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COLOR TV-I

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

Color television is here. The approval by the FCC of the NTSC (National Television Systems Committee) color television system will increase the entertainment possibilities of this relatively new medium to a point not dreamed of a few years ago. With the addition of color to the already complicated piece of electronic equipment comes added responsibilities for the service technician. The job of installing and keeping these receivers operating satisfactorily will become his obligation. A fundamental knowledge of the operation of the NTSC color TV system will be imperative to every successful TV technician.

Color receivers are already on display in a number of cities throughout the country. These color receivers are priced considerably higher than B & W receivers. In spite of the price it is expected that the 1954 production of color receivers will be oversold. Some stores are accepting orders based on three to six months delivery. Obviously both price and delivery will improve as production techniques improve and circuits become standardized.

Since color receivers are in production, sooner or later you will be called upon to service these receivers. An attempt will be made in this series of articles to acquaint you with the basic fundamentals of color television. Information on installation and typical troubles which may occur in color receivers will also be included. In order to understand the different circuits found in various receivers, it is recommended that you read as many articles as possible relating to color television. Every effort should also be made to attend any lectures or courses on color TV which may be given in your area.

This is important because it just isn't possible to completely cover in any series of articles or lectures all of the aspects of color TV or the circuits used in color receivers. As an example, there are already two different types of receivers. One of these is known as the I and Q type and the other as the R minus Y, B minus Y type receiver. It is entirely possible that other basic receiver circuits will be developed which will also produce good quality color pictures.

THE NTSC SYSTEM

The NTSC standards represent hundreds of thousands of engineering manhours voluntarily contributed by the most highly skilled engineers and scientists in the radio-electronics and allied industries. Since these standards resulted from the combined efforts of many companies, no single company is in a position to assume or accept full responsibility.

Color television has been talked about and various systems have been developed and demonstrated for a number of years. Each of these systems lacked certain requirements necessary for FCC approval and public acceptance. It was generally agreed that an acceptable system of color television transmission should include at least the following requirements:

(1) A color telecast should produce satisfactory black and white pictures on normal unmodified black-and-white receivers.
(2) A black-and-white telecast should produce satisfactory black-and-white pictures on a color TV receiver.
(3) Color telecasts should not require any more than the six megacycle channel allocation already established by the FCC for black-and-white telecasts.
(4) Color reproduction should be comparable with the quality of black-and-white reproduction.

These requirements have been fulfilled in the NTSC system.

COLOR PICTURE REPRODUCTION

It is reasonably easy to reproduce a "closed circuit" color picture. This is illustrated in block form in Fig. 1. A similar type of system could be used for

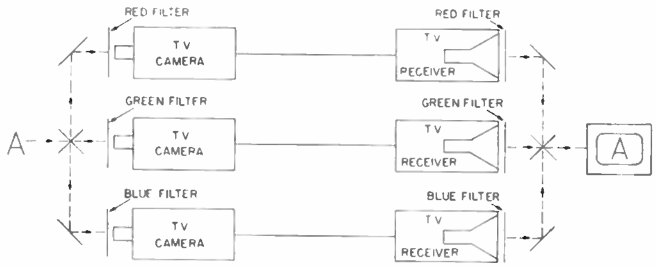

Fig. 1. One type of closed circuit color television.

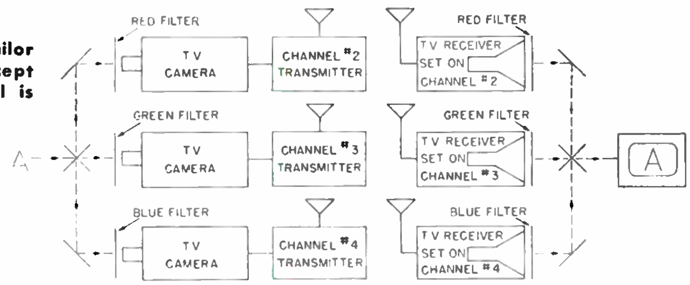

Fig. 2. A color TV system similar to that shown in Fig. 1 except that a separate TV channel is used for each color camera.

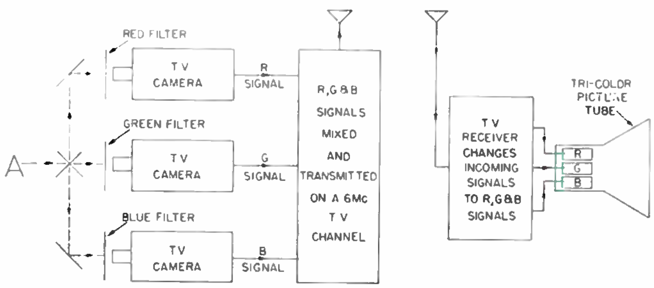

Fig. 3. Block diagram illustrating the transmission of color on a 6 mc bandwidth TV channel.

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color transmissions if the output of each camera were transmitted on a single TV channel as shown in Fig. 2. Obviously this would require the bandwidth of three TV channels and, in addition, three TV receivers, plus an optical system to superimpose the three separate images. This could be simplified somewhat in that a full 6 mc bandwidth would not be necessary for each channel since only one audio carrier would be required. This bandwidth would however, be considerably wider than the maximum of 6 mc established by the FCC for color transmissions. This type of color receiver would also contain fewer tubes and circuits than three separate receivers but would be both bulky and expensive to maintain and operate. Obviously a color TV system of this type would not be practical or acceptable to the general public.

The NTSC system combines the output of three color cameras and transmits the combined signal on a 6 mc bandwidth channel as shown in Fig. 3. The color receiver accepts this signal and changes it to red, green and blue signals which are combined in the tri-color tube to reproduce the original scene. This sounds relatively simple, however, it is not quite as easy as it sounds.

COLOR REPRODUCTION

Before discussing the method used in the NTSC system to transmit and reproduce color signals, it might be well to briefly discuss basic color reproduction. Color is a complex subject which can only be touched upon in an article of this type. Since the only difference between black-and-white and color television is the addition of color, it is important that the technician have an understanding of color mixing and color reproduction. The way in which different colors are produced must be known by the technician to intelligently service color receivers.

LIGHT WAVES

For the purpose of this article it can be assumed that light, like a number of other forms of radiant energy, travels in the form of a wave. The electromagnetic spectrum shown in Fig. 4 illustrates the different types of radiant energy and wave lengths of the different groups. We are familiar with wave lengths such as those shown in Table 1. This indicates the wave length of frequencies in different radio frequency bands as assigned by the FCC.

TABLE 1

Radio-frequency Bands

Frequency in mc	Frequency designation	Wavelength in meters	Wavelength in ft (approx)
0.01–0.03	Very low (vlf)	30,000–10,000	98,400–32,800
0.03–0.3	Low (lf)	10,000– 1,000	32,800– 3,300
0.3–3	Medium (mf)	1,000– 100	3,300– 330
3–30	High (hf)	100– 10	330– 33
30–300	Very-high (vhf)	10– 1	33– 3
300–3,000	Ultra-high (uhf)	1–0.1	3–0.33
3,000–30,000	Super-high (shf)	0.1–0.01	0.33–0.03

The wave length of the frequencies used for UHF television and radar are ordinarily considered very short. It can be seen in Fig. 4 that visible light waves are considerably shorter than the shortest r-f wave, and cover a band of wave lengths from about 400 to 700 millimicrons. Since terms used for light wave lengths such as millimicrons and angstrom units may not be familiar, a table of radiant energy frequency units is given below in Table 2.

TABLE 2

Radiant Energy Frequency Units

Unit	Measurement
1 Millimeter	= 1/1000 of a meter (0.03937 of an inch)
1 Micron	= 1/1000 of a millimeter
1 Millimicron	= 1/1000 of a micron or 1/1,000,000 of a millimeter
1 Angstrom Unit	= 1/10,000 of a micron

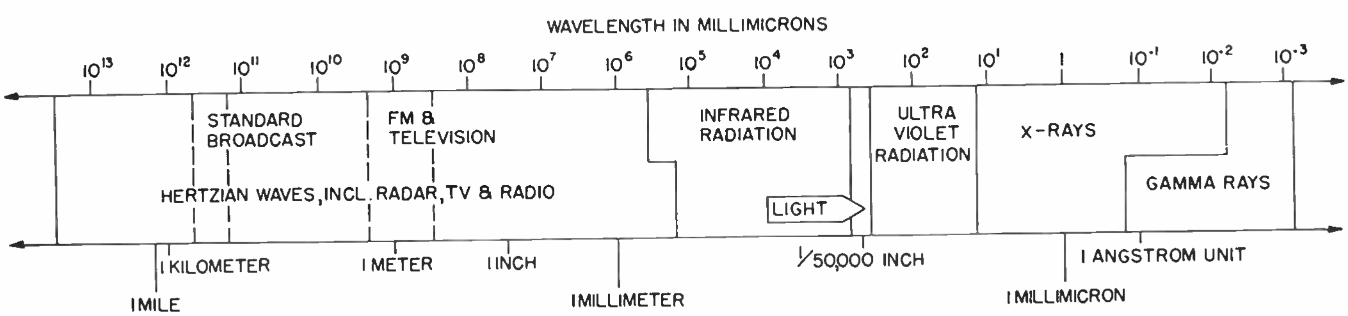

Fig. 4. The electromagnetic spectrum.

COLOR VISION

There have been many theories regarding color vision and most of these have had to be discarded because some important aspect could not be satisfactorily explained. As a result of these theories many experiments have been conducted, and a number of practical principles of color vision have been established.

The human eye can only see wave lengths between 400 and 700 millimicrons. All wave lengths above and below are invisible. The eye can, therefore, be compared with a tuned circuit such as an i-f circuit in a TV receiver which is designed to accept all wave lengths within a certain bandwidth. When the eye sees a single frequency, it sees one color, but when it sees a combination of frequencies from 400 to 700 millimicrons it sees white.

Visible proof of this can be seen by passing a white light through a glass prism as shown in Fig. 5. The white light will be separated into a number of colors of different wave lengths known as the visible spectrum. Both the wave length in millimicrons and the color are indicated on this drawing. The reason for this color separation is that the prism bends light of the shorter wave lengths more than light of the longer wave lengths. The order of these colors will be recognized as practically the same as those used in the color code for resistors and capacitors. A great many other colors will be seen in the spectrum between the colors shown in Fig. 5. These represent colors with wave lengths that fall between the colors indicated. For instance on the high frequency side of green the colors will change toward blue, and on the low frequency side toward yellow.

Since white light can be separated into a number of colors, white light *must be composed* of these same colors. If the process is reversed and the correct amounts of these colors are combined, a white light will be produced.

Before discussing the mixture of colors it might be well to point out that there are two methods available for the production of color pictures. These two methods are (1) the subtractive process and (2) the additive process.

SUBTRACTIVE COLOR MIXTURE

The subtractive process is the method used wherein incident white light is reflected from a color picture. Thus, if an area were treated with a particular color paint or pigment, such as red, all other components of the original white in the painted area would be absorbed or subtracted and the area would appear red. Another way of describing this process is to consider the red area as a tuned circuit which passes only the frequency of the color red and rejects all other frequencies. This is true of any color or mixture of colors. Color pictures in magazines are examples of the subtractive process. Practically all the frequencies in the externally applied light are absorbed except the wave length of the colors used in these pictures. If a magazine color picture is held at an angle some of the light may be reflected by the glossy paper and not absorbed. In this case the reflected light will contain all frequencies originally present and will, therefore, appear the same color as the source.

While we are discussing magazine photographs it might be well to point out that the eye is easily deceived. If a good magnifying glass is placed over a color picture in a magazine we find that:

(1) The picture is composed of a great number of colored dots.

(2) Practically every color is actually made up of a combination of different color dots. This is even true of solid colors.

(3) The eye blends these different color dots and sees a specific color instead of individual colors.

There are many examples of subtractive colors all around us; i.e., the clothes we wear, the paint used on the inside and outside of our homes, and even the grass, trees and flowers. All of these are subtracting color frequencies from light and what we see are the frequencies not subtracted.

Obviously some source of light must be present in order to subtract certain frequencies. If light is not present all subtractive colors appear black. This is one of the differences between the subtractive color process and the additive color process.

ADDITIVE COLOR MIXTURE

The additive process is the method used wherein incident or reflected light plays no essential part in color reproduction; instead the color possesses self-luminance. Phosphorescent signs, visible in the dark, are produced by the additive process. Stage presentations, in which costumes glow in the absence of external illumination, are other examples of the additive process. Color in both of these examples is produced by ultraviolet radiation which is absorbed by the fluorescent ink or dyes, and produces a radiation visible to the human eye.

Since television picture tubes are also self-luminescent it is only natural to employ the additive process in color television picture reproduction. Consequently, all future remarks relative to color TV will pertain to the additive process of color mixing.

VISUAL COLOR IDENTIFICATION

We know that the human eye responds to all frequencies between 400 and 700 millimicrons. We call this the visible spectrum. We also know that the eye cannot distinguish light of a certain wave length unless it is presented alone. As an example, the eye can identify a certain green when it is seen in the spread-out spectrum illustrated in Fig. 5, but it is not able to isolate a green sensation from white light. If the eye cannot analyze mixtures of wave lengths, we may conclude that it does not possess a separate sensitive mechanism for each wave length. In view of this, we may wonder how color and color combinations can be seen at all. It has been found that practically any color can be matched by combining red, green and blue light. These colors are, therefore, known as the primary colors. The requirements of a primary color are that no two of the primaries, when mixed, may match the third.

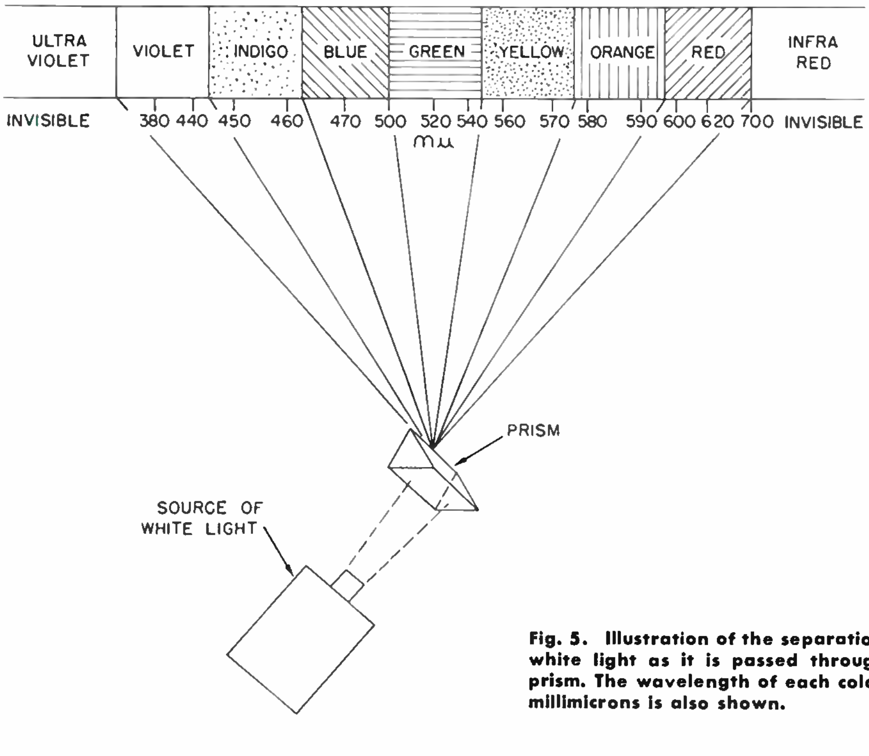

Fig. 5. Illustration of the separation of white light as it is passed through a prism. The wavelength of each color in millimicrons is also shown.

(Continued in next issue)

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, N. Y.

PILOT LIGHTS SUBSTITUTION

Many times the average radio or TV serviceman will find that he is temporarily out of bayonet-type pilot lights such as No. 47 or No. 51. To use a screw type like No. 40 in exchange, bend the inner slotted point down partially. This will engage the threads on the screw type pilot light and hold it securely in place. The original type may be re-inserted at any time by merely bending the point back.

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HORIZONTAL LOCK AND UNLOCK

In a few of the Magnavox CT-270's and as late a model as the CT-381, permanent horizontal locking was next to impossible due to leakiness as low as 1 megohm in an 82 MMFD button type capacitor from the grid of the Horizontal AFC tube to the junction of the Horizontal Lock Control and a 150K resistor leading to Horizontal Reactor Transformer. This would allow Horizontal AFC tube grid to become less negative and drift was determined by amount of varying leakage.

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CRITICAL VERTICAL SYNC.

In Philco receivers of the intercarrier type, where the sync pulses are picked off at the plate of the 1st V.I.F. 12AV7, a condition of critical vertical sync may be encountered. The vertical hold is used to lock the picture but after a minute or so the picture will slowly roll out of sync. All components in the vertical integrating and associated circuits were found to check normal. The cause was found to be an open coil which is part of the 4.5 mc trap located either in the control grid or plate circuit of the 12AV7, 1st video amplifier tube. Since the sync pulse information is picked off at the plate of this tube, an open coil in this trap creates a very high impedance for the 60-cycle vertical sync pulses which must pass through the capacitor part of this trap and hence very low vertical sync pulse amplitude. This condition can be corrected either by replacement or by repair if practical.

UNUSUAL CAUSE OF HIGH VOLTAGE FAILURE

In the Philco Model No. 50T1600 series and some 1951 Philco receivers using the same chassis, high-voltage failure may be caused by an unusual condition. All components in the high-voltage section may be found to be electrically normal, yet no high voltage can be developed. There is one visual indication of a defect in that a 4700-ohm 1-watt resistor connected to the cathode of the 5V4-G damper tube is excessively overheating. The defective component causing no high voltage and this resistor to overheat is an open C-86 40 mfd capacitor located in the *low-voltage power supply section* and connected from one end of the filter choke to ground. Since this capacitor provides an R.F. return to ground for the damper circuit, on opening the current then all passes through this resistor causing it to overheat. Another indication of this defect is an abnormally high damper voltage.

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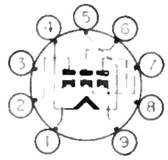
What's new! TWO TUBES DESIGNED FOR COLOR TV

6BJ7

The 6BJ7 is a miniature triple diode intended primarily for use as a d-c restorer in each of the three signal channels of color television receivers. The electrical characteristics of each section of the 6BJ7 are similar to those of each section of the 6AL5.

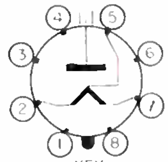
Heater Voltage, AC or DC .... 6.3 Volts
Heater Current .... 0.45 Amperes
Peak Inverse Plate Voltage .... 330 Volts
Peak Plate Current per Plate .... 10 Milliamperes
DC Output Current per Plate .... 1.0 Milliamperes
Heater-cathode Voltage
  Heater Positive with Respect to Cathode ... 100 Volts
  Heater Negative with Respect to Cathode .. 330 Volts
Tube Voltage Drop, Each Section
  $I_b = 10$ Milliamperes DC .... 2.7 Volts



2V2

The 2V2 is a filamentary diode designed for use in receivers as the high-voltage rectifier to supply power to the anode of the television picture tube. The comparatively high inverse voltage and average current capabilities of the tube make it suitable for use in conjunction with color picture tubes or with monochrome picture tubes which operate at high anode voltages.

		Series	Parallel	
Filament Voltage, AC or DC		2.5	1.25	Volts
Filament Current		0.2	0.4	Amperes
Peak Inverse Plate Voltage				
DC Component	15000	21000	.....	Volts
Total DC and Peak			33000	Volts
Steady-state Peak Plate Current	80	60	.....	Milliamperes
DC Output Current	2.0	1.0	0.2	Milliamperes
Tube Voltage Drop, approximate $I_b = 7.0$ Milliamperes DC			150	Volts



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