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Techni-talk on AM, FM, TV Servicing

GE Electronic TUBES

COLOR TV-II

In the previous issue a number of systems which could be used to produce a color TV picture were discussed. The additive and subtractive processes of color reproduction were also described. In this issue color reproduction will be described as well as the "color box" shown in Fig. 1. This color box can be built at a reasonable cost and will help considerably in the understanding of color reproduction. Construction details appear on pages 2 and 5.

COLOR FILTERS

It is generally believed that the human eye contains three light-sensitive systems, one responding to red light, one to green light, and one to blue light. Each of these systems responds to the wavelength of that particular primary color even when that color is combined with one or both of the other primary colors. As an example, a red filter passes light from *any* object or source containing the wave length of the color red. Fig. 2A illustrates that if a piece of red filter is placed over several different color bars, only those colors containing the wavelength of red will be passed. These colors will appear red. Those colors which do not contain the wavelength of red will appear black since the red filter blocks out or absorbs all frequencies except red. The light passed by the red filter represents the light which the red-light-sensitive system in the eye would ordinarily see *without* the filter. A TV camera *with* a red filter scanning the color bars in Fig. 2A would produce a signal only from those same colors which stimulate the "red-light-sensitive system" in the eye. These colors would be white, yellow and red. The green and blue color bars do not contain any of the red wavelength and would therefore appear black as shown. These two color bars would not produce a red TV camera signal nor would they stimulate the "red-light-sensitive system" in the eye.

Fig. 2B illustrates the light passed by the blue filter. This represents the light which stimulates the "blue-light-sensitive system" of the eye. It also shows the colors which would pass through a blue filter and produce a blue TV camera

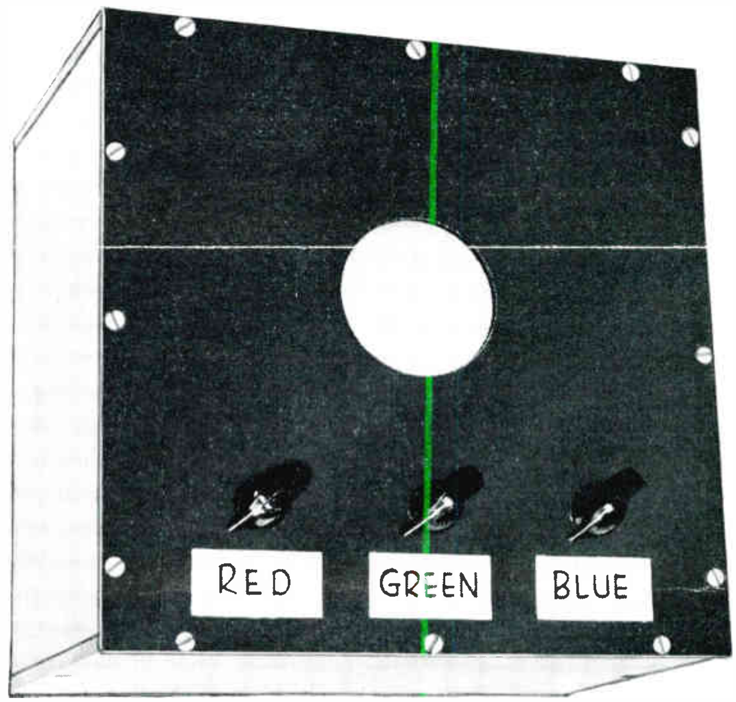

Fig. 1. A color box which will reproduce a considerable range of colors from ordinary xmas tree light bulbs.

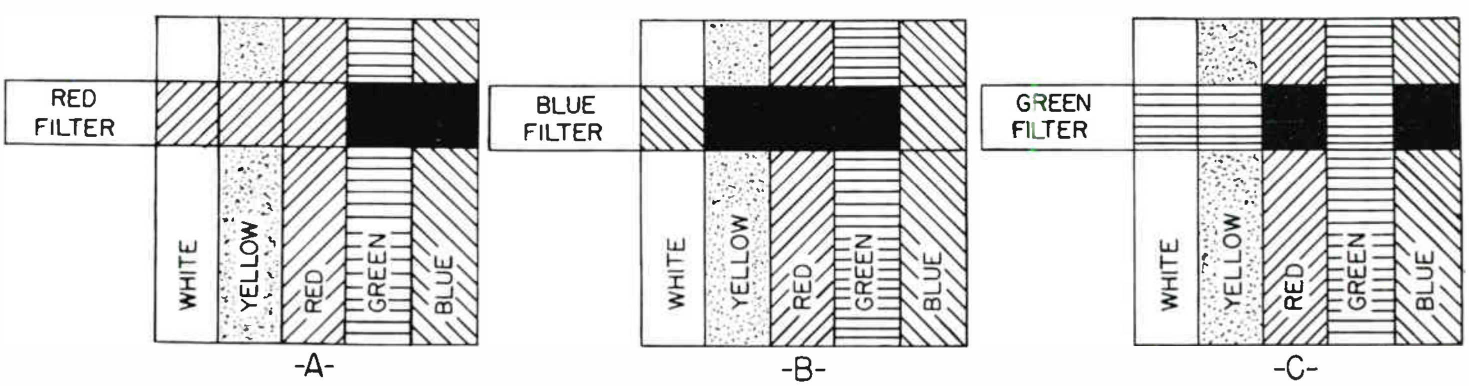

Fig. 2. Illustration of light transmitted by red, green and blue filters.

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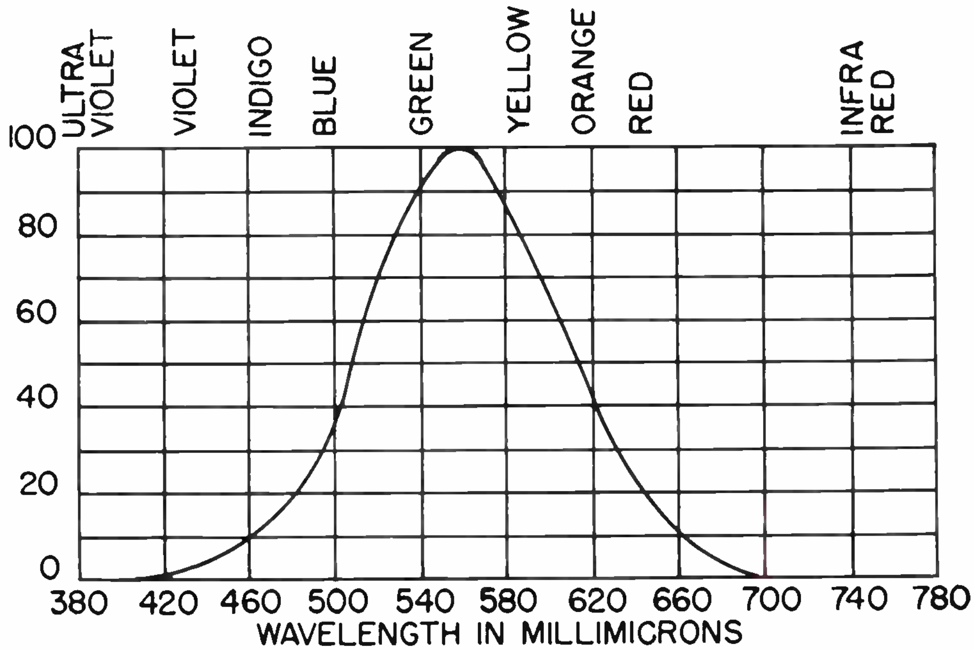

Fig. 3. Standard luminosity curve illustrating the normal color response of the human eye.

signal. The light passed by the green filter in Fig. 2C represents the light which will stimulate the green sensitive system in the eye and also produce a green TV camera signal.

It will be noticed that white is passed by all three filters in Figs. 2A, B, and C. This is due to the fact that white contains all three primary colors. It is the combination of these three colors which stimulates the three light-sensitive systems in the eye and produces a sensation of white. It is also the combination of these same three color camera signals which produces white on the screen of a color TV receiver.

It will be noticed that yellow is passed by the red and green filter in Figs. 2A and C, but blocked out by the blue filter in Fig. 2B. This shows that yellow contains both red and green wavelengths but it does not contain any of the blue wavelength. This will be discussed in greater detail later. Since red, green and blue are primary colors, they do not contain any other wavelengths and are passed only by the same primary color filters.

The color filter on each color TV camera has been chosen so that the camera tube produces a signal which is approximately the same as that seen by each light-sensitive system in the human eye. Each of the three light-sensitive systems in the eye acts the same as a filter since each one responds only to certain light frequencies. Therefore, the red-light-sensitive systems in the eye would respond only to the wavelength of red, and would be stimulated only by those frequencies passed by the red filter in Fig. 2A. The blue- and green-light-sensitive systems would respond only to blue and green wavelengths and would be stimulated by the light frequencies passed by the blue and green filters shown in Figs. 2B and C. The stimulation of one or more of the three light-sensitive systems produce the five original colors. These colors plus all the other colors seen by the human eye are the result of varying degrees of stimulation of the three light-sensitive systems in the eye.

It can be visualized that if each one of three TV cameras "sees" only the wavelength of one primary color, then all three cameras will see all three primary colors in the correct proportion. If these same three colors can be reproduced on the picture tube in the same proportion as seen by the cameras, a color picture tube will be produced which will have practically the same color tones as the original scene.

THE CIE LUMINOSITY CURVE

As previously mentioned, the human eye responds only to those frequencies between 400 and 700 millimicrons. The brightness response of the eye is not uniform as illustrated in the standard C.I.E. (International Commission of Illumination) luminosity curve in Fig. 3. This shows that the peak response of the eye is near the wavelength of green. Therefore a given amount of light energy may appear *much brighter* at some wavelengths than at others. This curve can

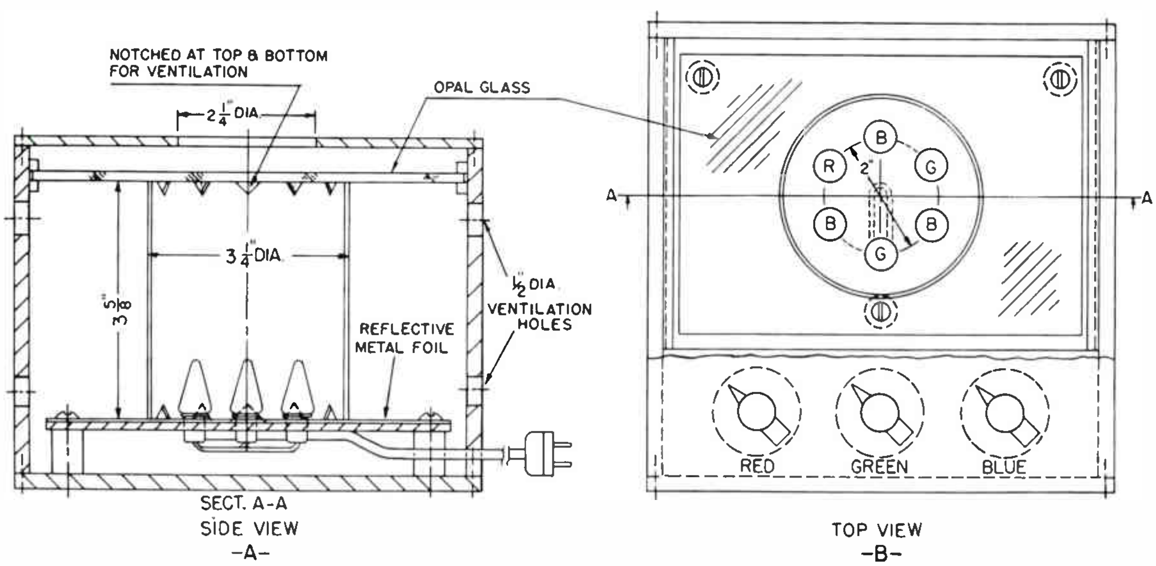

Fig. 4. Construction detail drawings of the color box shown in Fig. 1.

also be used to illustrate that when the eye sees white light it requires different proportions of red, green and blue. Since green appears brightest to the eye, a larger proportion of green is necessary for the eye to see white. Red is the next brightest and blue the least. The percentages which have been established to produce white on a color picture tube are a mixture of 59% green signal, 30% red signal, and 11% blue signal. The wavelengths of these three primary colors are present at just about these points on Fig. 3.

THE COLOR BOX

Before proceeding with the discussion of color reproduction it would be very helpful if the "color box" shown in Fig. 1 were available. This can be assembled in a reasonably short time and at a reasonable cost. The most expensive parts are the three rheostats. Since the resistance values are not too critical you may find one or more suitable units in your "junk box."

The following is a list of the material required:

- 1—8-ft a-c lead
- 6—Candelabra sockets (slotted upright bracket type)
- 1—110-v, 7.5-watt red xmas tree lamp
- 2—110-v, 7.5-watt green xmas three lamps
- 3—110-v, 7.5-watt blue xmas tree lamps
- 1—5000-ohm 25-watt wirewound rheostat (OHMITE TYPE H)
- 1—2500-ohm 50-watt wirewound rheostat (OHMITE TYPE J)
- 1—1000-ohm 50-watt wirewound rheostat (OHMITE TYPE J)
- 1—5 in. x 7 in. piece of opal glass 1/16 in. thick (available at most camera stores at about one dollar)
- 1—3¼ in. diameter cardboard tube (ordinary round salt box was used)
- 1—Box large enough to hold assembled parts
- 1—Piece of reflective material such as aluminum foil (placed beneath the bulbs to reflect light).

The box shown in Fig. 1 was larger than necessary (9 in. L x 9 in. W x 6 in. D) because a considerable amount of experimentation was required to obtain proper light diffusion. Any box rigid enough to hold the parts in place may be used. A metal utility cabinet available in sizes 9 in. x 6 in. x 5 in. or 10 in. x 8 in. x 7 in. would provide a very neat and practical housing.

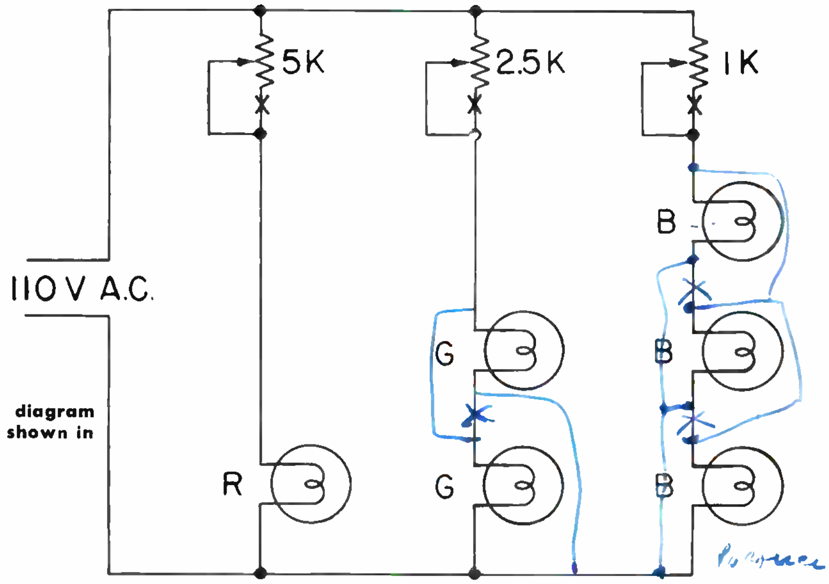

Fig. 5. Wiring diagram of the color box shown in Figs. 1 and 4.

A piece of hard fiber board was used for the subassembly shown in Fig. 4A. This was mounted 1 in. above the bottom of the cabinet. Six equally spaced ½ in. holes were drilled around a circle 2 in. in diameter as shown in Fig. 4B. Six ¾-in. equally spaced holes were also cut in the reflective foil around a circle 2 in. in diameter. The larger size prevented any possibility of the foil causing a short between sockets. The foil was cemented to the top of the board with each hole in the foil centered over a hole in the fiber board. Note that the bulb circle is not in the center of the box but above the center as shown in Fig. 4B. This allows sufficient space on the top panel to mount the three rheostats.

The six candelabra sockets were mounted in the six holes. The sockets had slotted upright mounting brackets which were bent toward the center. A single screw at the center held all six brackets in place. The position of only one of these brackets is shown in dotted lines on the bottom green socket in Fig. 4B. The bulbs were placed in the sockets which were wired as shown in Fig. 5. The complete subassembly board was mounted to the bottom of the box with three screws as shown.

Holes were cut in the top panel for the window opening and for the rheostats as shown in Fig. 1 and 4B. Ventilation holes were also cut in both sides as shown in Fig. 4A. Four or five holes at the top and bottom of each side should provide adequate ventilation.

It was found that when the rheostats were set at maximum resistance, the bulbs were not completely extinguished. This produced a slight "poisoning" of some colors at low illumination settings which was corrected by cutting the resistance wire as close to the maximum resistance end of the rheostat as possible. In this way when the rheostat arm is in the extreme counterclockwise position (front view) the rheostat is "open." This break is shown by the "X" at the bottom of each rheostat in Fig. 5.

A 3¼ in. diameter tube 3⅝ in. long was lined with plain white paper to provide good light diffusion with a minimum of absorption. Eight notches ½ in. deep were cut on both the top and bottom of the lined cardboard tube to provide ventilation. This tube was placed over the bulbs as shown in Figs. 4A and B. Side supports were fastened to the box to hold the opal glass in position. Pieces of wood or angle brackets may be used for these supports. The opal glass and top were assembled as shown in Fig. 4A and B.

A light shield made of cardboard tubing the same diameter as the window opening will help if the unit is used in relatively high illumination areas. This should be lined with black photographic paper to absorb any extraneous light.

In the next issue the actual use of the color box in conjunction with the chromaticity chart will be described. It is suggested that you construct some sort of a color box similar in operation to the one described. This type unit will prove invaluable in understanding color mixtures. It can also be used to demonstrate to your customers or other service technicians the basic method used to reproduce colors in color television. A complete understanding of this phase of color TV will be very helpful when troubleshooting color receivers.

What's new! # G-E SERVICE-DESIGNED TUBES

Specially developed for the TV service industry. Cost the same as types they replace.

FOR the first time anywhere, a line of tubes has been developed specially for TV servicing—G.E.'s new SERVICE-DESIGNED Tubes. Six types are described on this page. They will soon be followed by others, designed from the ground up to meet the practical requirements of your work.

Here's what G.E.'s new SERVICE-DESIGNED Tubes mean to you:

- **They cut callbacks on TV repair work, by doing a far more dependable job than their prototypes.**
- **Your tube-inventory requirements are lower. SERVICE-DESIGNED Tubes give top performance on all chassis.**
- **Your customers get more hours of trouble-free TV enjoyment . . . because SERVICE-DESIGNED Tubes have longer average life.**
- **They cost the same as their prototypes, despite improved performance and long life. You get higher tube value than ever before!**

SERVICE-DESIGNED 5U4-GA

The 5U4-G prototype was a tube that did a good electrical job, but was subject to damage from shocks and vibration. In the new SERVICE-DESIGNED 5U4-GA, you have a rectifier that can withstand hard usage. Here are the reasons why:

(1) Substantial mica supports brace the tube structure at both top and bottom, instead of at the top only. Also, double-fine plate construction gives better heat dissipation.

(2) Glass bulb now in straight-side, compact, and strong. It is specially "necked down" at bottom, so the base can be the same diameter as the 5U4-G —enabling the same ring-clamps to be used when installing the tube.

(3) Base construction has been changed to button-stem, with the leads passing through widely spaced individual seals at the bottom of the glass envelope, the same as with miniature tubes. This gives greater strength, also shorter leads and better lead separation. Another advantage of button-stem construction is improved heat conduction, which in turn reduces the chance of electrolysis and air leakage.

SERVICE-DESIGNED 5Y3-GT

A sturdier tube, with longer life! Mica supports now brace the tube structure both top and bottom . . . new button-stem base adds strength, separates the leads . . . double-fin plate construction gives the SERVICE-DESIGNED 5Y3-GT much improved heat dissipation.

SERVICE-DESIGNED 6BQ6-GA

"Running hot" shortened the life of many prototype 6BQ6-GT's. G-E designers went to the heart of the problem, and—while retaining the same basing layout for interchangeability—gave this tube a king-size bulb that means cooler operation under all normal conditions.

Also, because of special mica design and new processing techniques, the new SERVICE-DESIGNED 6BQ6-GA will handle higher pulse plate voltages than its preceeessor. Internal tube arcing is cut way down.

In many TV chassis, Type 6BQ6-GT now is pushed to the limit. Replacing with 6BQ6-GA's means far fewer service callbacks due to early tube failures.

A further important improvement in the SERVICE-DESIGNED 6BQ6-GA, is use of a special high-melting-point solder for the plate cap-terminal. This prevents loosening of the terminal when the tube is removed for testing.

SERVICE-DESIGNED 25BQ6-GA

Cut callbacks with this new tube that runs cooler than its prototype! All the improved features of the 6BQ6-GA. Larger bulb gives ample cooling. Tube handles higher pulse plate voltages. High-melting-point solder protects plate cap-terminal.

SERVICE-DESIGNED 6SN7-GTA

Type 6SN7-GTA has been redesigned to give top performance in all synchroguide and other TV circuits. Among measures taken to assure this result, is a special factory "chopper" pulse test. The test is made at voltages equal to the lowest line voltages that will be encountered in TV chassis of any make.

In all respects and in all circuits, the SERVICE-DESIGNED 6SN7-GTA now will replace Type 6SN7-GT. Capacity of the new tube is much superior to the old. This is proved by the following cross-tabulation of ratings:

	Old 6SN7-GT	New 6SN7-GTA
Max plate voltage	300 v	500 v
Max plate dissip., per plate	2½ w	5 w
Max heater-cathode voltage	90 v	200 v

SERVICE-DESIGNED 1B3-GT

Install and forget! This new tube does a superior job for longer! Special lead glass wards off electrolysis and air leakage. There is a new ring around the filament which stops "bowing" and the filament burn-outs that frequently result.

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