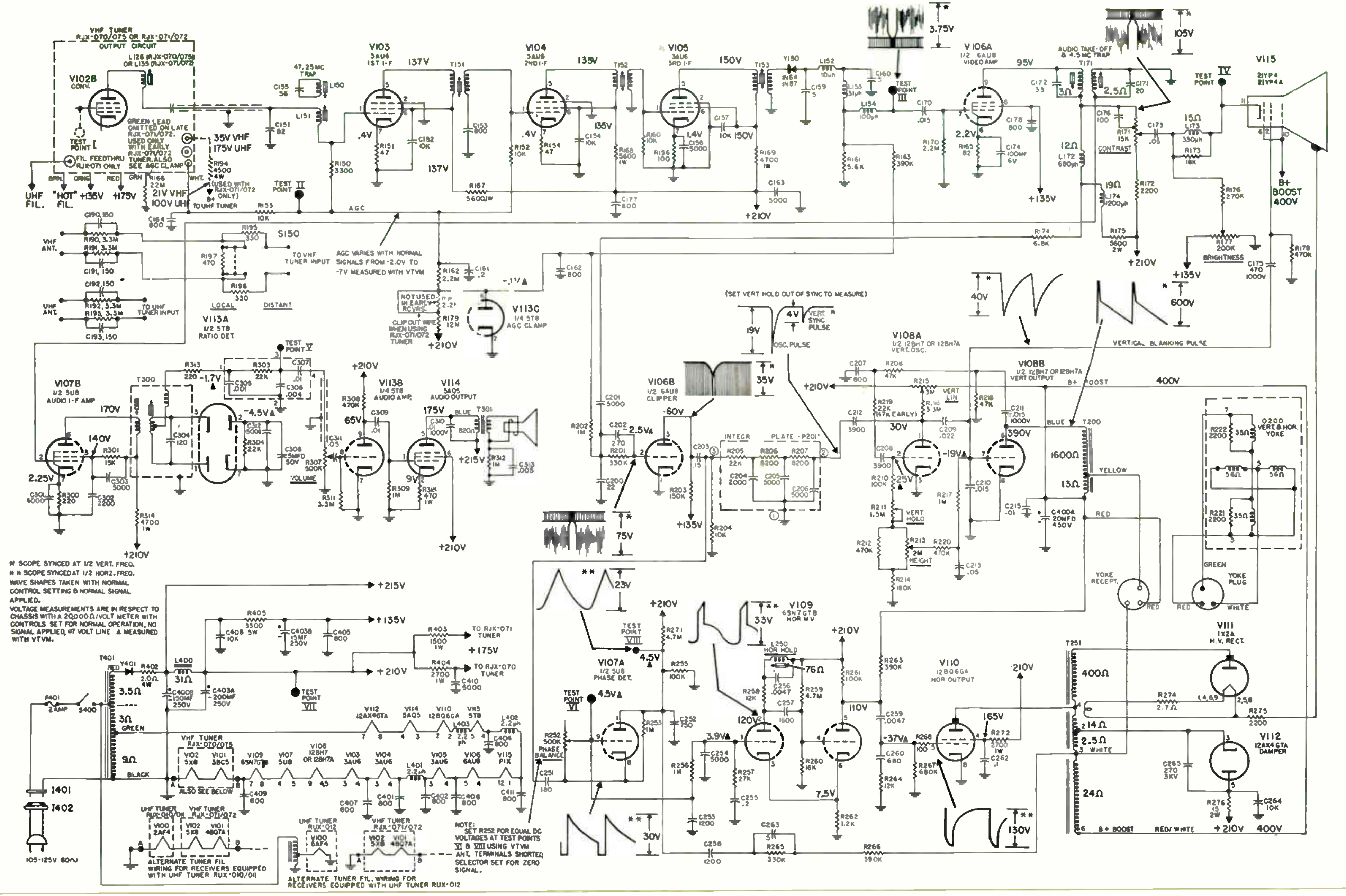
	MODELS	
Preliminary diagram for "N" line General Electric receivers. These receivers use the *new* 600 ma tubes with controlled heater warm-up time.	21C106	21T32
	21C107	21T33
	21C108	21T36
	21C109	21T37



Schematic diagram for VHF Tuner RJX-070/075



Schematic diagram for VHF Tuner RJX-071/072



21-inch "N" Chassis—Schematic Diagram

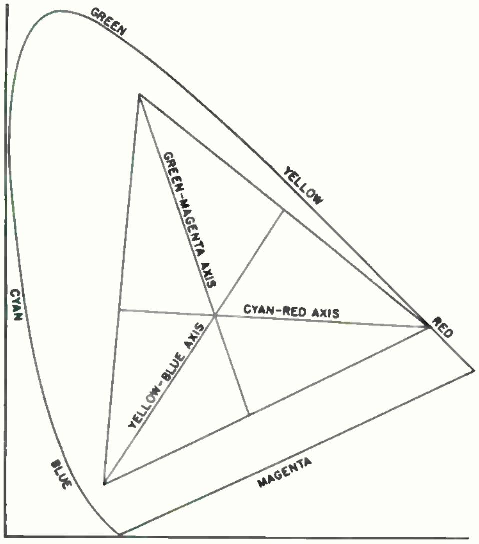


Fig. 5. If the color axes shown in Fig. 4. are superimposed on the chromaticity diagram each color axis will fall in the correct color area.

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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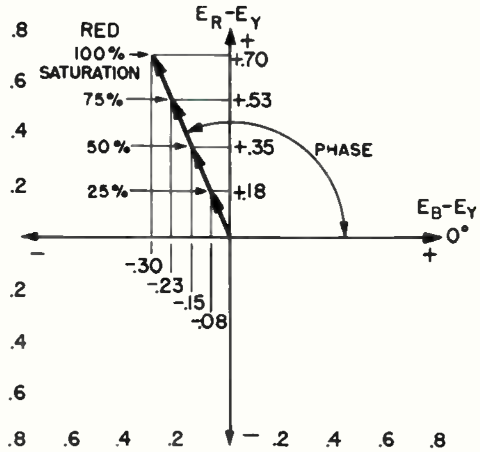


Fig. 7. Various voltages produced by 25, 50, 75 and 100% saturated red.

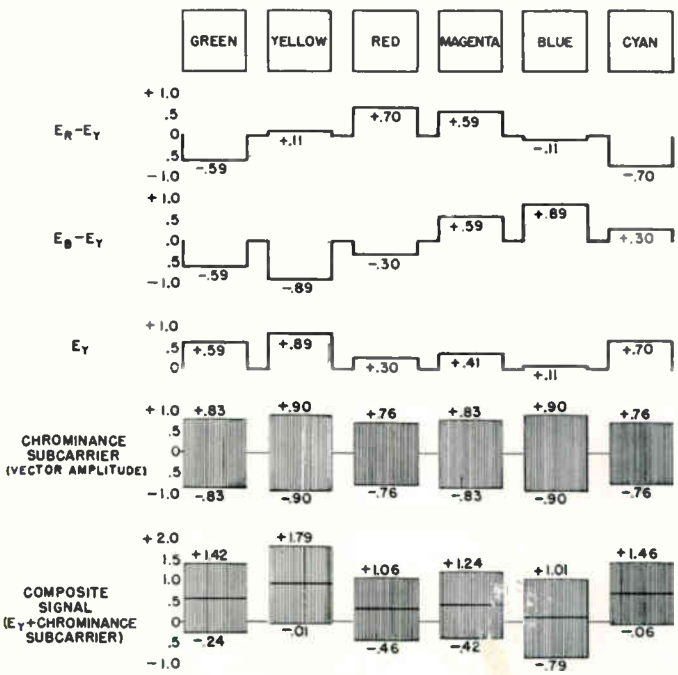


Fig. 8. Signal voltage amplitude resulting from the combination of the chrominance subcarrier and the brightness signal.

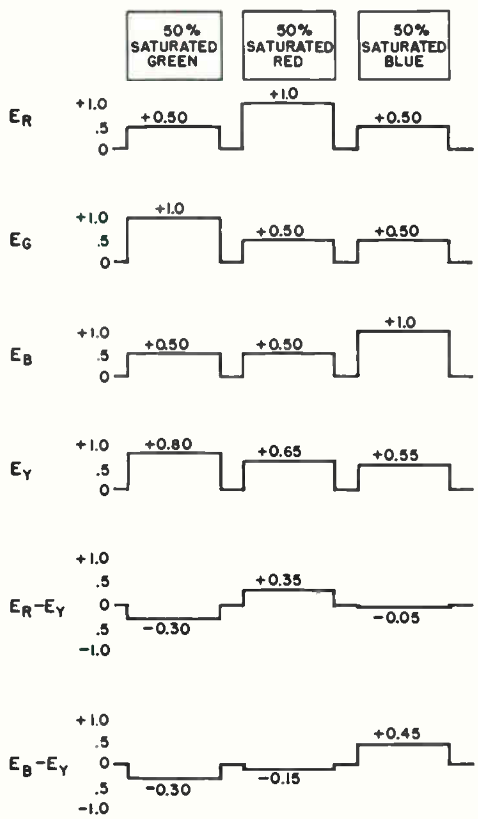
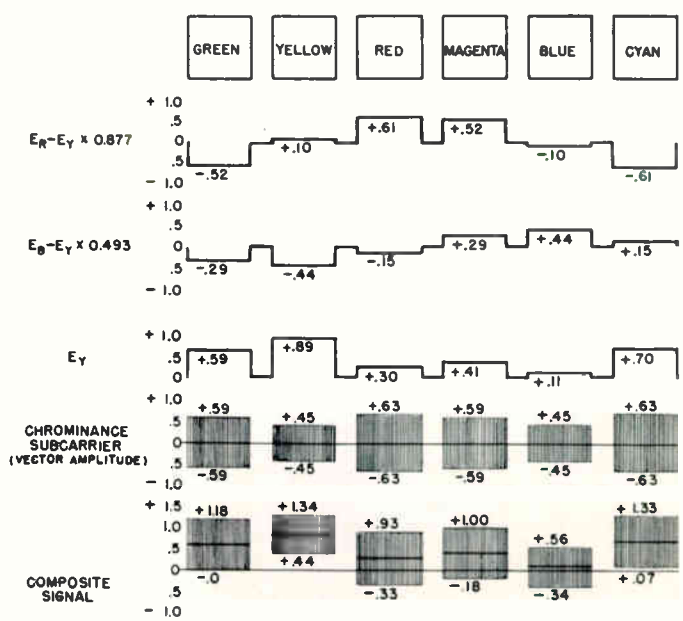


Fig. 6. Signal voltages developed as a result of scanning 50% saturated colors.

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



BENCH NOTES

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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.

(Continued from page 5)

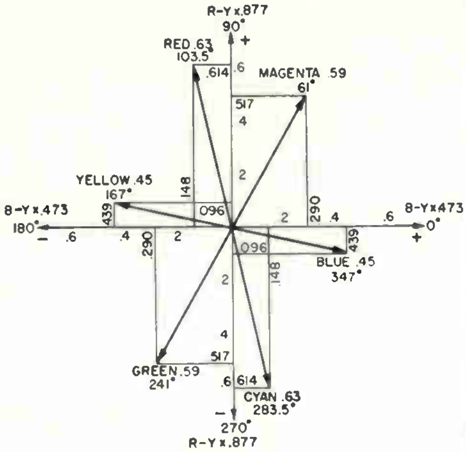


Fig. 10. Vectors produced by the corrected $E_R - E_Y$ and $E_B - E_Y$ voltages shown in Fig. 9.

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. 4. 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.

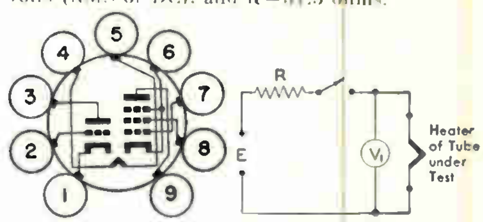
The 6AU8, as a result of its controlled heater warm-up characteristic, is especially suited for use in television receivers which employ series-connected heaters. When the tube is used in conjunction with other 600-milliampere types which exhibit essentially the same heater warm up characteristic, heater 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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Form 3547 Requested.