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Exhibit No. ....

BEFORE THE FEDERAL COMMUNICATIONS COMMISSION

Washington 25, D. C.

In the Matters of:

Amendment of Section 3.606 of the Commission's Rules and Regulations	DOCKET NOS. 8736 and 8975
Amendment to the Commission's Rules, Regulations and Engineering Standards Concerning the Television Broadcast Service	DOCKET NO. 9175
Utilization of Frequencies in the Band 470 to 890 mc for Television Broadcasting	DOCKET NO. 8976

A SIX-MEGACYCLE COMPATIBLE HIGH-DEFINITION COLOR TELEVISION SYSTEM

RADIO CORPORATION OF AMERICA

September 26, 1949

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A SIX-MEGACYCLE COMPATIBLE HIGH-DEFINITION COLOR TELEVISION SYSTEM

I. Introduction

IN the "Comments of the Radio Corporation of America in Docket No. 8736, et al.," dated August 25, 1949, a general description was given of the RCA color television system. Additional information concerning this system was contained in the "Engineering Statement Supplemental to Comments of Radio Corporation of America in Docket No. 8736, et al.," dated September 6, 1949.

In the following pages much of the material contained in the Supplemental Engineering Statement is repeated in order that it may be readily available in one booklet. Additional information is included on certain sections, particularly: sampling and dot interlacing, receiving equipment characteristics, receivers and color converters.

The color system described herein, and which will be demonstrated at these hearings, has its roots in the simultaneous method first disclosed by Radio Corporation of America on October 30, 1946 and subsequently described in detail at the Hearing in Docket No. 7896.

The new system, as in the case of the wide-band simultaneous system, is completely compatible with the current black-and-white television system.

In addition, the new system includes later developments which, in essence, compress the simultaneous system into a 4-megacycle band suitable for a total channel assignment of 6 megacycles. Not only is the system so compressed, but no detail is lost in the process. This in turn insures a high-definition color picture, while at the same time preserving the normal definition of the black-and-white picture.

The compression of the simultaneous system is accomplished by a combination of two processes:

(a) use of the mixed-highs principle; and

(b) color-picture sampling and time-multiplex transmission.

These band-saving techniques are described in the following pages.

II. Studio and Related Equipment Characteristics

A block diagram of the color television broadcasting station is shown in Figure 1.

Studio Apparatus

The color camera (live, film, or slide), its related equipment, and the synchronizing generator are the same components used in the wide-band simultaneous system. These were described by RCA in Dockets No. 7896 and No. 8976. (See also: *RCA Review*, Vol. VII, No. 4, pp. 459-468, December, 1946; *Proc. I.R.E.*, Vol. 35, No. 9, pp. 861-875, September, 1947.)

This studio apparatus provides three signals, one for each of the primary colors (green, red and blue). Each of these signals may contain frequency components out to a maximum of four megacycles, and in addition an average or dc component.

Signal Routing

For one signal routing of Figure 1, each color signal passes through a low-pass filter which eliminates frequency components above two megacycles. The green-channel signal coming out of its particular low-pass filter is designated as G_L on Figure 1, indicating that at this point the signal contains the dc component and ac components with frequencies of two megacycles or less. The three low-frequency signals, G_L, R_L and B_L are then sent into an electronic commutator or sampler (discussed below).

For the second signal routing of Figure 1, the three-color signals from the camera are combined in electronic Adder No. 2 and then are passed through a band-pass filter. The output of this filter contains frequencies from two to four megacycles, with contributions from each of the three color channels. The signal at the output of the band-pass filter is designated as M_H, the mixed-high signal. The mixed-high frequencies are fed to Adder No. 1 which, as will be seen, is also receiving the signal from the sampler and from the synchronizing generator.

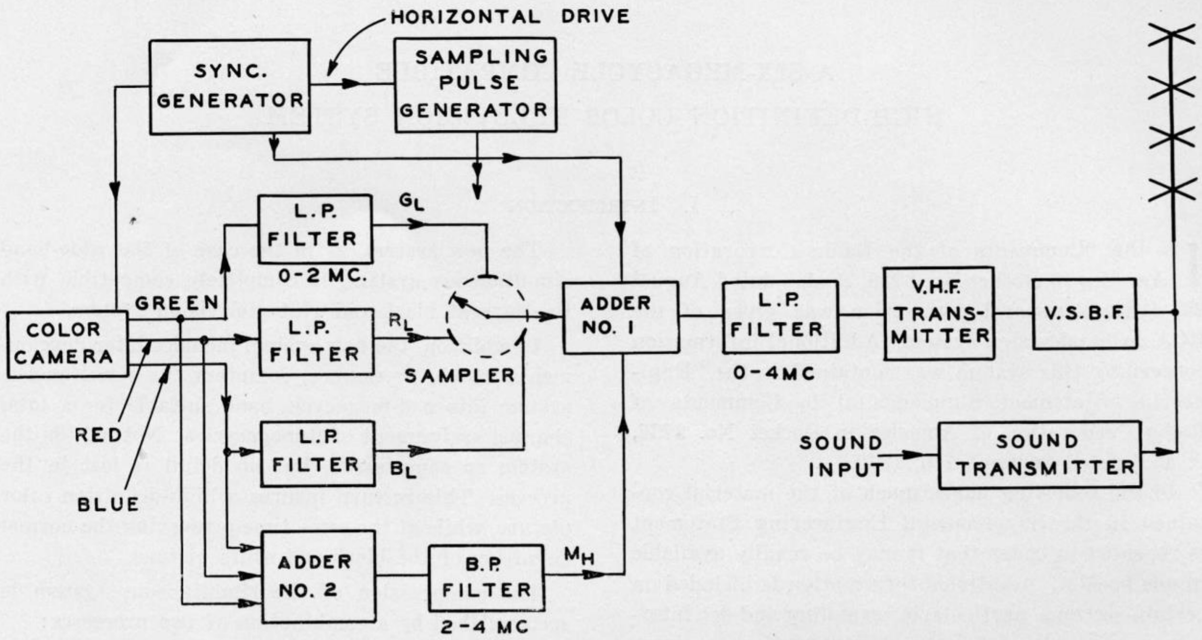

Fig. 1—Block diagram of the color television transmitter.

Mixed-Highs

The principle of mixed-highs, referred to above, was described by RCA in Docket Nos. 7896 and 8976. It has been demonstrated that the mixed-highs procedure is successful and satisfactory in a wide-band simultaneous system.

In the new RCA color television system, at the transmitting end, the sampling process (discussed below) is capable by itself, of providing high-frequency components of each color signal. Since the sampling frequency determines the highest frequency which will be passed, when the high-frequency components of each color signal are combined the resulting band-width does not exceed four megacycles.

However, flying-spot devices used as film and slide scanners inherently have poor high-frequency response, due to the fact that their phosphors, particularly the red, have a long decay time. It is often necessary, therefore, to peak the higher-frequency response of such devices. This peaking, of course, raises the level of the high-frequency noise components. When the entire frequency band of zero to four megacycles is sampled, the 3.8-megacycle sampling frequency beats the high-frequency noise to low frequency and vice versa. Because, in the case of pickup devices of the type referred to above, the high-frequency noise has been peaked, an even interchange of noise components does not occur, as it would if the noise spectrum were uniform. Consequently, after the sampling process has taken place, the low-frequency noise components will have been accentuated. This causes a coarse-grain structure in the picture which may be objectional to the eye.

Experience has shown, therefore, that there is a definite advantage gained in sampling only the lower half of the video band (up to two megacycles) and using the principle of mixed-highs for the upper half of the video band (from two to four megacycles), and this procedure is used at the transmitting end.

In pick-up equipment with uniform noise characteristics, no such effects as above described exist. This means that either the dual procedure given in the above paragraph or sampling only may be used. This also applies to receiving equipment.

Sampling and Combining Process

The sampling pulse generator, which embodies time-multiplexing techniques, is an integral part of the electronic commutator and makes use of the trailing edge of the horizontal synchronizing pulse to time the sampling of each of the color signals.

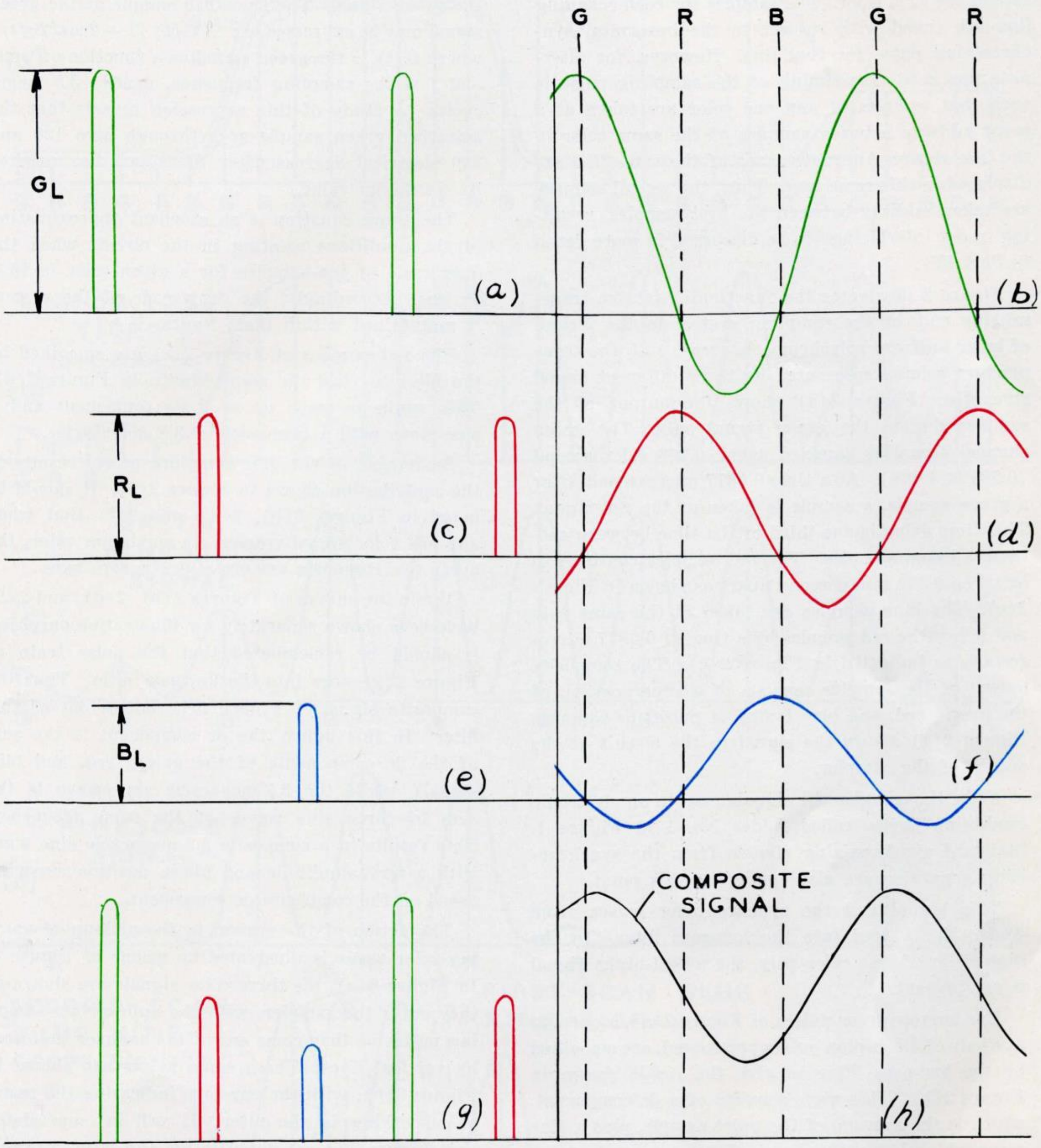

Fig. 2—Functioning of the sampling system at the transmitting end.

In the sampler, each color signal is sampled for a very short time, at a rate of 3.8 million times per second for each color. The samples for each scanning line are timed with respect to the horizontal synchronizing pulse for that line. However, for alternate line scans the timing of the sampling pulse is such that samples of any one color are taken at a point midway between samples of the same color in the line above. Alternate scans of the same line are displaced in this same way. Thus, the second samples are taken midway between the first samples, resulting in dot interlacing (to be discussed in more detail in Part IV).

Figure 2 illustrates the functioning, at the transmitting end, of the sampling system in the pickup of large uniform polychromatic areas, with the three primary colors represented by three different signal strengths. Figure 2(a) shows the output of the sampler due to the green signal only. The green channel signal is sampled every 0.263 microsecond ($0.263 = 1/3.8$). At a time 0.0877 microsecond after a green sample, a sample is taken of the red signal. This time delay is one-third of the time between successive green samples. The red samples continue to be taken 0.263 microsecond apart as shown in Figure 2(c). The blue samples are taken at the same rate and follow the red samples by a time of 0.0877 microsecond, as indicated in Figure 2(e). The composite output of the sampler consists of a superposition of the green, red, and blue trains of pulses or samples. Figure 2(g) shows the signal in the circuit at the output of the sampler.

From the sampler the signals pass to an electronic combining device called Adder No. 1 in Figure 1. Standard synchronizing signals from the synchronizing generator are also applied at this point.

This signal and the synchronizing pulses from Adder No. 1 feed into the low-pass filter. In the case of large area color only, the mixed-highs signal is not present.

The narrow green pulses of Figure 2(a), occurring at a rate of 3.8 million pulses per second, are smoothed by the low-pass filter to give the result shown in Figure 2(b). This wave consists of a dc component, which is the average of the pulse sample, plus a sine wave which has a frequency of 3.8 megacycles (the filter having removed the higher order harmonics). The 3.8-megacycle sine wave and the dc component change together, as the green signal changes in strength, in such a way that the signal of Figure 2(b) always passes through zero at the same interval of time after the peak regardless of the strength of the green signal. The smoothed sample of the green signal may be expressed as: $\frac{1}{3}\,G(t)\,[1 + 2\cos(2\pi f t)]$ where $G(t)$ is the green signal as a function of time, and f is the sampling frequency, namely 3.8 megacycles. A study of this expression reveals that the smoothed green sample goes through zero 120 and 240 electrical degrees after the signal has reached its maximum value.

The above equation is an excellent approximation of the conditions existing in the circuit when the duty cycle of the samples for a given color is 15% or less. Accordingly, the duty cycle of the system is maintained within these limits.

The red samples of Figure 2(c) are smoothed by the filter to yield the result shown in Figure 2(d). This again is made up of a dc component and a sine wave with a frequency of 3.8 megacycles.

Smoothing of the blue sampling pulses results in the contribution shown in Figure 2(f). It should be noted in Figures 2(b), 2(d), and 2(f) that when any one color signal reaches its maximum value, the other two responses are crossing the zero axis.

While the curves of Figures 2(b), 2(d), and 2(f) have been shown separately for illustrative purposes, it should be remembered that the pulse train of Figure 2(g) goes into the low-pass filter. Thus the composite signal of Figure 2(h) comes out of this filter. In this figure, the dc component is the sum of the dc components of the green, red, and blue signals, while the 3.8-megacycle sine wave is the sum of three sine waves of the same frequency. This results in a composite 3.8-megacycle sine wave with a new amplitude and phase position superimposed on the composite dc component.

The action of the system in the pick-up of varying color areas is illustrated by means of Figure 3. In Figure 3(a), the three color signals are shown as they enter the sampler, with the appropriate sampling pulses as they come out of the sampler indicated by vertical lines. These same pulses are shown in Figure 3(b), with the envelope indicating the result of smoothing in the filter. It will be appreciated that Figure 3 is not quantitative and is used purely for illustrative purposes. Fine detail of the color picture, carried by the higher frequency components, is, of course, now supplied by the mixed-highs signal, but this cannot be easily shown in the diagram.

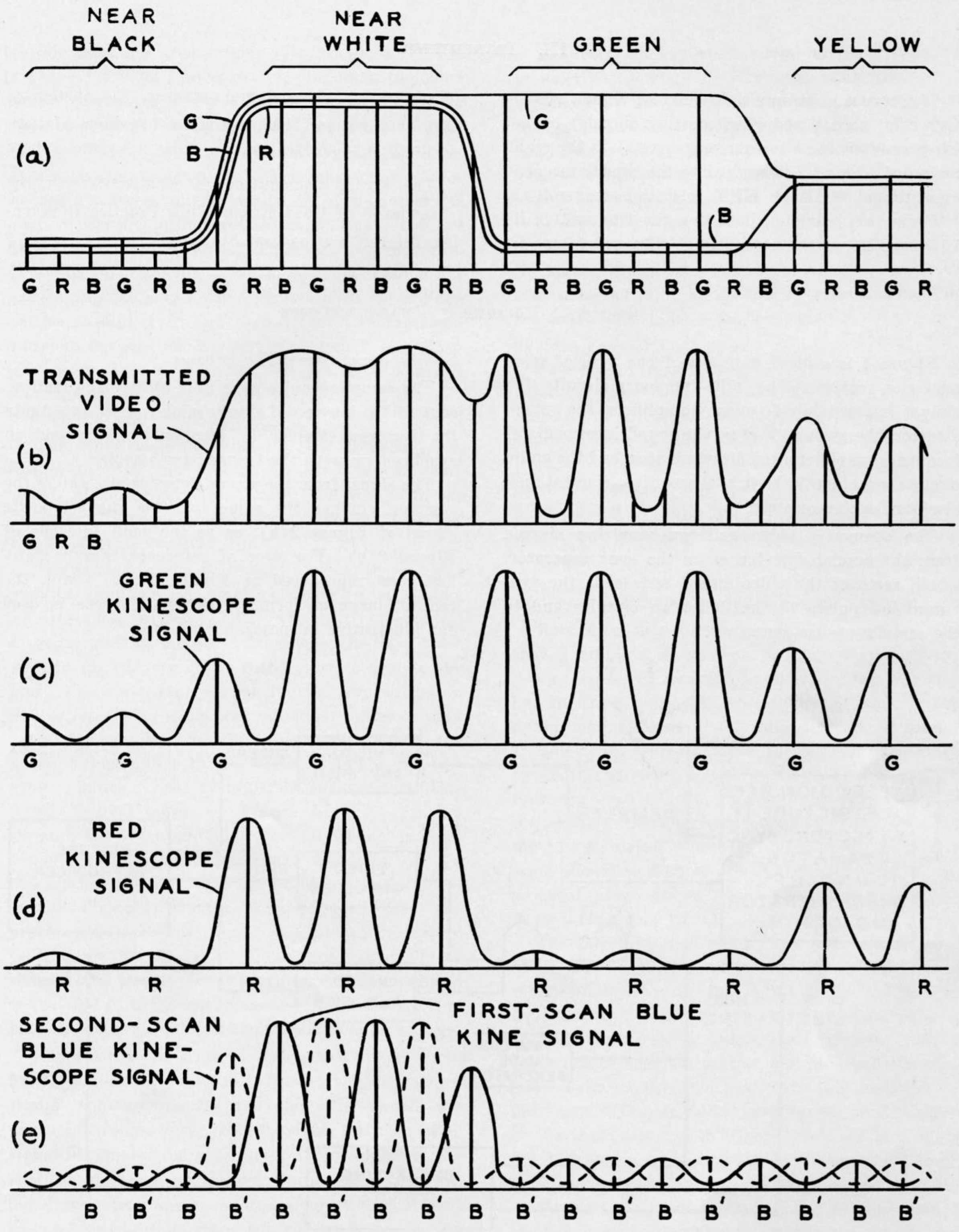

Fig. 3—Action of the system in the presence of varying color areas.

III. Transmitter

The output (time-multiplexed color signal, mixed-high color signal, and synchronizing signals) of the low-pass filter (zero to four megacycles) in the right center of Figure 1 is applied to the modulator of a conventional VHF or UHF television transmitter.

From this point on, including the transmitter itself, together with the vestigial sideband filter, diplexer, sound channel and antenna, the system is that of a normal black-and-white television station, with no changes necessary.

The signal transmitted is consistent with the "Standards of Good Engineering Practice Concerning Television Broadcast Stations."

IV. Receiving Equipment Characteristics

Figure 4 is a block diagram of one type of color television receiver. The radio-frequency circuits, the picture intermediate-frequency amplifiers, the second detector, the sync separator, the sound intermediate-frequency amplifiers, the discriminator, and the audio circuits are identical with those of a conventional black-and-white receiver.

The composite video and synchronizing signals from the second detector enter the sync separator, which removes the video signal and sends the synchronizing pulses to the deflection circuits and to the sampling pulse generator.

Sampling and Smoothing Process

The sampling pulse generator utilizes the trailing edge of the horizontal synchronizing pulse to actuate the receiver sampler in identical fashion and in synchronism with the transmitter sampler.

The signal from the second detector also enters the sampler. It has the same form as the composite signal of Figure 2(h), or as the solid envelope of Figure 3(b). For ease of reference, Figure 2(h) has been reproduced as Figure 5(a). Again, the case of large uniform polychromatic areas is used for illustrative purposes.

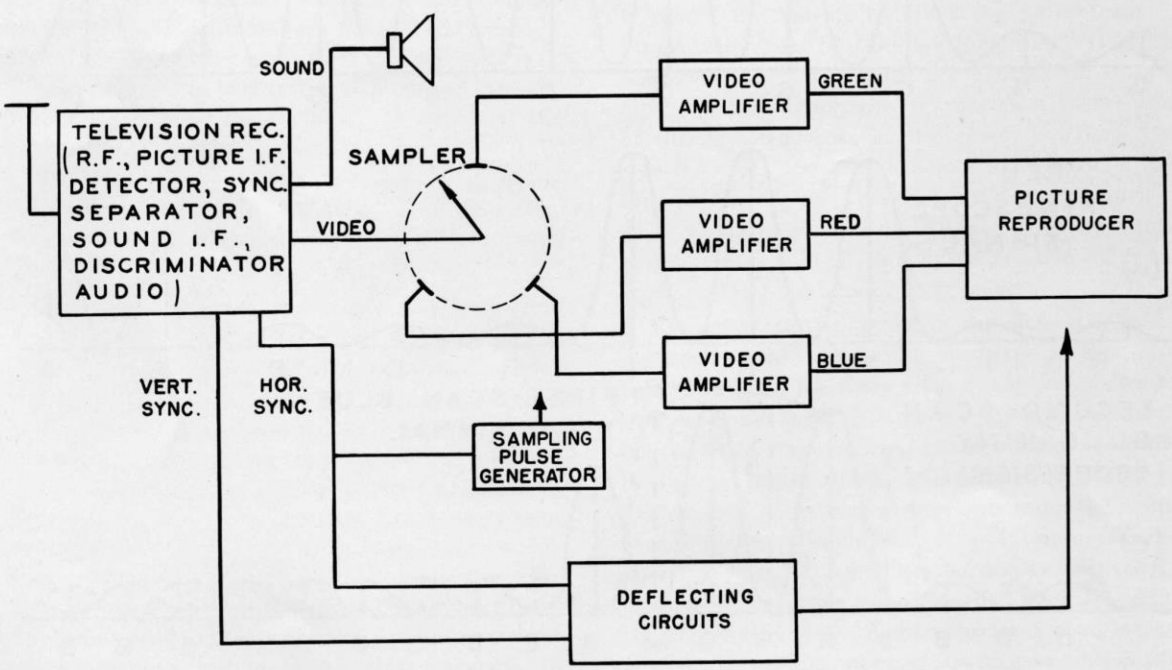

Fig. 4—Block diagram of one type of color television receiving equipment.

The electronic commutator samples the composite signal every 0.0877 microsecond, producing the short pulses shown in Figure 5(a). The amplitude of each of these pulses is determined by the amplitude of the composite wave at that particular instant.

The commutator feeds these pulses into three separate video amplifiers which in turn control the picture-reproducing apparatus which may consist of three cathode-ray tubes or kinescopes having appropriate color-producing phosphors. This method for portraying the single color picture with three kinescopes is similar to that demonstrated to the Commission during the Hearing on Docket No. 7896. (See also: *RCA Review*, Vol. VII, No. 4, pp. 459-468, December 1946; *Proc. I.R.E.*, Vol. 35, No. 9, pp. 861-875, September, 1947.)

The video amplifiers have a flat frequency response to four megacycles, and must cut off completely at 7.6 megacycles. (Reference here is to the frequency response of the video amplifiers only and not to channel requirements.)

The sampler sends the pulses to each of the video amplifiers and its attendant kinescope in succession. For instance, in Figure 5(a), the first pulse shown in green goes to the green kinescope, the next pulse goes to the red, while the third pulse is sent to the blue. The green receives the fourth, seventh, tenth, and so on. Thus, while the individual pulses coming out of the sampler are 0.0877 microsecond apart, the green pulses going to the video amplifier for the green picture repeat every 0.263 microsecond. The green channel pulses of Figure 5(a), in passing through the video amplifier, lose all frequency components except the fundamental frequency of 3.8 megacycles and the dc component. The resultant smoothed signals are shown in Figure 5(b). The green, red, and blue signals are shown in superposition on this figure for illustration. It should be remembered that at this point the green signal shown is that fed to the green kinescope, while the red and blue signals are applied to their individual kinescopes.

Examination of Figures 2(b), 2(d), 2(f), and 2(h), has already revealed that, when the green signal is maximum, the red and blue signals are passing through zero. Hence, since the composite signal is sampled for green by a narrow pulse at the receiver at this exact instant, the receiver sampling pulse is a true measure of the green signal and includes no dilution from the red or blue signals. Likewise, the red and blue samples are each taken at points on the composite signal where no crosstalk is contributed from the other two color signals.

The above statement concerning absence of crosstalk holds good for all frequency components up to one-half the sampling frequency. For frequency components approaching the sampling frequency in order of magnitude, from a purely circuit aspect, crosstalk is present. However, the physiological characteristics of the eye which make possible the application of the mixed-highs principle apply equally well to the crosstalk of the higher-frequency components. Consequently, crosstalk in the fine detail is of no consequence.

Assuming that the kinescope actually cuts off with negative applied signal, and neglecting the non-linearity of the input control-voltage vs. light-output characteristic of the kinescope, the solid lines of Figure 5(c) may be regarded as the effective light intensity along one line scan in green. Figures 3(c), 3(d), and 3(e) show the effective signals for the green, red, and blue kinescopes, again for a single line scan.

Picture Dot Interlacing and Scanning Sequence

Returning now to Figure 5(c), it may be seen that a single line scan on the green channel lays down a series of green dots on the screen as shown by the solid lines. As was indicated above, these dots occur at a rate of 3.8 million times per second. If fine detail were involved to such an extent that two adjacent pulses in the green channel in a single line scan were of different amplitude, it is basic that the highest frequency component of use in establishing picture detail would be a sine wave which went from a crest to a trough in the time between the two adjacent green pulses. This sine wave would then have a frequency of 1.9 megacycles.

The fact that each pulse has a rise equivalent to twice this frequency allows the use of picture-dot interlacing to secure full detail up to a frequency band 3.8 megacycles wide. This is accomplished by shifting the sampling pulses the next time that the same line is scanned so that the dots are then laid down between the dots that were laid down in the first scan. This second series of green dots is shown by the broken curves in Figure 5(c). In this figure, the dots shown by broken curves are the same amplitude as the dots shown by the solid curves. For resolution of very fine detail, the dots laid down in the first scan would differ in amplitude from the dots laid down in the second scan of this same line.

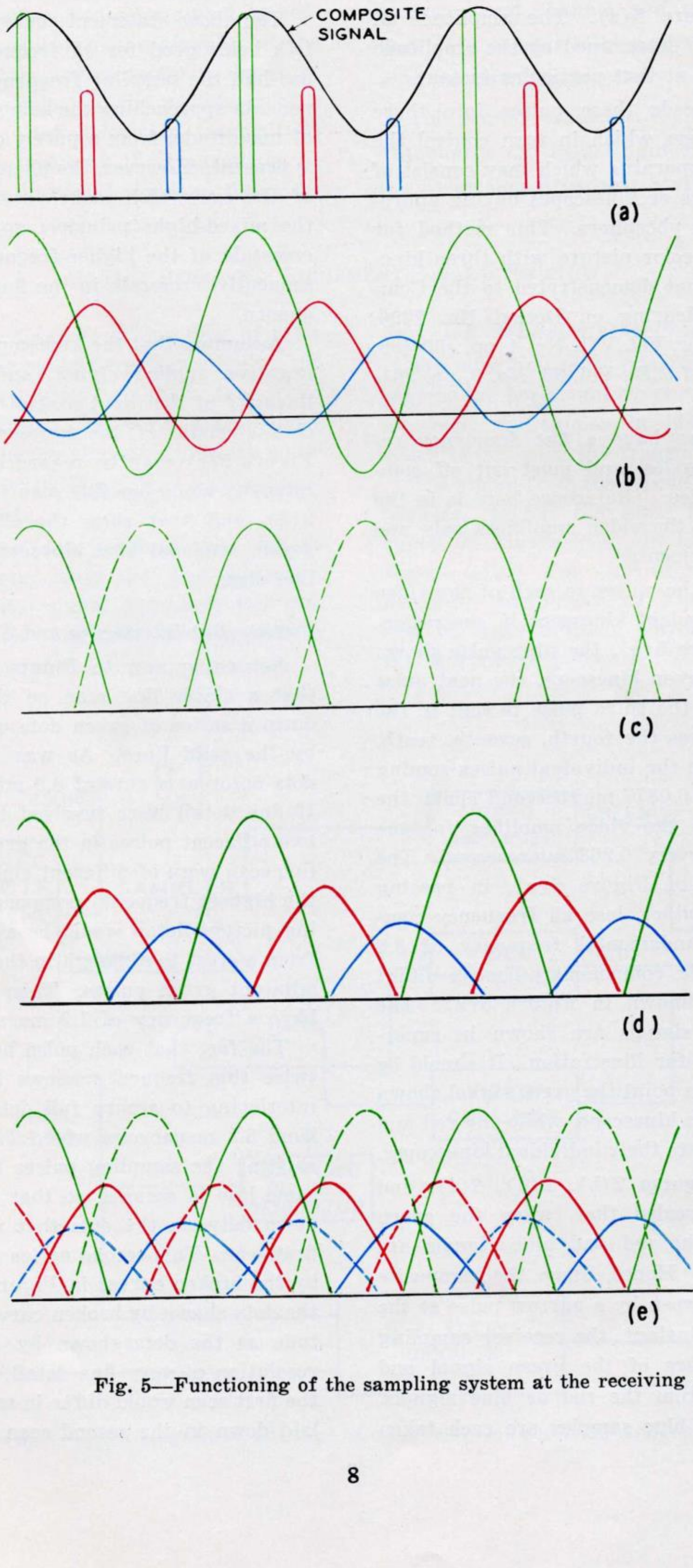

Fig. 5—Functioning of the sampling system at the receiving end.

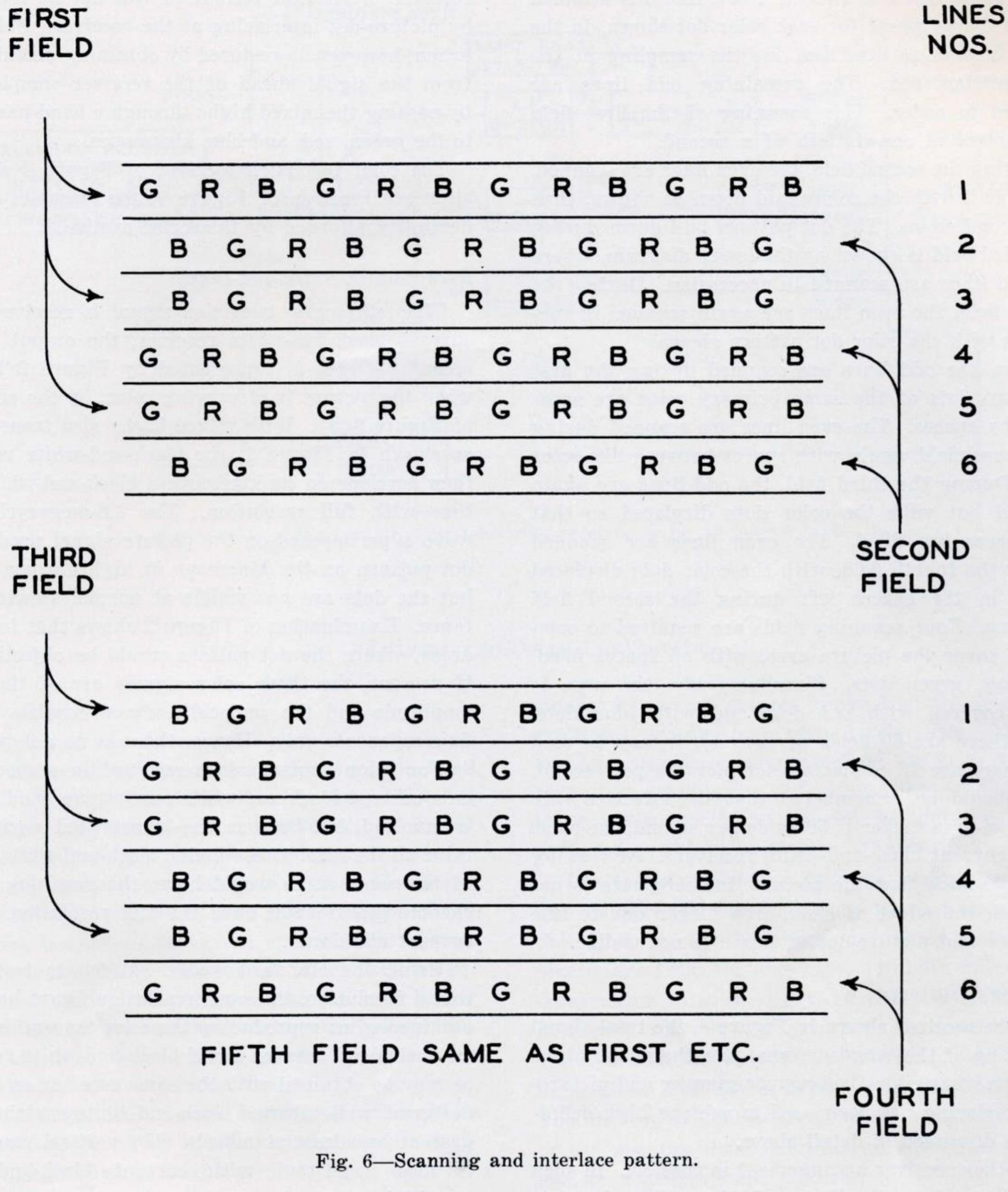

Fig. 6—Scanning and interlace pattern.

Inspection of Figure 5(d) reveals that while a single line scan lays down a series of green dots on the screen with space between dots, this space is filled at the same time by red and blue dots, with great overlapping of the dots. The effect of the successive scans of a single line, Figure 5(e), shows even more clearly the complete covering the line area with picture dots of three colors.

The scanning and interlace pattern used in the RCA color television system is illustrated in Figure 6. Each letter represents the center of a color dot area on the screen. The actual areas, of course, overlap to a great extent as discussed above.

During the first scanning field, illustrated in the upper diagram in Figure 6, the odd numbered lines are scanned in order. Colored dots are laid down in order along line 1 as shown. Next, line 3 is scanned with a displacement for each color dot shown, in the same fashion as described for the sampling at the transmitting end. The remaining odd lines are scanned in order. This scanning of the first field takes place in one-sixtieth of a second.

During the second field, the even lines are scanned, first line 2 with the colors laid down as shown, then line 4, and so on. The dot pattern laid down during the third field is shown by the lower diagram, where the odd lines are scanned in succession. During the fourth field, the even lines are again scanned in succession with the color dot pattern shown.

Thus, the odd lines are scanned during the first field, but dots of the same primary color are separated by spaces. The even lines are scanned during the second field, again with spaces between like color dots. During the third field, the odd lines are again scanned but with the color dots displaced so that the spaces are filled. The even lines are scanned during the fourth field, with the color dots displaced to fill in the spaces left during the second field scanning. Four scanning fields are required to completely cover the picture area, with all spaces filled, with say, green dots. Simultaneously, the area is being covered with red dots and with blue dots. Since there are 60 fields per second, it may be said that there are 15 complete color pictures per second.

It should be remembered that the effective rate for large-area flicker is 60 fields per second, the same as for current black-and-white receivers. At viewing distances such that the picture line structure is not resolved, the effect of small-area flicker due to line interlace and picture-dot interlace is not visible.

Receiving Systems

In the receiver shown in Figure 4, the total signal consisting of the sampled signal plus the mixed highs has been inserted in the receiver sampler and picture-dot interlacing has been used to achieve high definition as discussed in detail above.

Another receiver arrangement is possible. In such a receiver, shown in Figure 7, the entire signal is fed into the sampler as before, but, in this case, low-pass filters with cut-off frequencies of approximately two megacycles are inserted between the sampler and the kinescopes. The low-frequency filters smooth out the pulses of Figure 5(c), so that the adjacent dots of a single color in one line scan now almost completely overlap. Because the pulses have been broadened by the two-megacycle filters in this receiver, horizontal resolution will not be increased by picture-dot interlacing at the receiver. Full resolution, however, is restored by obtaining mixed highs from the signal ahead of the receiver sampler and by-passing the mixed highs through a band-pass filter to the green, red, and blue kinescopes.

The color television receiver of Figure 4 and the alternate receiver of Figure 7 are examples of the flexibility afforded by this color system.

Reception in Black-and-White

When the color television signal is received on a current black-and-white receiver, the output of the second detector is represented by Figure 2(h), or, when the picture is of varying color, by the envelope of Figure 3(b). With mixed highs also transmitted as shown in Figure 1, the black-and-white receiver then develops on its kinescope a black-and-white picture with full resolution. The 3.8-megacycle sine wave superimposed on the picture signal produces a dot pattern on the kinescope in high chroma areas, but the dots are not visible at normal viewing distance. Examination of Figure 2 shows that in white areas, where the dot pattern would be objectionable if present, the three color signals are of the same amplitude and the composite signal consists of the dc components only. Hence, there is no dot pattern.

For color transmissions received in monochrome on a current black-and-white receiver no band saving is involved, but because the transmitted signal contains all the resolution which a black-and-white signal of the same scene would have, the resulting monochrome picture will have the full resolution of the current standards.

Using the standard wedge pattern to test horizontal resolution, the same resolution figure has been obtained when reproducing the color transmission on an unchanged current model black-and-white receiver as may be obtained with the same receiver on a well-designed, well-adjusted black-and-white system using present broadcast standards. The vertical resolution is also consistent with current black-and-white standards.

When a color receiver is tuned to a television broadcasting station transmitting a black-and-white signal, the picture will appear in black-and-white with full resolution on the color receiver picture reproducer. The successive pulses delivered to the three kinescopes will all be of equal magnitude, and, hence, will produce varying intensities of white — or a normal black-and-white picture.

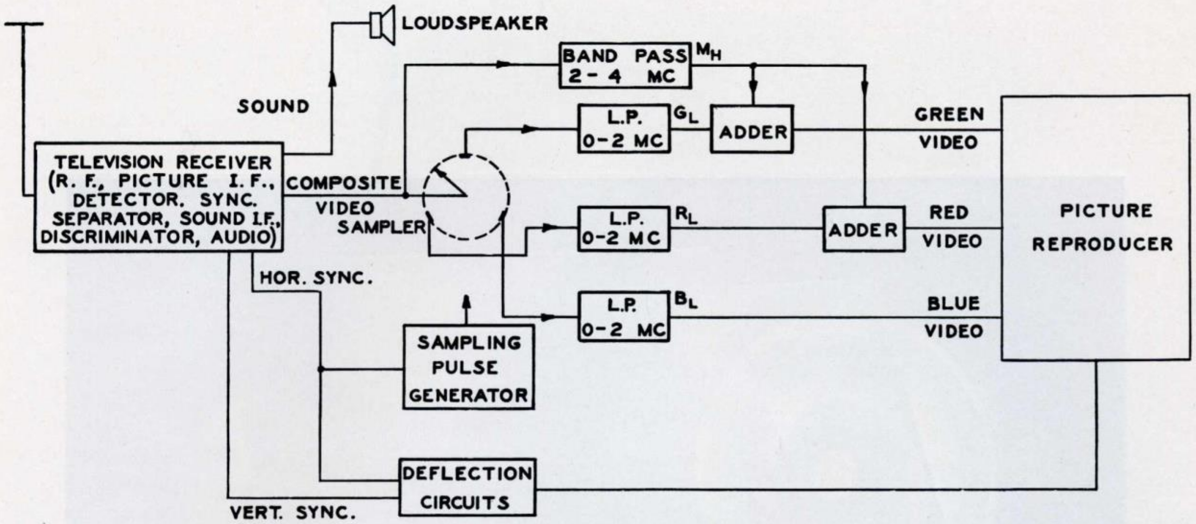

Fig. 7—Block diagram of color television receiver using by-passed highs.

V. Receivers and Color Converters

Picture Reproducing Systems

One method for portraying a single color picture makes use of three kinescopes, reflective optics, and dichroic mirrors in a projection system. This has been previously demonstrated and described during the Hearing in Docket No. 7896.

Another method also makes use of three kinescopes in a projection system but uses refractive optics and dichroics instead of reflective optics. This system appears to lend itself more readily to compact design.

A third method uses three kinescopes with a pair of dichroic mirrors so arranged to permit essentially direct viewing. This system appears to lend itself more readily to a lower cost design.

A fourth method uses two kinescopes with a single dichroic mirror. This system appears particularly attractive for use in inexpensive receivers and color converters.

Because color receivers will probably be simplified by a color picture reproducer of the single-tube type, intensive research efforts on the problem are being continued.

Direct-View Receiver

Figure 8 represents a direct-view picture-reproducing system utilizing three kinescopes which are standard in every respect except that the phosphors are green, red and blue, respectively. The green, red and blue signals are impressed on the grids of their respective tubes. The deflecting yokes of the three tubes are connected in parallel, so that the rasters produced on the three screens are identical.

The tubes are viewed through dichroic mirrors. The red dichroic mirror reflects the red image from the red tube, the blue dichroic mirror reflects the blue image from the blue tube, and both mirrors are transparent to green light, so that the green tube is viewed directly through both dichroic mirrors. The red dichroic mirror is also transparent to blue light, so it does not interfere with the blue image. The mirrors and tubes are properly arranged so that to the eye the three pictures appear superimposed and are viewed as one picture.

Figure 9 shows three standard-size ten-inch kinescopes and the two dichroic mirrors mounted in a framework for proper viewing from the top, through a fully silvered mirror. A receiver using the above arrangement could be housed in a cabinet of the type shown in Figure 10. It is possible in this arrangement that, if the kinescopes are shortened the cabinet size can be materially reduced.

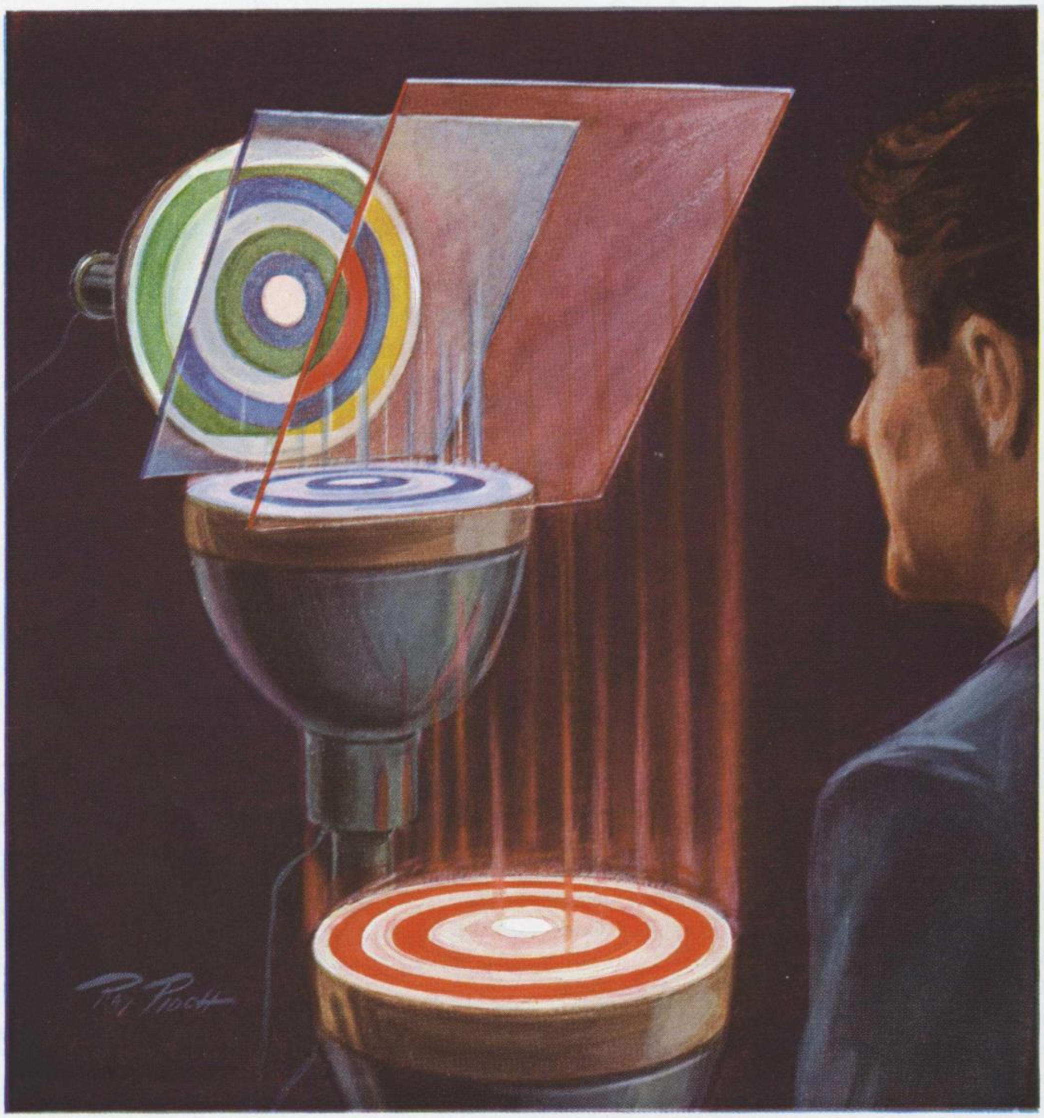

Fig. 8—Direct-view picture-reproducing system using three kinescopes and a pair of dichroic mirrors.

Fig. 9—Positioning of ten-inch kinescopes for direct-view picture-reproducing system.

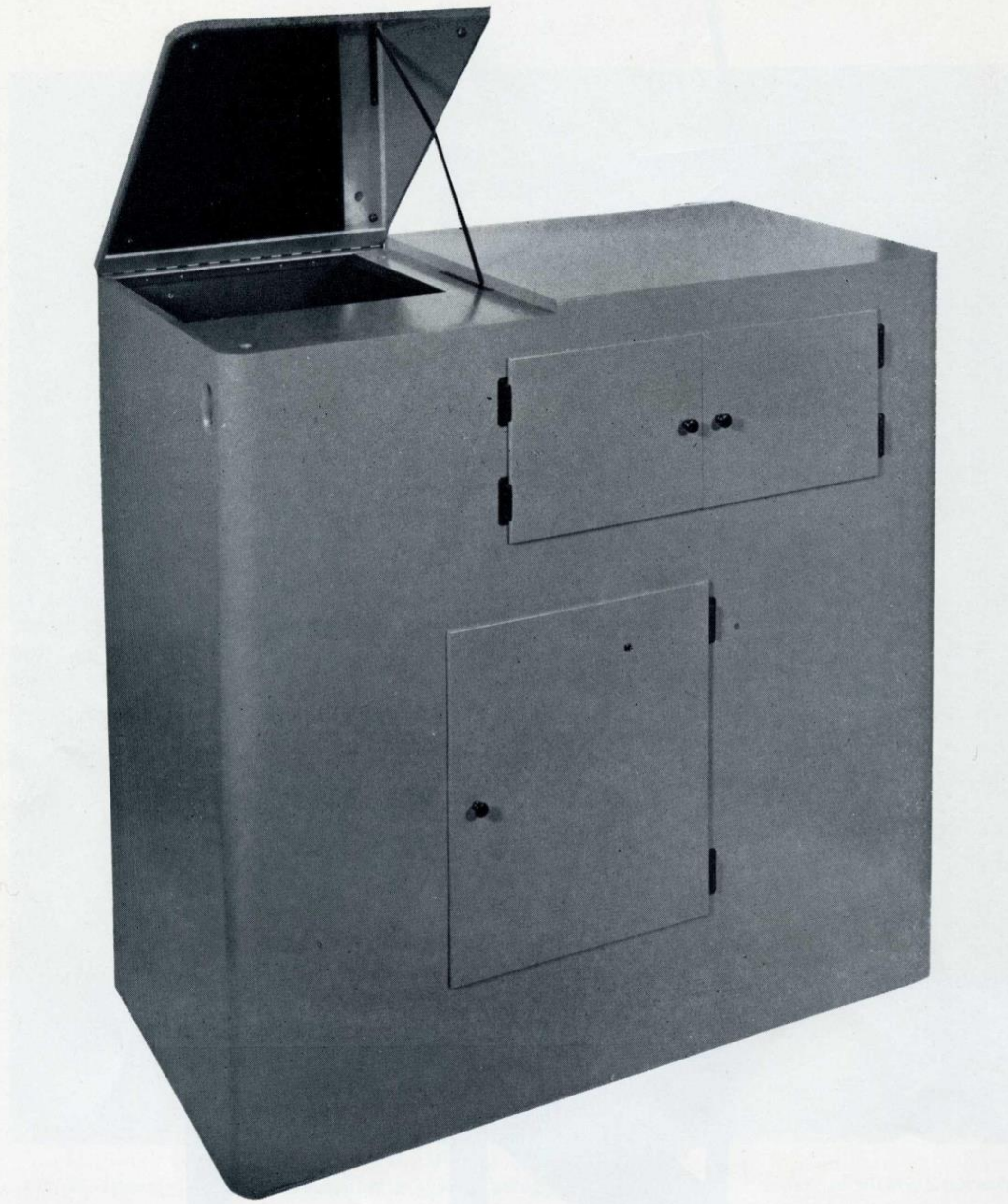

Fig. 10—One type of cabinet for direct-view receiver utilizing three kinescopes and a pair of dichroic mirrors.

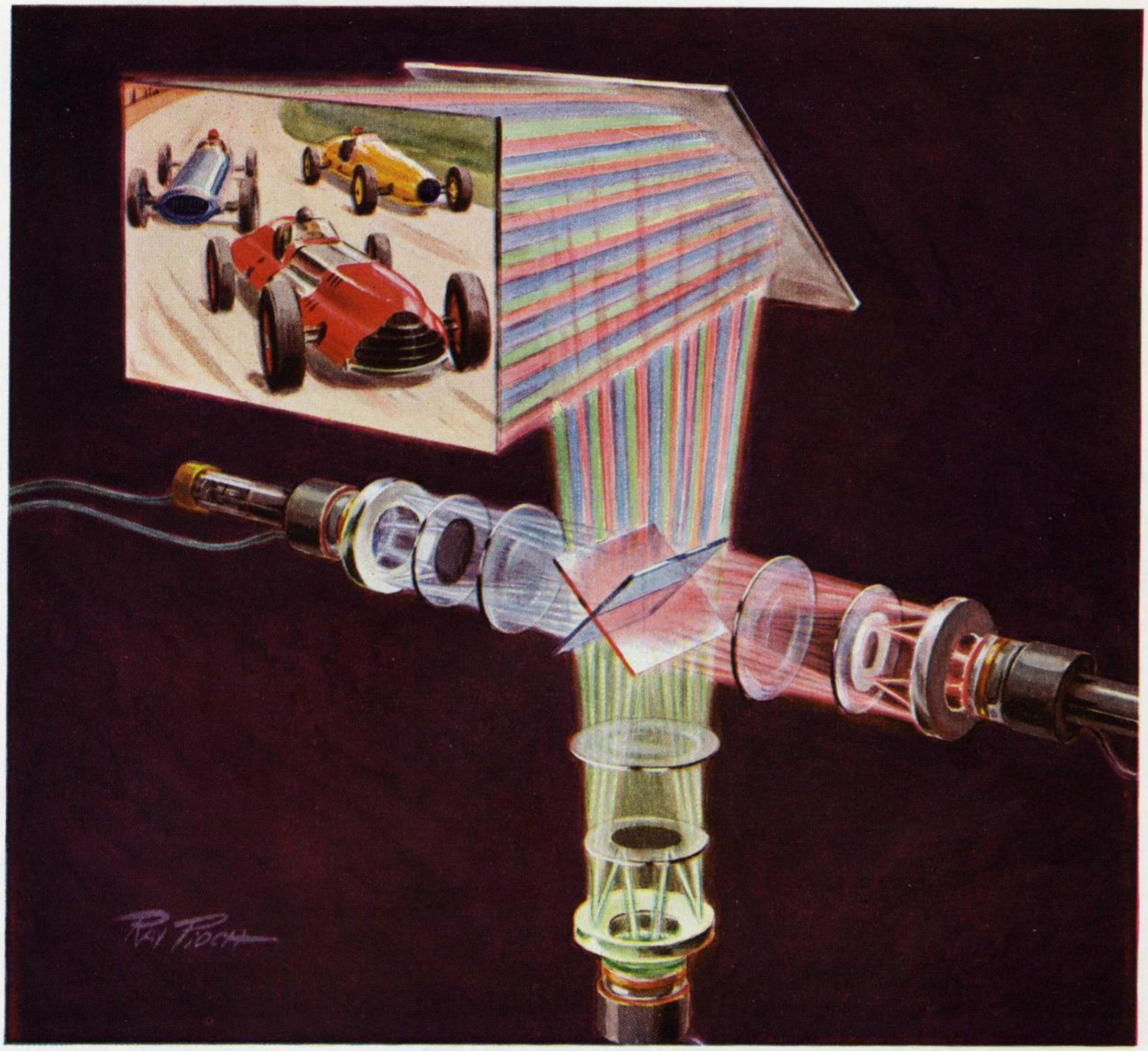

Fig. 11—Projection picture-reproducing system using three projection kinescopes, reflective optics and a pair of dichroic mirrors.

Projection Receiver

Another type of picture reproducing system is shown in Figure 11. This gives a projection picture, 15 x 20 inches. Three projection kinescopes are used which are standard except for the phosphors. Each tube control-grid is connected to the appropriate video channel, and the deflection yokes are supplied from a common source. Each tube is arranged in a reflective optical system. The light rays from each tube first strike a plane mirror, from which they are reflected to a spherical mirror of the proper focal length to produce an image on the screen. Beyond the spherical mirror the rays pass through a correcting lens and thence via a plane reflecting mirror to the projection screen.

The green image passes through the red-and-blue-

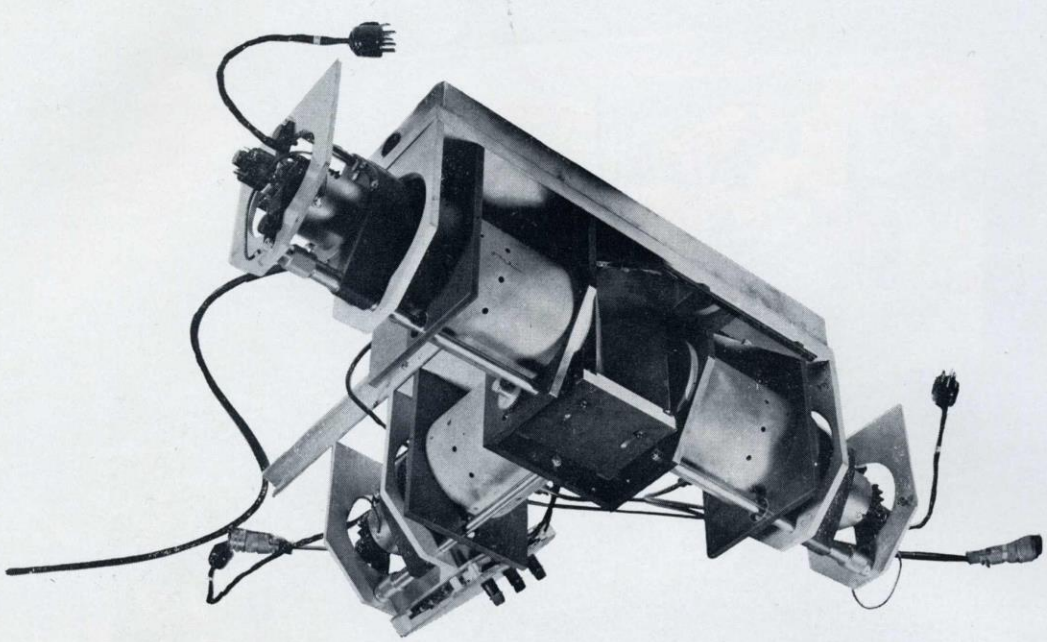

Fig. 12—Arrangement of the projection tubes and optical system used in the projection receiver.

reflecting dichroic mirrors. The red image is reflected to the screen by the red-reflecting dichroic mirror. Similarly, the blue image is reflected to the screen by the blue-reflecting dichroic mirror. The complete optical system is so arranged that the three images are superimposed, in register and focus, on the projection screen, where they are viewed as a single color picture.

Figure 12 is a photograph of the reflective optical system showing the mechanical arrangement of the projection tubes and the optical system. The receiver employing this system is shown in Figures 13 and 14.

Projection Receiver with Magnifying Lens

The same type of projection picture reproducing system, referred to above, is used in the television receiver shown in Figure 15. Here the projected picture is smaller, and is viewed through a magnifying lens.

Color Converters

To convert a current black-and-white receiver to receive color transmissions in color requires the addition of color sampling circuits and a picture reproducer.

The size of the color converter for a direct-view picture or for a large projected picture is determined by the size of the kinescopes and the optical system. When the cabinet size and shape have been determined by these elements, the circuit components which need to be added to those already available in the black-and-white receiver can be fitted around the kinescopes and optical system in the cabinet without increasing its size.

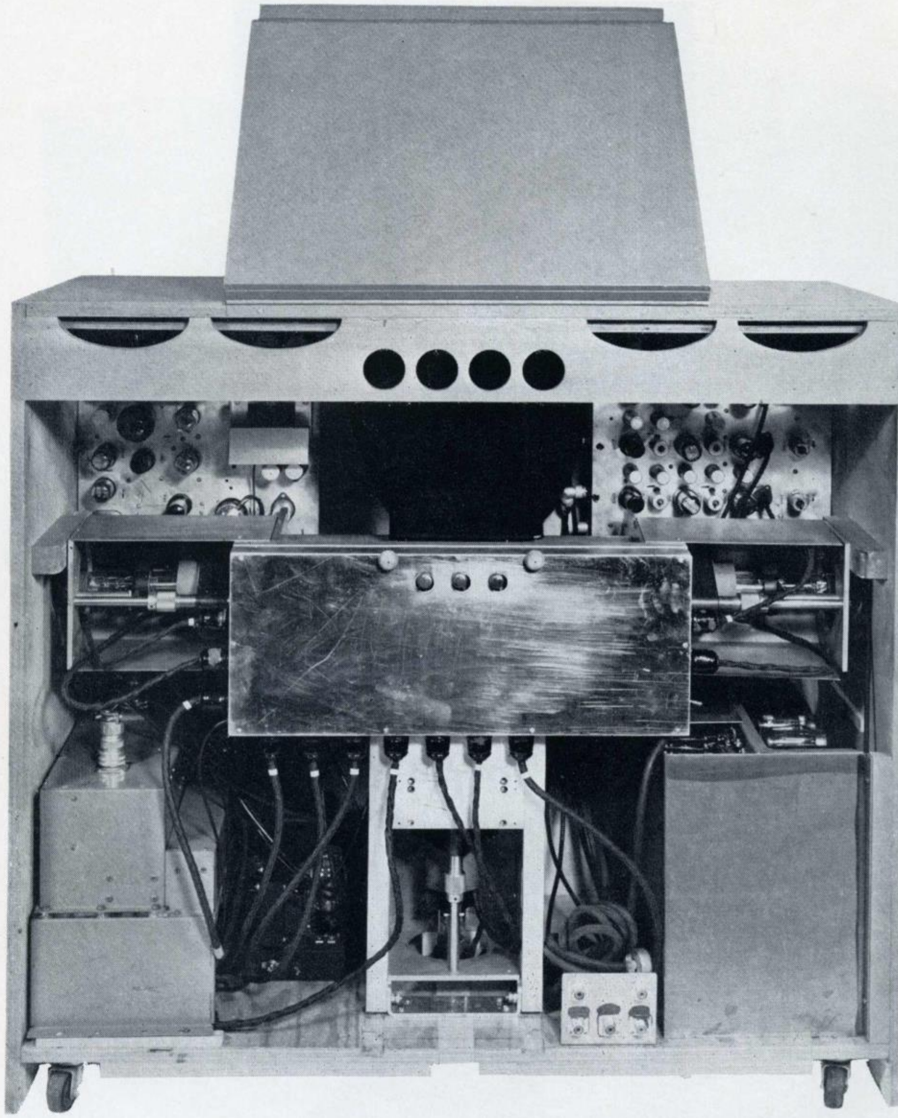

Fig. 13—Rear view of the projection receiver with 15 by 20 inch picture.

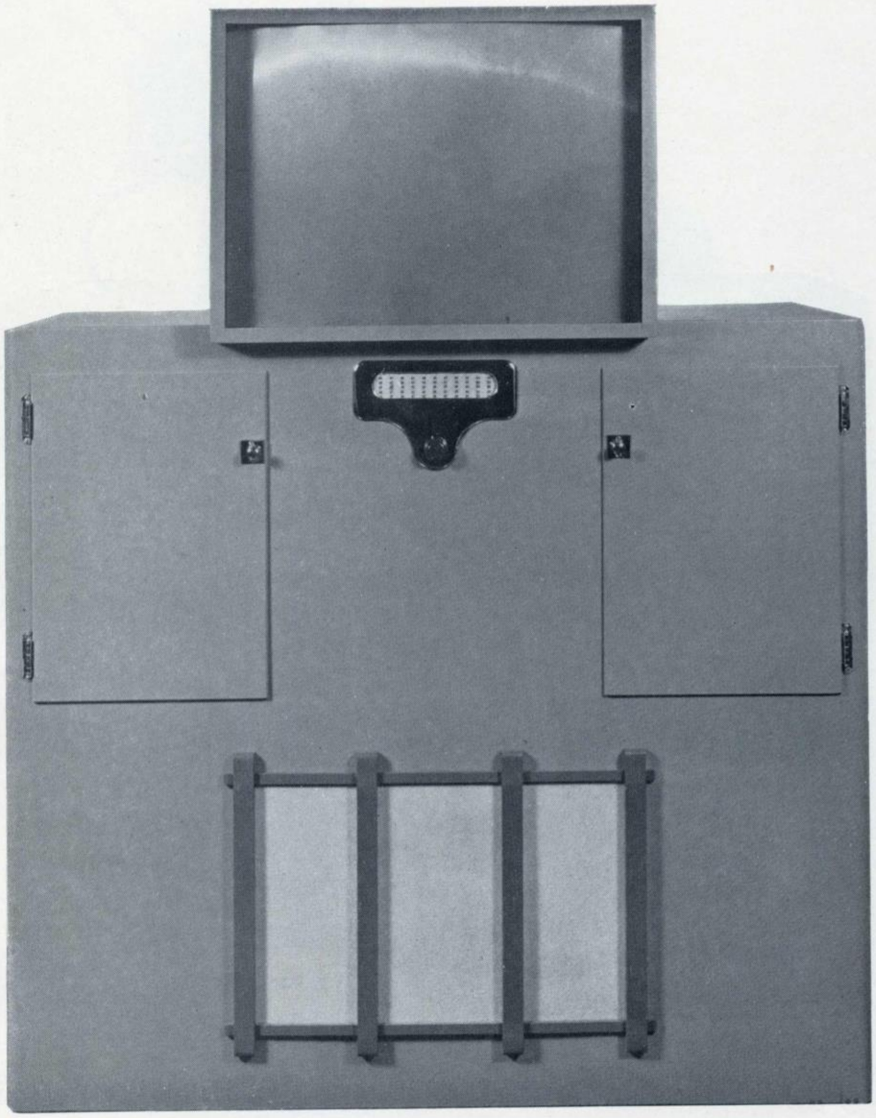

Fig. 14—Projection receiver with 15 by 20 inch picture.

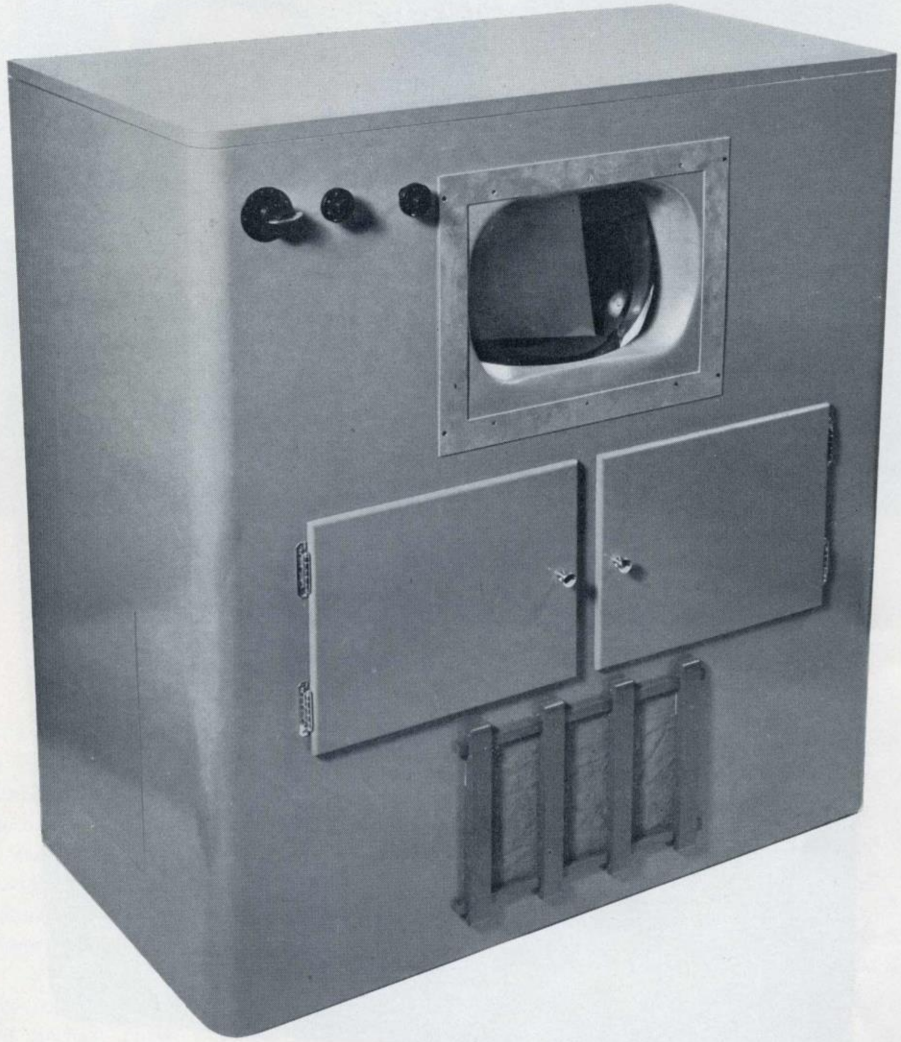

Fig. 15—Projection receiver using reflective optics and magnifying lens.

Fig. 16—Direct-view color converter.

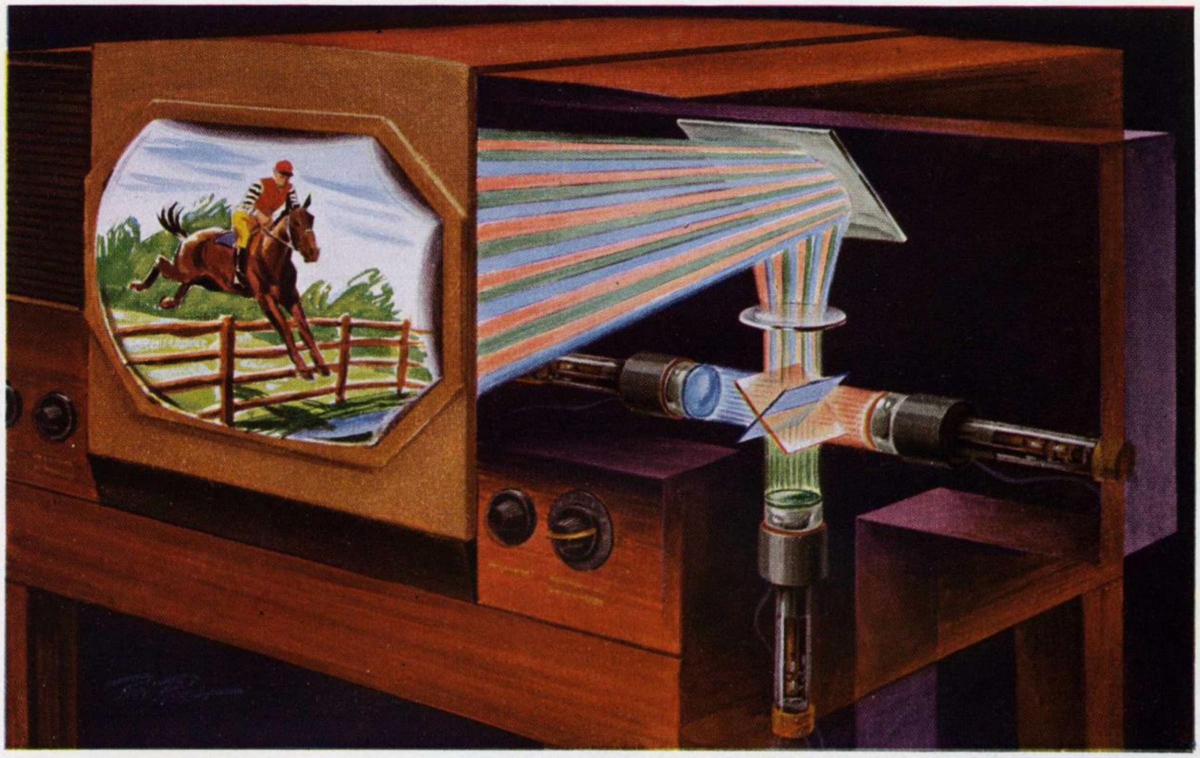

Fig. 17—Color converter using small projection kinescopes and refractive optics.

A direct-view converter using three 10-inch kinescopes is shown in Figure 16. Interconnections between the standard receiver and the converter are made by a simple harness cable plugged into the tube sockets of the standard receiver. (Reduction in cabinet size through the use of shorter kinescopes, previously mentioned in connection with the direct-view color receiver, applies as well to this color converter.)

A smaller color converter can also be made which gives a projected picture. Three 1½-inch projection tubes are mounted as shown in Figure 17. The complete kinescope and optical system assembly is mounted on the back of a standard television receiver, which can be either a table model or a console. The kinescope (any size) is removed from the black-and-white receiver and the color picture is projected, through the space it occupied, to a screen mounted in the normal picture-mask opening. An additional chassis containing the sampling circuits, deflecting circuits and power supplies is mounted under or back of the television receiver.

Figure 17 shows this system as applied to a color converter, but the principles apply equally well for a color receiver.

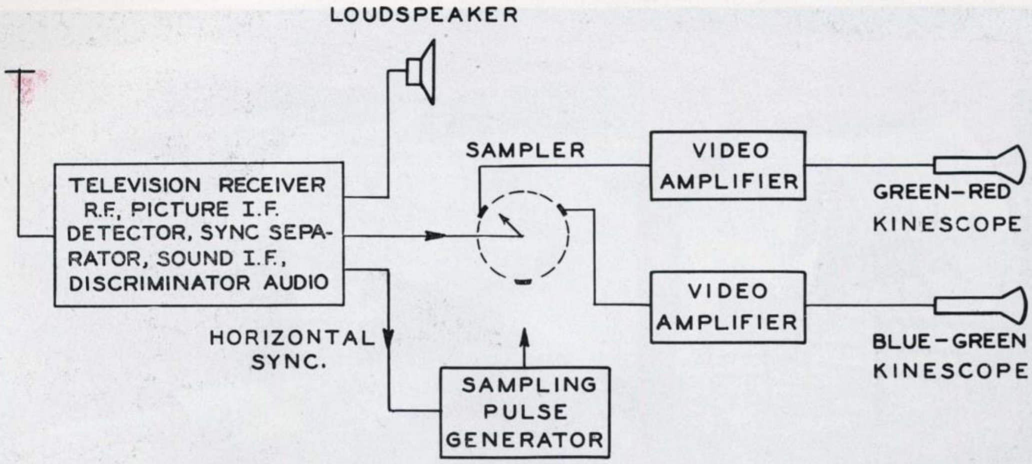

Fig. 18—Block diagram of two-color television receiver.

Two-Color Systems

Color transmissions can be received on a simplified receiver which reproduces the picture in two colors only, instead of three. The two colors used are green-red and blue-green.

A block diagram of such a receiver is shown in Figure 18. This system is similar to that shown in Figure 4 except that only two video channels are required, and the method of sampling the composite signal is altered.

With reference to Figure 3, it was explained that, for the three-color system, the composite signal was sampled for green at the instant the red and blue components were passing through zero. In like manner, it was sampled for red and for blue when the other two colors in each case were zero. Figure 19 represents the same signals as Figure 2 and shows the different positions of the sampling pulses for a two-color picture-reproducing system. The composite signal is sampled for blue-green at a time when both blue and green components are present in a positive direction. This is indicated by the line labeled *B-G*. The composite signal is sampled for green-red at a time represented by the lines marked *G-R*. As indicated in Figure 19, no sample is taken at the third point. The sampling is repeated for each of the two color combinations once each 0.263 microsecond.

After the composite signal is sampled, the two color signals are amplified in separate video amplifiers having frequency cutoff characteristics as described in connection with the three-color receiver. They are then impressed on the grids of their respective kinescopes.

In the case of a color converter for an existing black-and-white receiver, the black-and-white kinescope in the receiver is used with a suitable color filter placed in front of it. Another kinescope is added and viewed through a dichroic mirror and suitable color filter.

The color converter employing this two-color system is shown in Figure 20. All of the components of the standard black-and-white receiver are used, including the deflecting circuits and second anode power supply. The only equipment that is added is the second kinescope and the sampling circuit. Connections between the television receiver and the color converter are few and are easily made. The foregoing points to the possibilities for a very low-cost color converter.

The principle of the two-color system is illustrated in Figure 21.

The two-color picture-reproducing system is also applicable to a simple and inexpensive color receiver. In this case, however, the two kinesopes will be made with the proper color phosphors and no filters are required.

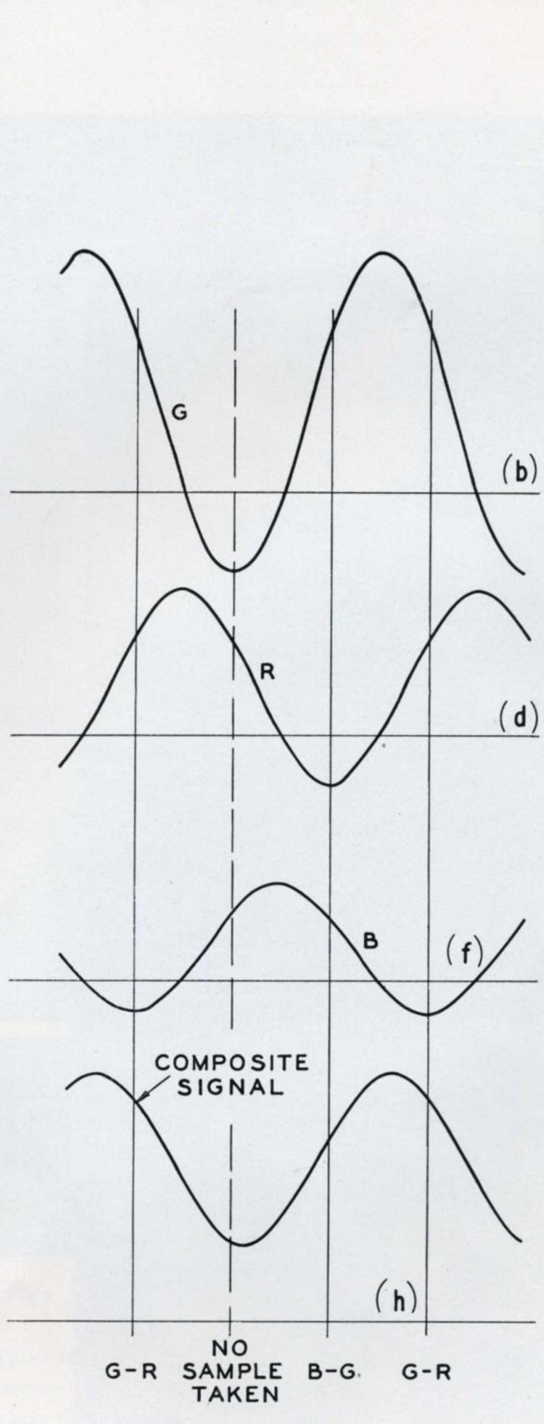

Fig. 19—Receiver sampling positions for the two-color system.

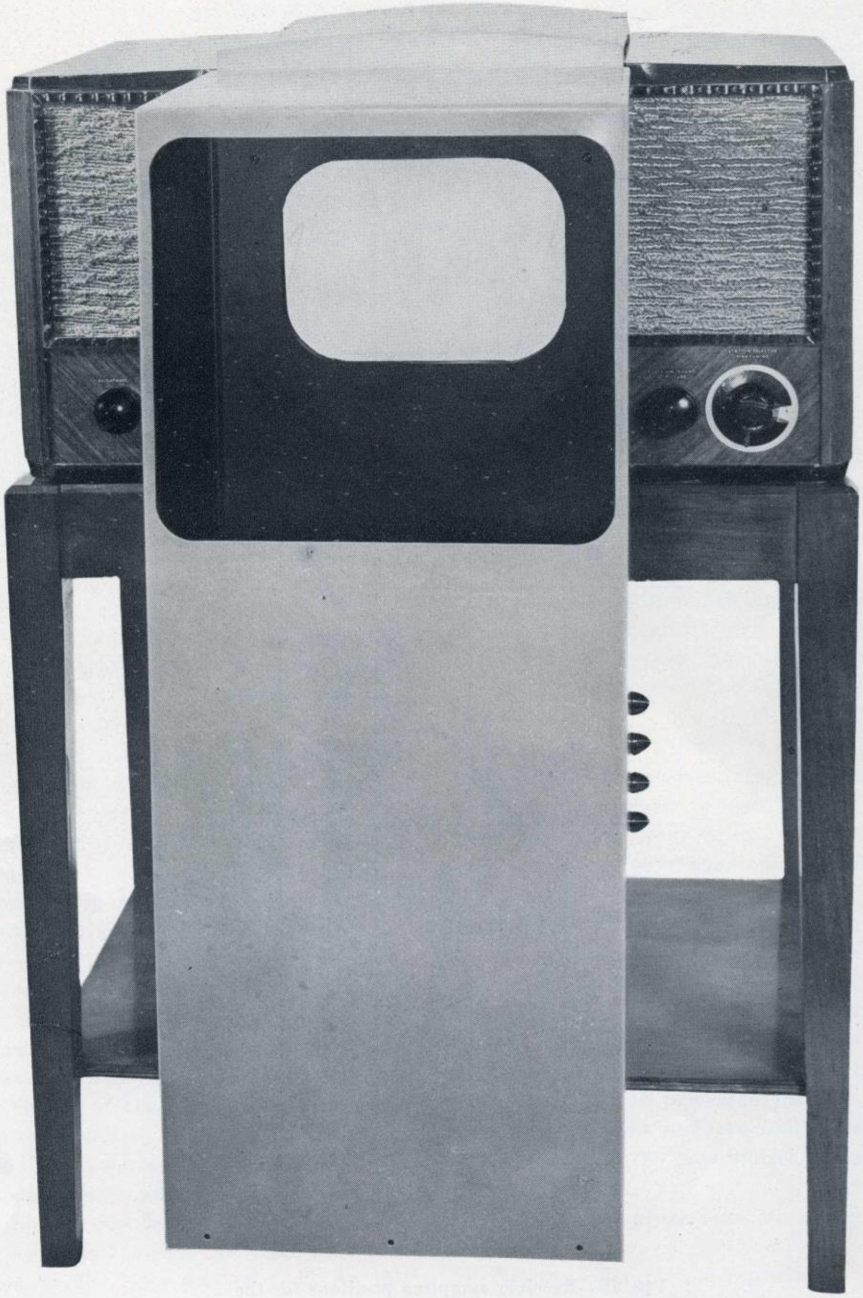

Fig. 20—Color converter using two-color picture-reproducing system.

Fig. 21—Two-color picture-reproducing system.

VI. Summary of System Characteristics

The all-electronic color television system described herein is a fully compatible system, employing the current standards of 525 lines, sixty fields per second, and line interlacing. It provides a high-definition color (and black-and-white) picture in the standard six-megacycle channel through the use of the mixed-highs principle and time-multiplexing with picture dot interlacing.

The transmitted signal is consistent with the "Standards of Good Engineering Practice Concerning Television Broadcast Stations." This is the fundamental basis for compatibility and means that a current monochrome receiver will respond in the same way as it would if a standard black-and-white camera originated the picture signal.

LIST OF ILLUSTRATIONS