

Oct. 2, 1945.

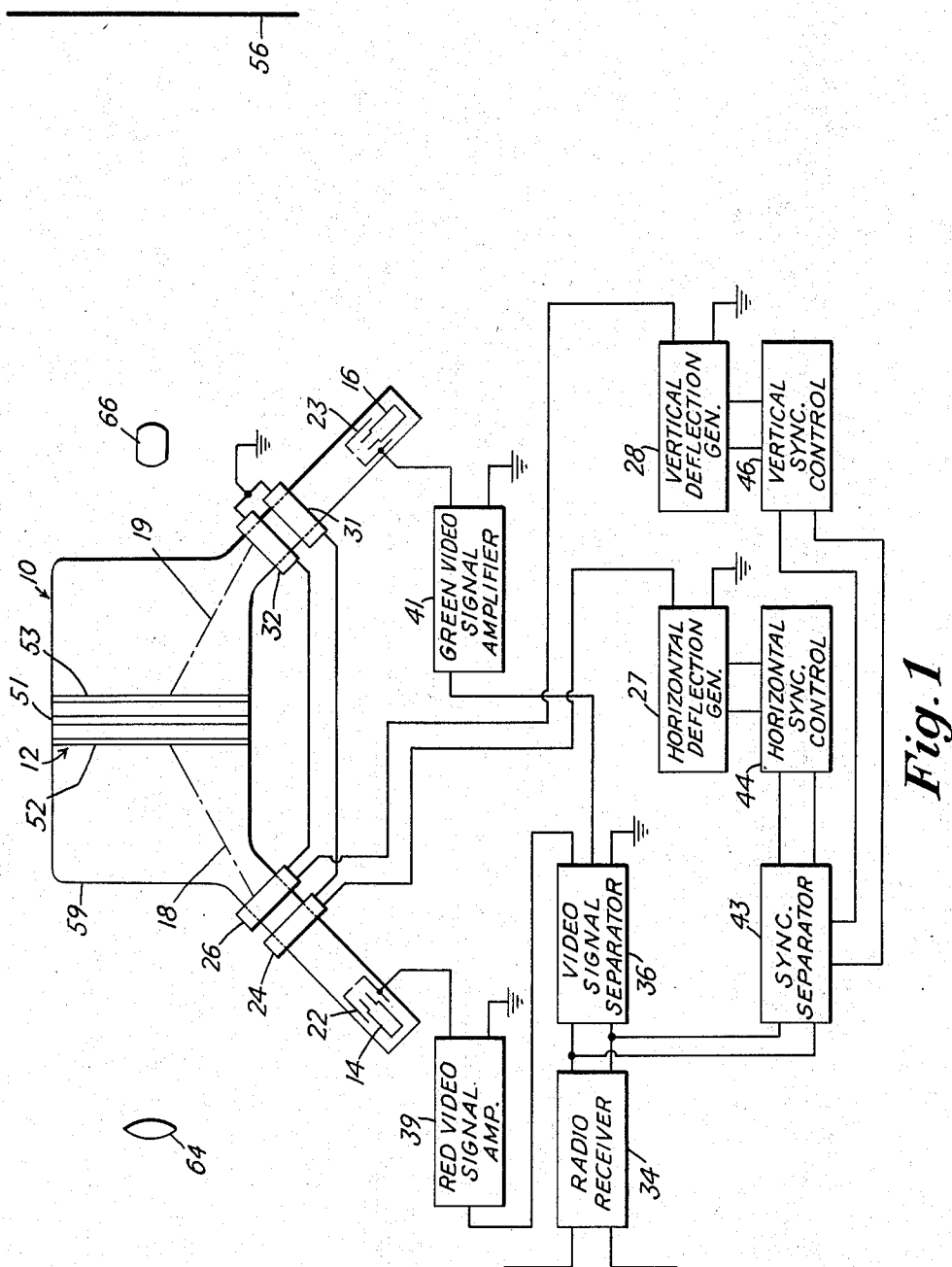
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2,386,074

COLOR TELEVISION

Filed Nov. 29, 1943

2 Sheets-Sheet 1



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Fig. 6



Fig. 5

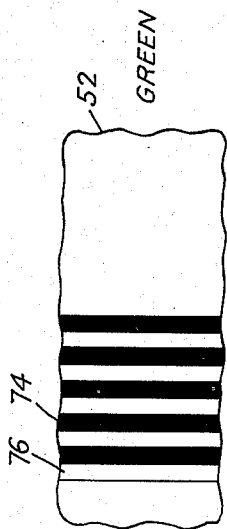
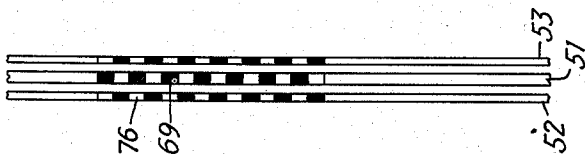


Fig. 2

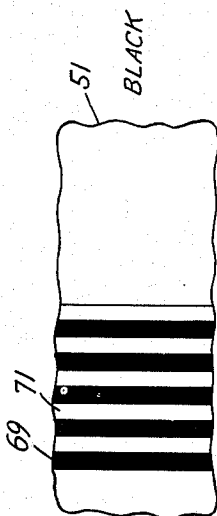


Fig. 3

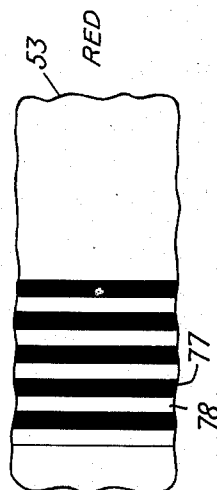


Fig. 4

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COLOR TELEVISION

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Application November 29, 1943, Serial No. 512,161

10 Claims. (Cl. 178—5.4)

The present invention relates to systems for the reproduction of television images in natural colors, and more particularly to a color television system in which signals representing different colors are generated and used simultaneously to reproduce an image in color.

In practicing the present invention, sets of modulated signals, each representative of the presence and intensity of one of the primary colors of the view or object to be transmitted, are derived by color separation apparatus at the transmitter by any known method and apparatus. These sets of modulated signals are transmitted simultaneously by any known method and are separated and applied at the receiver in a novel manner in accordance with this invention to provide a brilliant projected reproduction at the receiver.

Therefore, the primary object of the present invention is to provide a novel color television system capable of reproducing an image of a view or object brilliantly and in natural colors.

Another object of the present invention is to provide a novel color television system capable of reproducing an image of a view or object on a projection screen.

A further object of the present invention is to provide a novel television receiving system in which sets of modulated signals representing one or more colors control the amount and color of light transmitted from a light source to a viewing surface.

Still another object is to provide a novel image reproducing tube for reproducing images in natural color of a scanned object or view.

A further object of the present invention is to provide a novel light controlling device for transmitting light of a predetermined color and intensity.

A still further object of the invention is to provide a novel image reproducing tube having a light controlling device for transmitting light of a predetermined color and intensity.

The foregoing and other objects of the invention will appear from the following description of several illustrative embodiments thereof.

Fig. 1 is a diagrammatic showing of a system embodying the invention for reproducing an image in the natural colors of the original;

Figs. 2 to 6 illustrate in detail a portion of the apparatus employed in the system of Fig. 1.

In Fig. 1 there is shown a television receiving apparatus having an image reproducing tube 10, provided with a light controlling device indicated in its entirety by reference character 12, for pro-

jecting images in color in accordance with the invention. The tube 10 is equipped with two cathode ray gun structures 14 and 16 for developing beams of electrons 18 and 19. The gun 14 is provided with a control electrode or grid 22 for modulating the beam 18, and the gun 16 is provided with a grid 23 for modulating the beam 19. Horizontal and vertical deflecting coils 24 and 26 are connected to horizontal and vertical deflection generators 27 and 28 to produce scanning action of the beam 18 in a manner which is well known. The horizontal and vertical deflecting coils 31 and 32 associated with electron gun 16 are shown as being connected in series with the coils 24 and 26 so that the same deflection current traverses the two coils connected in series thereby simplifying the operation of the deflection system. It will be understood however that electrostatic deflection may be employed.

A television system arranged in this manner but having a fluorescent screen receiver tube and apparatus and circuits for obtaining television transmission and reception is shown in a patent to Bedford 2,191,121, granted February 27, 1940. The deflection and control circuits shown and described therein and in a patent to Vance, 2,137,039, granted November 15, 1938, or in a patent to Tolson et al, 2,101,520, granted December 17, 1937, may be employed in connection with the tube 10 of this invention. The various electrodes of the electron guns 14 and 16 of the tube 10 are to be supplied as usual with suitable operating potentials. This may be done as shown in the Bedford patent above referred to.

A radio receiver 34 suitable for the reception of television signals from a more or less distant transmitter and equipped with the usual selective circuits, amplifiers, and a demodulating device is connected as shown so that its output is furnished to a video signal separator 36. In the system selected for illustrating the invention, this arrangement is so designed that where incoming video signals are modulated in accordance with the several colors of the original subject, such as a view or object, these signals will be separated into two distinct sets, one representing the signals produced when the original is scanned through a red color filter, for example, and the other representing signals produced when the original is scanned through a green color filter, for example.

Signal separation of the red and green signals may be accomplished by transmitting these signals as modulations of two different frequencies and selecting these modulated frequencies by tuned circuits.

Transmitters for scanning images and objects in this manner are known and may comprise separate scanning devices, one for each color, operating synchronously; or the original view or object may be scanned sequentially in the manner shown in Patent No. 2,297,524, to E. I. Anderson, granted September 29, 1942. If the scanning arrangement shown in the Anderson patent is employed at the transmitter for developing signals representing two colors, for example, it will be understood that signal storage will be necessary at either the transmitting station or at the receiver to store one of these sets of color modulated signals so that it may be released simultaneously with reception of the other color modulated signal so that the grids 22 and 23 of the tube 10 will be affected simultaneously with signals representing different colors. Signal storage may be accomplished by providing separate storage equipment, or by relying on the capability of modern camera tubes to store signals. An example of such a modern tube is the "Orthicon."

As shown in the illustrative example, modulated signals representing the red portion of the original are amplified in a video signal amplifier 39 and are applied to the grid 22. Likewise, the remaining signals representing a different color, for example green, are applied to the grid 23 by way of video signal amplifier 41.

The demodulated signal from the radio receiver 34 is applied in the usual manner to a synchronizing separator 43 which separates the horizontal and the vertical pulses normally present in the demodulated television signal so that these may be applied to the horizontal and vertical synchronizing controls 44 and 46 respectively to control the operation of the previously mentioned horizontal and vertical deflection generators 27 and 28. This general arrangement for synchronizing a receiver is shown in detail in the Bedford patent referred to above and has been described herein merely for the sake of completeness of the disclosure.

The light controlling arrangement 12 referred to previously comprises a fixed screen or raster 51 and radiant energy sensitive screens or rasters 52 and 53. The relative positions of these rasters and the marks thereon are shown in Figs. 5 and 6 of the drawings, Fig. 6 illustrating the operation of the light controlling device. It will be understood that Figs. 5 and 6 may be considered as sectional views of the light controlling arrangement 12, as viewed from a position above the tube 10 in Fig. 1 of the drawings. The position of the tube and the angular position of the light controlling device in the tube may, of course, be varied.

Figs. 2 to 4 of the drawings taken together may be considered as a vertically exploded view of the light controlling arrangement 12. The stationary raster 51 and the radiant energy sensitive rasters 52 and 53 are similar to the stationary and radiant energy sensitive rasters disclosed and claimed in applicant's copending application, Serial No. 512,160, filed Nov. 29, 1943, entitled "Method of and apparatus for producing luminous images." In order that the disclosure of the present invention may be complete, the description of the several rasters 51 to 53 will be given in detail.

In the tube 10, radiant energy for physically distorting the light sensitive rasters 52 and 53 is obtained from the beams 18 and 19, and the small area which is to be distorted is selected by

moving the beam. Therefore, it will be seen that since the successive positions of both of the beams are controllable in Fig. 1, the distortion will occur in small selected successive areas. The beams 18 and 19 are preferably moved concurrently and impinged on small areas on each side of the device 12 which are in register or substantially in register so that an image substantially in the natural colors of the original may be projected by light transmission upon a viewing screen 56.

Light for this purpose which is projected through the transparent wall 59 of the tube onto the light controlling device 12 is obtained from a light source 58. A reflector 62 and a light condenser 64 concentrate the light and also insure a uniform distribution of the light on the surface of the device 12. A lens or lens combination or diffusor 66 projects an image of the device 12, or at least luminous portions thereof, onto the screen 56. With diffused light behind the light controlling device, the picture in colors may be viewed directly.

By selecting the different elements of the optical arrangement shown by way of example, the size of the image on the screen 56 may be controlled with respect to the size of the light controlling device 12. It will be understood that the diagrammatic showing of Fig. 1 is not intended to indicate with accuracy the optical train involved or the relative size of the parts. For example, the screen 56 and the image on the screen may be very large in proportion to the total area of the light controlling device 12.

The stationary raster 51 may, for example, be formed by employing a sheet of transparent or translucent substance, such, for example, as glass, mica, transparent or translucent plastics, or a wire mesh, etc. An opaque substance (Figs. 3, 5, and 6) of any kind is applied to the surface of the material comprising the raster 51. It will be seen from Fig. 3 that this opaque substance is applied in the form of strips 69 so that these strips alternate with transparent strips 71. This substance may be applied photographically or by any known contact printing process, such as typographical or intaglio printing or by a lithographic process. The rasters 52 and 53, shown more in detail in Figs. 2 and 4 respectively, which are radiant energy sensitive, and more particularly, physically deformable upon impingement of a cathode ray beam, are preferably in the nature of thin supported or unsupported films. As an example, each of the films composing the rasters 52 or 53 may be $1/50,000$ of an inch thick for good results in colored image reproduction. It will be understood, however, that the figure given is not intended as limiting the invention. The thickness may vary within wide limits, and numerous factors such as the radiant energy beam intensity will be considered in determining the thickness of either deformable raster for a given purpose.

The material of which each raster film 52 or 53 is composed is selected primarily in view of its high temperature coefficient of expansion. The film may be composed of cellulose acetate, cellulose nitrate, or a film of gelatin. A liquid known as "Parlodeon," obtainable commercially, gives good results in practice.

In preparing the film with "Parlodeon," the commercially obtainable liquid may be poured on water so that it forms a thin film on the surface of the water. This thin film may be lifted from the surface of the water upon which it floats. Cellulose acetate and cellulose nitrate are ob-

tainable commercially in thin film form, and self supporting gelatinous films are also obtainable. The radiant energy sensitive raster 52, however it may produced, is provided with marks or strips 74 (Fig. 2) alternating with the strips 76 of the exposed translucent film material. For the raster 52 in a two color television system such as is illustrated by way of example in Fig. 1, the coating material of the strip 74 is green in color so that green light or approximately green light is transmitted through these strips. The radiant energy sensitive raster 53 is also provided with marks or strips 77 alternating with the strips 78 of the exposed transparent or translucent film material. The material forming the strips 77 is red in color so that red light or approximately red light is transmitted by these strips when this raster is used with the raster 52 in the two color system shown by way of example. Referring to Fig. 5, it will be seen that the rasters 52 and 53 are located with respect to the raster 51 so that the opaque strips 69 on the raster 51 register with the transparent strips 76 and 78 of the rasters 52 and 53. For purpose of illustration, the marks or strips 69, 74, and 77 are shown as completely impregnating the material of each raster. However, as pointed out above, it will be sufficient for the purpose of the invention, if these strips are merely printed on the surface of the raster.

Figs. 5 and 6 taken together in conjunction with Fig. 1, illustrate the principle of operation of the light controlling device to reproduce colored images. Assume, for example, that two-color television signals are being received by the radio receiver 34, these signals representing the red portions and green portions respectively of the field of view or object scanned at the transmitter. These signals will be separated during operation in known manner by the signal separator 36. The signals representing the red portions of the original subject are amplified, if desirable or necessary, in the amplifier 39 and are applied to the grid 22 of the electron gun structure 14 associated with the green raster 52. The signals representing green portions of the original are or may be amplified in the amplifier 41 and applied to the grid 23 of the electron gun structure 16 associated with the red raster 53. The beam deflection means 24 and 26 and 31 and 32, associated with each gun structure, cause the cathode ray beams 18 and 19 to simultaneously scan the device 12. The beam 18 scans the raster 52, and the beam 19 scans the raster 53. Also, while the light filters and rasters are bluish-green and orange-red they are referred to as green and red for convenience.

While reference is made herein to red portions of the original and green portions of the original and signals representing these portions, it will be understood that these signals also are generated in varying degrees of modulation by varying shades or hues of green and red.

When the electron beams 18 and 19 are cut off from both guns by a blanking voltage or other blanking means, the screen 56 will appear dark since substantially no light will get through the triple raster. When the beam 18, controlled by the red signals, impinges on the green raster 52, it will open up in relation to the other rasters in the manner shown in Fig. 6 of the drawings by reason of heat expansion. A spot of red light will then appear on the screen 56. In a like manner, when the beam 19 heats the red raster 53 under control of the green signals, the red raster

will open up in relation to the other rasters and a green spot will appear on the screen 56. According to the amount of red and green light transmitted, combinations representing other colors present in the original may be obtained. These combinations of colors may be designated as "beat colors."

With the red raster 53 open, the opening of the green raster 52 to various degrees will produce different shades of green to white through pale greens.

With the red raster 53 closed, the observed color will go from green to black through the dark greens. When the green raster is completely open, shades of red from white through pink may be obtained.

With the red and green rasters open completely, a bright yellow will be obtained. As the red and green rasters close, the observed colors will be tan, brown, and black.

The lines on each raster within the aspect ratio may be greater in number than the number of horizontal lines into which the image of the viewed subject is divided or the horizontal lines multiplied by the aspect ratio, in which case the vertical line structure of the device 12 will not limit the resolution to a degree greater than it is limited by the horizontal lines.

Where interlaced scanning is employed of the character described in a patent to Ballard, No. 2,152,234, granted March 28, 1939, the thermal capacity of the red and green raster can retain its deformation during the cycle of interlacing when the beam is cut off. In this manner the guns 18 and 19 may operate alternately as the optical effect will be the same in accordance with the invention as though these beams operated concurrently.

For more rapid cooling, and therefore for less image persistence, the raster 51 may be used as a heat conductor, and it may, in order to enhance this effect, be provided with radiating fins on the outside of the tube 10.

Where the interlaced scanning system is employed for interlacing the red and green scanning cycles, the deflection coils connected in series, as shown, provide for the same current flowing in each series connected deflecting coil, and therefore interlacing of successive red and green scanings will be obtained in a simple and effective manner.

As disclosed above and also in the copending application referred to herein, it is possible to provide the lines upon the several rasters by a photographic process. In order that this may be done accurately, a large screen may be provided which has alternate dark and light stripes of suitable width thereon. A much reduced image of this screen may be projected upon a sensitized sheet of material which is to be used for any one of the rasters, and the latent photographic image may then be developed so as to provide alternate transparent strips and dark or colored strips which have the desired degree of fineness in spacing and in width. The rasters 52 and 53 can be given the desired color by tinting them to the required colors or converting a silver image raster or screen structure into an appropriately colored dye image by methods well known in the color photographic art.

Various modifications of the system shown and described herein by way of example are possible without departing from the spirit and scope of the invention described herein, and it is desired that any and all of such modifications be considered

within the purview of the present invention defined by the hereinafter appended claims.

Having now described the invention, what is claimed and desired to be secured by Letters Patent is the following:

1. In a system for reproducing images in color, a source of illumination, a viewing screen, a light controlling device interposed between said screen and said source, said light controlling device including a relatively undistortable screen, a red screen distortable on application of heat and a green screen distortable on application of heat, means for heating said red screen in successive localized areas under control of a green image signal modulated heat source, and means for heating said green screen in successive localized areas under control of a red image signal modulated heat source whereby to produce in cooperation with said relatively undistortable screen a luminous image in colors on said viewing screen.

2. In a system for reproducing images in color, a source of illumination, a viewing screen, a light controlling device interposed between said screen and said source, said light controlling device including a relatively undistortable screen, a red screen distortable on application of heat and a green screen distortable on application of heat, means for heating said red screen in successive localized areas under control of a green image signal modulated heat source, and means for simultaneously heating said green screen in the same successive localized areas under control of a red image signal modulated heat source whereby to produce in cooperation with said relatively undistortable screen a luminous image in colors on said viewing screen.

3. In a system for reproducing images in color, a source of illumination, a viewing screen, a light controlling device interposed between said screen and said source, said light controlling device including a relatively undistortable raster, a distortable red raster and a distortable green raster, means for scanning said red raster with a green image signal modulated cathode ray, and means for scanning said green raster with a red image signal modulated cathode ray whereby to produce in cooperation with said relatively undistortable screen a luminous image in colors on said viewing screen.

4. In a system for reproducing images in color, a source of illumination, a viewing screen, a cathode ray tube having therein a light controlling device interposed between said screen and said source, said light controlling device including a relatively undistortable raster, a distortable red raster and a distortable green raster, means in said tube for scanning said red raster with a green image signal modulated cathode ray, and means in said tube for scanning said green raster with a red image signal modulated cathode ray whereby to produce in cooperation with said relatively undistortable screen a luminous image in colors on said viewing screen.

5. In a color television system, means for receiving signals representing portions of a given color of an image, means for receiving signals representing portions of another given color of the image, a cathode ray tube having scanning means providing a scanning ray, means for modulating the ray from said scanning means by one set of said received signals, a multiple light valve comprising sections expandable upon application of heat thereby to be responsive to radiant energy in said tube having one element thereof responsive to said ray and capable of passing light of

a predetermined color upon activation by said ray, a second scanning means in said tube providing a second scanning ray, said multiple light valve having a second ray sensitive element therein responsive to said second ray and capable of passing light of a predetermined color upon activation by said second ray, means for modulating said second ray with signals representing said second color, and means for illuminating said multiple light valve whereby a luminous image is produced upon concurrent activation of said ray responsive elements of said multiple light valve by said scanning rays.

6. In a color television system, means for receiving signals representing red portions of an image, means for receiving signals representing green portions of the image, a cathode ray tube having scanning means providing a scanning ray, means for modulating the ray from said scanning means by said received red signals, a multiple light valve comprising sections expandable upon application of heat thereby to be responsive to radiant energy in said tube having one element thereof responsive to said ray and capable of passing green light upon activation by said ray, a second scanning means in said tube, said multiple light valve having a second ray sensitive element therein responsive to said second ray and capable of passing red light upon activation by said second ray, means for modulating said second ray with said green signals, and means for illuminating said multiple light valve whereby a luminous image is produced upon concurrent activation of said elements of said multiple light valve by said scanning rays.

7. A color determining light valve comprising a fixed element, a deformable element disposed on one side of said fixed element, said deformable element permitting light of a given color only to pass upon deformation thereof, and a second deformable element on the other side of said stationary element, said second element permitting light of another given color to pass upon deformation thereof.

8. A color determining light valve comprising a fixed screen element having alternate opaque and light transmitting portions, a radiant energy sensitive deformable element disposed on one side of said fixed element, said deformable element permitting light of a given color only to pass upon deformation thereof, a second radiant energy sensitive deformable element on the other side of said stationary element, said second element permitting light of another given color to pass upon deformation thereof.

9. The light valve of claim 8 in which said deformable elements are in the form of a membrane having a degree of thinness such that it expands readily upon impingement of a cathode ray beam.

10. A color determining light valve comprising a fixed screen element having alternate opaque and light transmitting portions, a deformable element disposed on one side of said fixed element having alternate opaque and red light transmitting portions, said deformable element permitting red light to pass upon deformation thereof, and a second deformable element on the other side of said stationary element having alternate opaque and green light transmitting portions, said second element permitting green light to pass upon deformation thereof, said red and green light transmitting portions being disposed in register with said light transmitting portions of said fixed screen element.

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