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Report on the construction, operation, and progress of the "Chromatron," a single-gun picture tube for color TV

Fig. 1. Lineup of Muntz color TV sets using the Chromatic color picture tube, which may be seen in the background.

**The Chromatic**

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Tube which also contains a separate color structure, frame, and flanges. While the RCA system employs three electron guns, the "Chromatron" uses only a single gun, but it would be possible to use three guns.

The deflection components used for the "Chromatron" are essentially the same as used for black-and-white picture tubes. This is a considerable advantage over the RCA design which requires complex deflection yokes, a purity coil, and convergence and centering adjustments. The simplification at the neck of the tube is possible in the "Chromatron" because the complete color switching section is part of the color screen structure.

The RCA tri-color tube has a screen consisting of small dots of colored phosphors each of which lights up either in red, green, or blue. These color dots are arranged in the correct sequence and the colored picture is the composite of the amount of light coming from a large number of dots.

The "Chromatron" uses lines of colored phosphor instead of dots and a special wire screen behind the phosphor strips makes the electron beam dance back and forth between the color strips to produce, effectively, a series of color dots. Fig. 4 shows the principle of the "Chromatron" color structure. A number of vertical strips are laid out, each containing a colored phosphor.

The color sequence is arranged so that a green strip falls between each red and blue one. Behind the phosphor is a fine wire grid, spaced so that an electron beam passing between two wires will hit the green phosphor if there is no voltage between the wires.

The phosphor screen is aluminum backed, just as in some types of black-and-white picture tubes, and the aluminum backing is connected to a terminal outside the tube. If a voltage is applied between the two wire grids and the aluminum backing, a series of electron lenses will be set up between the wires and the screen. These lenses help to focus the electron beam so that a sharp spot is obtained on the screen. Although the focusing produced by these lenses is not as effective as the focusing coil or electrostatic focus element back in the electron gun, this "post deflection focus (PDF)" system has a considerable effect on the size of the spot. Because the acceleration of the electrons in the beam is so high near the screen, the focusing potential required is much greater than at the electron gun.

**Editor's Note:** Although, to date, most manufacturers of color TV receivers have designed their color TV sets for use with the 3-gun color tube, as produced by RCA, CBS-Hytron, and others, a large segment of the industry is investigating the possibility of using a single-gun tube such as described in this article. This tube is based upon the invention of Dr. E. O. Lawrence, and the development of the Chromatic Television Laboratories, Paramount Inc., and all others concerned in the color television industry are divided on which type of tube will predominate in the future. Each has its advantages and disadvantages.

Which tube will be more popular? This depends upon which tube will result in a more simplified circuit, lower over-all set production cost, lower picture tube cost, and which tube will give the better picture. Although there is no reason why both the 3-gun tube and the single-gun tube cannot live side-by-side, in the final analysis, the public will decide as to which will be more popular.
In addition to the focusing potential, another voltage can be applied between the set of wires located behind the red and the blue phosphor strips. Depending on the polarity and magnitude of this voltage, the electron beam will be deflected from striking the green strips and hit the red or blue strips.

The color of the spot is therefore determined by the instantaneous voltage between the two sets of wire grids, while the size of the spot is determined by the d.c. voltage between the aluminum backing and the electrical center of the two wire grids. This is similar to the application of centering voltage in an electrostatic deflection cathode-ray tube. In the simplified sketch of Fig. 5, the condition is illustrated where the electron beam hits a green strip because no potential exists between the red and blue wire grids. If a positive voltage is applied to the red wire grid, for example, the electron beam would be deflected slightly more to the left and hit a red phosphor strip.

In addition to the deflecting action of the two wire grids, the electron beam is also moved by the vertical and horizontal deflection coils located around the neck of the tube. It should be understood that the action of the two wire grids is in the order of a minute jiggling motion, superimposed on the horizontal and vertical sweep movement of the electron beam. The colored phosphor strips, the wires, and the spacing between the wires are all so small that from the standard viewing distance individual colors are not discernible.

For operation under the NTSC standards for all electronic color TV, the color switching rate for the wire grids is 3.58 mc, the frequency of the color subcarrier. Rigid standards are needed to maintain the phase relationship between the three color components since it is this relationship which delivers the color or chromaticity information.

To switch at this rate raises some problems when we consider that the wire grids contain considerable capacity and require quite some power to move the electron beam sufficiently. The d.c. voltage on the wires for focusing is on the order of 5000 volts and the a.c. switching signal must, accordingly, be strong, usually about 500 volts. In one practical demonstration the driving power was about 25 watts. To increase the efficiency of the system somewhat an external inductance was used to resonate the approximately 1200 µfd. capacity due to the wire grids.

The problem of driving the wire grids, however, is being solved by new driving methods and a modification in the design of the “Chromatron.” One approach is to move the grid wires further away from the screen and, thus, reduce the capacity. This would help to reduce the required driving power considerably. In addition to the switching circuits it is also necessary to key the cathode or control grid of the electron gun so that only the red picture information or brightness level exists during the instant that the electron beam hits the red phosphor, and so on for the other colors. To accomplish this, the output of the three video amplifiers are switched, each delivering its signal, in turn, to the picture tube.

A block diagram of the circuitry needed to utilize the “Chromatron” (Continued on page 156)
Chromatic Color Tube
(Continued from page 53)

with the NTSC color TV system is shown in Fig. 3. The four video sections, containing the brightness and the three color signals, are required for the NTSC color system since the fine picture detail is transmitted on the brightness signal, and for color information each requires a separate amplifier. For the color signals, the amplifiers are relatively narrow-band stages, but for the brightness signal a 3.5 to 4 mc. bandwidth is desirable. Not shown in Fig. 3 is the synchronous detector which supplies the brightness and color signals. Also omitted are the vertical and horizontal deflection circuits.

The keying section is required to switch the output of each of the three color stages onto the single electron gun. In the RCA tri-color picture tube this is not necessary since each color channel is connected to one of the three electron guns. The tri-color tube is essentially a simultaneous device, while the "Chromatron" breaks the simultaneous NTSC system into a dot-sequential picture.

The operation of the color grids and their associated circuits is shown in some detail in Fig. 3. In order to maintain the d.c. focus potential between the two color grids and the aluminized phosphor backing, a center-tapped coil is required to make this potential equal at both grids. In Fig. 3, it is assumed that the secondary of the output transformer is resonated with the color grid capacity and properly matched to the primary for maximum transfer.

The driver stage can be a power amplifier driven by a voltage amplifier which, in turn, is driven by the color synchronizing oscillator. This 3.58 mc. oscillator is controlled by means of a keyed a.f.e. system from the color synchronizing burst transmitted after each horizontal synchronizing pulse in the composite color signal. In order to obtain true color rendition it is absolutely essential that the frequency remain constant and no phase shift or distortion be introduced.

The high voltage section of the "Chromatron" is somewhat different than for the RCA tri-color picture tube. Good regulation of the anode voltage is not required for the "Chromatron" whereas it is for the tri-color tube.

At the time of writing, several demonstrations of the "Chromatron" have been given. When demonstrated with the NTSC color TV system the "Chromatron" itself appears fairly good. The pictures on one of the tubes appeared to have considerable red streaking which apparently was due to the red phosphor's long persistence. This feature can be remedied by using a different red phosphor. At a viewing distance of about 10 feet, the individual lines are not visible and the viewer sees only the complete color picture.

One interesting aspect of the line structure is the fact that the lines and the grid wires behind them can be oriented either vertically or horizontally and both types of tubes have been tested. It was found that when the colored phosphor lines are in the same direction as the horizontal scanning lines the color moire pattern is much less visible at closer viewing distances. The actual width of the color phosphor lines has not been definitely set, but tubes with strips as narrow as 0.010 inch (10 mils) have been built. When these strips are applied horizontally, the resulting line structure is fine enough to enable the viewer at ordinary distances to see the complete color picture exclusively.

Chromatic Television Laboratories and some other tube manufacturers are developing improved tubes. Some of the planned improvements include much narrower phosphor strips, permitting a greater number of strips and therefore better resolution. Color grids will be made of finer wire and a better
set of colored phosphors is under consideration. The problem of the persistence of the phosphors can be solved when a color combination is found which produces the correct primary colors and has equal brightness and persistence under the same accelerating potential. In the sample tubes demonstrated so far, the correct phosphor combination was lacking, but some fairly good pictures were observed with a compromise arrangement of phosphors.