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COLOR TELEVISION SYSTEM

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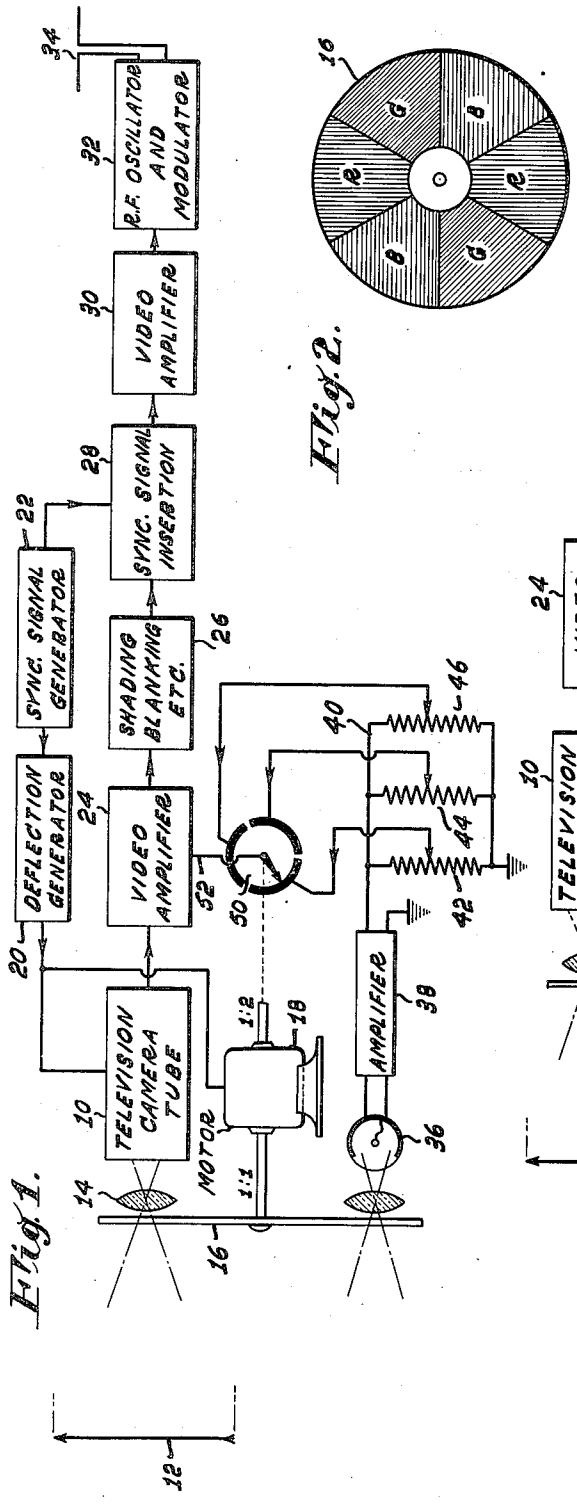


Fig. 1.

Fig. 2.

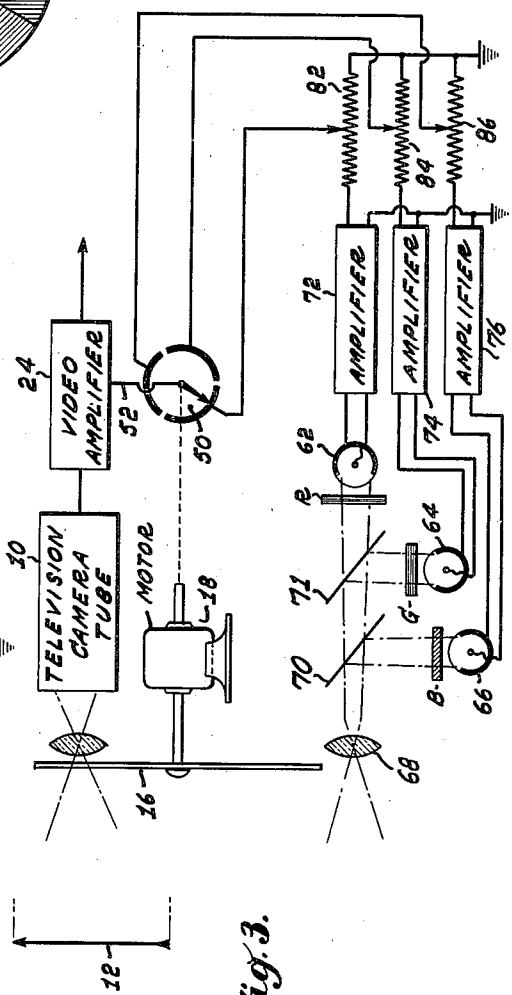


Fig. 3.

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COLOR TELEVISION SYSTEM

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11 Claims. (Cl. 178—5.4)

This invention relates to an improvement in television transmitters and, more particularly, to color television transmitting systems.

In the transmission of color television images, the image is generally separated into three color components, and image signals are generated which are indicative of these three color components. The television image signals may be transmitted simultaneously over three channels or sequentially over a common channel. The latter method of transmission is frequently used at present.

In the production of television image signals representative of the three color components, a television image pickup or camera tube is employed for converting light values into electrical values. A light image of one or another of the color components is projected on the television pickup tube and, by appropriate scanning means, signals are then generated which are indicative of the light value of that particular color image. Where sequential transmission of signals is employed, a single television image pickup tube may be used and optical images of the different color components may be sequentially projected upon the light responsive electrode of the television pickup tube.

In order that the optical images may be sequentially projected upon the light responsive electrode of the image pickup tube, a color filter disc, drum or similar apparatus is generally employed, the color filter disc or drum being located in the optical axis of the television camera. When the color disc or drum is rotated in synchronism with one of the deflection rates, generally the field deflection rate, a series of television image signals is generated which are sequentially representative of the plurality of color components of the subject matter to be transmitted.

By reason of the fact that the filters used in the filter disc or drum do not transmit light with the same degree of efficiency, and by reason of the fact that the television pickup tube does not have equal response for all color components, or because of variations in the electrical performance of the circuits through which the video signals pass, the television image signals generated by the television image pickup tube may not occur in their proper relative signal strengths in order to produce a properly color balanced television image. Various other factors enter into the production of the television image signals and control the relative signal strengths of the television image signals generated for each differently colored image.

In order that the produced television image may be properly balanced with respect to color, it is generally necessary to include at the television transmitter some means for individually altering the intensity of the television image signals representative of a particular color with respect to the signals representative of another particular color. In other words, a single television image signal or video signal amplifier operating at uniform over-all gain cannot be completely satisfactorily employed where a proper balance of color is desired at the receiver and, as a result, it is necessary to provide some compensatory measures whereby the relative signal strengths of the produced video signals may be altered so that the desired results may be accomplished at the television receiver.

It has been proposed to employ a single video amplifier channel in the television transmitter and sequentially to alter the over-all gain of the video amplifier channel so that signals representative of a particular color may be amplified to a greater or lesser extent than signals representative of another color. Such a mode of operation, therefore, requires that the gain of the single video amplifier channel be sequentially altered in synchronism with the projection of differently colored optical images on the light responsive electrode of the television image pickup tube and in synchronism with the production of television image signals representative of these separate color components. Such a system is shown and described in Goldsmith application, Serial No. 418,109, filed November 7, 1941.

In one form of the present invention an automatic gain control potential is developed, and selectable portions of the developed automatic gain control potential are sequentially applied to the video amplifier thereby to sequentially alter the gain of the amplifier. This sequential application of varying degrees of the developed automatic gain control potential is synchronized with respect to the production of the television image signals so that the amplification to which the produced signals are subjected by the video amplifier may be sequentially altered to produce proper balance of color in a reproduced image.

The automatic gain control potential is developed from a light responsive element or photoelectric cell, and light from the subject matter to be televised is permitted to fall on the light responsive element through a color filter disc or drum which may, in actual practice, be the same

color filter disc or drum used in connection with the television image pickup tube.

In another form of the present invention, three separate automatic gain control potentials are developed, the development of each potential being in response to light or an optical image projected upon separate light responsive cells through stationary color filters corresponding to the color components projected upon the light responsive electrode of the television image pickup tube. Of the developed automatic gain control potentials indicative of each color component, a predetermined portion of the developed potentials may be used and applied sequentially to the video amplifier channel associated with the television transmitter.

It is, therefore, one purpose of the present invention to provide in a color television transmitting system means whereby the intensity of the television image signals representative of the different color components may be independently altered in order to produce a desired color balance in a television receiver.

Another purpose of the present invention resides in the use of a single video amplifier channel in a television transmitter for amplifying television image signals representative of different color components of an optical image, together with means for sequentially altering the gain of the video amplifier in order that signals representative of one particular color component may be amplified by a greater or lesser percentage than signals representative of another particular color component.

Still another purpose of the present invention resides in the provision of means for generating a cyclically varying automatic gain control potential for sequentially altering the gain of a video amplifier channel in a color television transmitting system in order that a properly balanced color television image may be reproduced.

Still a further purpose of the present invention resides in the provision of means in a color television transmitting system whereby a sequentially varying automatic gain control potential may be produced in response to the projection of light or an optical image upon a light responsive element, the light responsive element being separate and distinct from the television image pickup tube.

A still further purpose of the present invention resides in the provision of a plurality of light responsive elements corresponding in number to the number of color components transmitted in a color television transmitting system, each of the separate light responsive elements being provided with different color filters so that different automatic gain control potentials may be independently developed, portions of which are sequentially applied to a video amplifier channel in the television transmitter for producing proper color balance in a reproduced color television image.

Various other purposes and advantages may become more apparent to those skilled in the art from the following detailed description, particularly when considered in connection with the drawing, wherein like reference numerals represent like parts and wherein:

Figure 1 shows one form of the present invention;

Figure 2 shows in detail an example of a scanning disc which may be employed in connection with the apparatus shown in Figure 1; and

Figure 3 shows a modification of the present invention.

Referring now to the drawing, and more particularly to Figure 1, there is shown a television image pickup or camera tube 10 which may be of the "Orthicon" or "iconoscope" type, and this tube performs the function of converting an optical light image into a series of television image signals. An optical image of an object 12 to be televised is projected upon a light responsive surface of the television image pickup tube 10 by an optical system shown generally at 14, and interposed in the optical system is a filter assembly represented in the drawing as disc 16. This disc, as shown more specifically in Figure 2, comprises a plurality of different color or light filter elements, and in the particular illustration of Figure 2 the filters are arranged in pairs. The color filter disc 16 is shown merely by way of example, since it is conceivable that a color filter drum or similar color filter supporting means may be employed. The color filter disc 16 may be assumed, for a tricolor additive system, to be composed of separate color filter areas of red (R), green (G), and blue (B), which are the generally selected colors. In a two-color system, the colors may be reddish orange and a bluish green, with the disc then preferably formed into four segments of two pairs of colors.

The color filter disc is rotated by means of a motor 18, and in order that the picture signals for each succeeding field deflection of the television image pickup tube may represent different color components of the subject matter to be televised, the rotation of the motor 18 must be synchronized and properly phased with respect to the deflections of the cathode ray beam in the television pickup tube.

For this purpose a deflection generator 20 of any suitable and known form is employed for generating both the line and frame deflection potentials, and energy from the deflection generator is supplied to the motor for maintaining the desired synchronous and phase relationship between the rotation of the color filter disc and the operation of the television image pickup tube. The deflection generator 20 is supplied with energy from a synchronizing signal generator 22 which operates to produce the desired synchronizing signals for maintaining synchronous operation between the transmitter and receiver.

The developed television image signals are supplied to a video amplifier channel 24 where their signal intensity is increased, and the output from the video amplifier may be supplied to a control circuit where signal shading, return line blanking and other corrections may be applied, if necessary. Shading is generally desirable to some extent where television pickup tubes of the "iconoscope" type are used, and a blanking of the picture signals during the beam return time interval is generally desirable in order to produce a desired image signal series.

The output from the correction control circuit 26 is then supplied to a synchronizing signal insertion circuit 28 where the synchronizing signals, as produced by the synchronizing signal generator 22, are combined with the television image signals to produce a complete composite television video and synchronizing signal which may be applied to a further video amplifier 30. The output of this amplifier may then be used to control the modulation of a radio frequency oscillator 32 which, in turn, supplies energy to an appropriate transmitting antenna 34.

If television image signals were at all times developed in their proper relative intensities for each of the plurality of color components of the subject matter televised, then no correction of the relative signal strengths of the image signal would be necessary and the produced signals could be transmitted using a more or less conventional television transmitting system. Due to the lack of linearity in light transmitting efficiency of the optical system over the entire color range, and due to the lack of uniform color response of the television image pickup tube, signals representative of one color component are developed in an intensity greater or less than that necessary to produce a properly balanced television image at the receiver. As a result, some means must be provided, as explained above, for changing the relative intensities of the television image signals representative of different color components of the subject matter televised.

For this purpose a control potential is preferably applied to the video amplifier 24 in the form of an automatic gain control potential, and this potential may operate to alter the gain of the amplifier tubes contained in the amplifier in a manner similar to the operation of automatic gain control in a conventional radio receiver.

The automatic gain control potential is normally applied to the control electrode of one or more of the amplifier tubes in the video amplifier to alter the average or direct current potential of the control electrode of the controlled tube or tubes relative to its associated cathode. For generating the automatic gain control potentials, a light responsive device or photocell 36 is provided, the output of which is supplied to an amplifier 38. In order that the light responsive element 36 may develop potentials sequentially representative of the different color components of the object to be televised, the light responsive element is positioned in back of a color filter disc, and for simplicity it is possible to use the same disc 16 as is used in connection with the television pickup tube.

Since the disc comprises, for example in the schematic form shown, a total of six color filters arranged in pairs of three different colors, the light responsive element 36 may be positioned diametrically across the disc with respect to the disc area through which light passes to the television image pickup tube so that when light of any particular color is being projected on the light responsive electrode of the television image pickup tube, light of the same color is being projected upon the photo-cathode of the light responsive element 36. This light originally emanates from the object area whose image is focused upon the television image pickup tube 10. The intensity of this light will then produce a corresponding potential in the load circuit of the light responsive element, and when this potential is suitably amplified, it is then impressed upon conductor 40. Since this potential remains substantially fixed throughout practically an entire field deflection cycle and corresponds to an integration of the light over the entire object area, it is desirable that the amplifier 38 be in the form of a direct current amplifier in order that no attenuation of the signal may result. The time constant of the system 36, 38, 40, 42, 44, and 46 should be so arranged as to cause the system to respond essentially to light from one field scanning duration or period, or less, only. Thus the potentials on conductor 40 follow the sequence of field scannings.

The output signal or the automatic gain control potential produced thereby will, therefore, fluctuate or have a different value for each succeeding field cycle by reason of the fact that a different color filter is interposed in the optical axis of the light responsive element 36. A cyclically varying potential will, therefore, be developed on conductor 40 which has a time period corresponding to the field deflection rate and which is repeated for each color repetition cycle. In general, it is helpful if the color sensitivity of photocell 36 is similar to that of the image pickup tube 10.

The potentials which are developed on conductor 40 for each succeeding frame cycle may not, in fact, be the required automatic gain control potential necessary in the video amplifier 24 for obtaining the proper relative signal strengths to assure proper color balance in the receiver. Accordingly, three separate potentiometer elements 42, 44, and 46 are connected between the conductor 40 and ground (or some other point of fixed potential), and the movable contacts of these potentiometers are connected to 120° segments of a commutating device 50. Associated with the 120° segments of the commutating device is a movable arm or contact which cooperates with the signals, and this movable arm is preferably driven by the motor 18 in order to assure the desired synchronous operation. If the segments occupy approximately 120°, then one complete revolution of the contact arm is necessary for each half revolution of the color filter disc 16 and, as a result, the rotational speed of the contact arm should be twice that of the color filter disc.

The movable contact arm is connected to the control electrodes of one or more of the amplifier tubes in the video amplifier 24 by means of conductor 52 and, as may be seen in Figure 1 of the drawing, conductor 52 is sequentially connected to the movable contact points of potentiometers 42, 44 and 46. By an adjustment of the movable contacts along the potentiometer elements 42, 44 and 46, varying degrees of the developed automatic gain control potential available at conductor 40 may be supplied to the conductor 52 and to the video amplifier 24, so that the gain of the video amplifier 24 may be altered for each field frame, the extent of the gain for any particular field cycle being determined by the position of the movable contact along the potentiometers 42, 44 and 46.

The gain of the video amplifier 24 will, therefore, be controlled cyclically by the potential developed on conductor 40, and, as stated above, the gain of the amplifier may be determined by the setting of the movable contacts along the potentiometer control elements. The gain of the amplifier will, therefore, be cyclically controlled and will remain substantially constant for any particular color, assuming there is no change in the light intensity or color content of the subject matter being televised.

If, however, the lighting in the studio or the light present on the subject matter, regardless of its location whether outside or within a studio, is altered in any respect a corresponding change will be present in the potential developed on conductor 40. To assist in compensating for such fluctuations or variations, the use of the separate light responsive element 36 and the circuit arrangement as shown in Figure 1, there-

fore, compensates not only for lack of proper color balance but also compensates, at least in part, for light intensity fluctuations insofar as the lighting of the subject matter is concerned.

Any desired color balance within limits may be obtained by an independent adjustment of the movable contacts associated with potentiometers 42, 44 and 46, and since virtually no current will be present in conductor 52, an adjustment of any one of the three potentiometers does not have any appreciable effect upon the remaining potentiometers or their adjustments. Accordingly, the color intensity of any particular color may be conveniently altered without appreciably or noticeably affecting the intensity of the other colors involved in the color television system.

A modification of the invention described above and shown in Figure 1 is represented in Figure 3, wherein a television image pickup tube 10 is shown which produces television image signals which are applied to a video amplifier 24. A color filter disc 16 is employed, as in Figure 1, and this disc is rotated by means of motor 18. The remaining portion of the television system is not shown in Figure 3 for the sake of simplicity, but any appropriate and desired system may be employed.

In Figure 3, three separate light responsive elements 62, 64 and 66 are employed, each of which receives light from the subject matter televised. The use of the three light responsive elements is based on the assumption that a tricolor television system is moved, but the number of light responsive elements will naturally be chosen in accordance with the number of color components employed in the color television system.

It is possible to project light from the televised subject matter upon all three light responsive elements by means of a common lens system 68 if an appropriate optical system is used. In the particular arrangement shown in Figure 3, light from the subject matter is projected by means of lens 68 upon the light responsive element 62 through a pair of partially silvered reflectors 70 and 71 and also through a red filter R. Light from the subject matter is also directed upon the light responsive element 64 through partially silvered reflector 70, and by reflection from the reflecting surface 71 through the green filter G. Similarly, light is permitted to fall upon the light responsive element 66 by reflection from the reflecting surface 70 after transmission through the blue filter B. It is not necessary that a well focused object image be projected on the photo-cathode of the light responsive elements 62, 64 and 66, but should a semblance of or approximation to a focal condition be desired, it is necessary that the optical displacement of the light responsive elements from the lens 68 be maintained substantially identical. Accordingly, the position of the light responsive elements should be chosen in accordance with the focal length of the lens system 68.

The outputs from the three (or the plurality of) light responsive elements are supplied individually to separate amplifiers 72, 74 and 76 which, as in Figure 1, are preferably direct current amplifiers. The output from each of the amplifiers is then applied across the resistance element of separate potentiometers 82, 84 and 86. The movable contacts of these potentiometers are then connected to a distributor 50 similar to the distributor shown and described in connection with Figure 1, in order that the automatic gain control potentials developed by each light responsive element may be individually and sequentially applied to the video amplifier 24 by way of conductor 52. To obtain the desired color balance, it is merely necessary to alter the position of the movable contacts associated with potentiometers 82, 84 and 86, and once a desired color balance is obtained, such a balance will be retained regardless of lighting conditions within normal limits.

In the system shown in Figure 3, it is not necessary to employ the color filter disc insofar as the color balance system is concerned since separate light filters R, G, and B for red, green, and blue, respectively, are provided, each individually associated with a separate light responsive element. The light responsive elements may, therefore, be positioned at any desired or strategic position with respect to the television pickup tube or the television camera, although naturally it is desirable to have both elements in approximately the same location in order that approximately the same lighting effects are present at both the camera and the automatic gain control device.

If a single or common lens system 68 is not desired, separate lenses may be employed for each of the plurality of light responsive elements 62, 64 and 66. Since the light which is permitted to fall on the light responsive elements shown in Figure 3 does not pass through the color filter disc 16, the disc may be made of three color filter sections (or any multiple thereof) for a tricolor system, or in multiples of two for a bicolor system, and the ratio of speed of the movable contact arm of the potentiometer with respect to the speed of rotation of the color filter disc should naturally be chosen in accordance with the relative number of color segments on the disc and the relative number of conducting segments on the commutator.

Mechanically operated commutators 50 are shown in Figures 1 and 3, but it is to be understood that in a practical television system electronic switching would preferably be employed for reasons obvious to those skilled in the art. Since electronic switching is well known to those skilled in the art, the mechanical representation of the commutator is believed sufficient and adequate for the purpose of the present invention.

Various alterations and modifications may be made in the present invention without departing from the spirit and scope thereof, and it is desired that any and all such modifications and alterations be considered within the purview of the present invention, except as limited by the hereinafter appended claims.

Having described the invention, what is claimed as new and desired to have protected by Letters Patent is:

1. A color television transmitting system comprising a television image pickup tube, means for projecting optical images of a subject matter to be televised upon a light responsive surface in said tube, the images sequentially representing the light content of a plurality of different color components of the subject matter, means including said tube for converting the optical images into a series of television video signals, a video amplifier for increasing the intensity of the produced video signals, a light responsive element, means for sequentially projecting light representing a plurality of different color components of the subject matter upon the light responsive element to develop a corresponding control potential, and means sequentially to apply predetermined intensities of the developed control potential to the

video amplifier to alter the amplification thereof in synchronism with the sequential projection of the different color component images on the light responsive electrode of the television image pickup tube.

2. A color television transmitting system comprising a television image pickup tube, means for sequentially projecting optical images representing a plurality of different color components of a subject matter to be televised upon a light responsive surface in said tube, means including said tube for converting the optical images into a series of television video signals, a video signal amplifier for increasing the intensity of the produced video signals, a light responsive element, means for sequentially projecting light representing a plurality of different color components of the subject matter upon the light responsive element to develop a corresponding gain control potential, and means sequentially to apply predetermined intensities of the developed gain control potential to the video signal amplifier thereby to alter the effectiveness thereof in synchronism with the sequential projection of the different color component images on the light responsive electrode of the television image pickup tube.

3. A color television transmitting system comprising a television camera tube, means for projecting upon a light responsive surface in said tube optical images sequentially representative of the light intensity of a plurality of different color components of the subject matter to be televised, means including said tube for converting the optical images into a series of television video signals, a video signal amplifier for increasing the intensity of the produced video signals, a plurality of light responsive elements corresponding in number to the plurality of different color component images of the subject matter, means for projecting light of a different color component of the subject matter upon each light responsive element whereby a control potential will be developed by each light responsive element in accordance with the intensity of the light of that particular color component, and means sequentially to apply a predetermined portion of the developed control potentials to the video amplifier to alter the amplification thereof in synchronism with the conversion of the optical images into television video signals.

4. A color television transmitting system comprising a television camera tube, means for projecting upon a light responsive surface in said tube optical images sequentially representative of the light intensity of a plurality of different color components of the subject matter to be televised, means including said tube for converting the optical images into a series of television video signals, a video signal amplifier for increasing the intensity of the produced video signals, a corresponding plurality of light responsive elements, means for projecting light of a different color component of the subject matter upon each light responsive element whereby a separate gain control potential will be developed by each light responsive element in accordance with the intensity of the light of that particular color component, and means sequentially to apply a predetermined portion of the developed gain control potentials to the video amplifier to alter the amplification thereof in synchronism and in phase with the conversion of the optical images into television video signals.

5. A color television transmitting system comprising a television image pickup tube, an optical system for projecting optical images of a subject matter to be televised upon a light responsive electrode in said tube, a color filter assembly interposed in the optical axis whereby the optical images sequentially represent the light intensity of a plurality of different color components of the subject matter, means including said tube for converting the sequential color optical images into a series of television video signals, a video signal amplifier for increasing the intensity of the produced video signals, means including a light responsive tube for producing a control potential in accordance with the color component light intensities of the subject matter, and means including a switching arrangement for applying a predetermined portion of the developed control potentials to the video amplifier to alter the amplification thereof in synchronism with the operation of the television image pickup tube.

6. A color television transmitting system comprising a television image pickup tube, an optical system for projecting optical images of a subject matter to be televised upon a light responsive electrode in said tube, a color filter assembly interposed in the optical axis whereby the optical images sequentially represent the light values of a plurality of different color components of the subject matter, means including said tube for converting the sequential color optical images into a series of television video signals, a video signal amplifier for increasing the intensity of the produced video signals, means including a light responsive element for producing a gain control potential having an intensity determined in accordance with the color component light values of the subject matter, and means including a switching device for applying a predetermined portion of the developed gain control potentials to the video amplifier to alter the amplification thereof in synchronism and in phase with the sequential conversion of the optical images into the television video signals.

7. A color television transmitting system comprising a television image pickup tube having a light responsive electrode, means for projecting upon said electrode a series of optical images that are sequentially representative of the light intensity of a plurality of different color components of the subject matter to be televised, means including said tube for converting the optical images into a series of television video signals, a video signal amplifier for increasing the intensity of the produced television video signals, means for producing a plurality of control potentials comprising a plurality of light responsive elements each responsive to a different color component of the subject matter to be televised, and means including a switching arrangement for sequentially applying a predetermined portion of the produced control potentials to the video signal amplifier sequentially to alter the amplification thereof in synchronism with the sequential production of the television image signals representative of different color components of the subject matter televised.

8. A color television transmitting system comprising a television image pickup tube having a light responsive electrode, means for projecting upon said electrode a series of optical images that are sequentially representative of the light intensity of a plurality of different color components of the subject matter to be televised, means including said tube for converting the optical images into a series of television video signals, a video signal amplifier for increasing the intensity of the

produced television video signals, means for producing a plurality of gain control potentials comprising a plurality of light responsive cells each responsive to the intensity of a different color component of the subject matter to be televised, and means including a switching device for sequentially applying a predetermined independently adjustable portion of the produced gain control potentials to the video signal amplifier sequentially to alter the amplification thereof in synchronism and in phase with the conversion of the optical images of the different color components of the subject matter televised into television video signals.

9. The method of operating a color television transmitting system for establishing a desirable color balance which comprises the steps of sequentially producing a plurality of optical images representative of the light intensity of a plurality of different color components of the subject matter to be televised, converting the sequentially produced optical color images into a series of television video signals, increasing the intensity of the produced television video signals, utilizing light sequentially corresponding to the intensity of the different color components to develop a gain control potential that sequentially varies in accordance with the light intensity of different color components of the subject matter televised, and utilizing predetermined portions of the developed sequentially varying gain control potential to vary the extent to which the intensity of the video signals is increased.

10. The method of operating a color television transmitting system for establishing and maintaining a desirable color balance which comprises the steps of sequentially producing a plurality of optical images representative of the light intensity of a plurality of different color components of the subject matter to be televised, converting the sequentially produced optical color images into a series of television video signals, increasing the intensity of the produced television video signals, utilizing light corresponding to the intensity of the different color components to independently develop a plurality of gain control potentials in accordance with the light intensity of the different color components of the subject matter televised, and sequentially utilizing a predetermined portion of the plurality of developed gain control potential to cyclically vary the extent to which the intensity of the video signals is increased.

11. The method of operating a color television transmitting system for producing a desirable color balance which comprises the steps of sequentially producing a plurality of optical color images representative of the light values of a plurality of different color components of the subject matter to be televised, cyclically converting the optical color images into a series of television video signals, increasing the intensity of the produced television video signals, utilizing light derived from the subject matter to be televised to develop a cyclically varying gain control potential in accordance with the light intensity of the different color components of the subject matter televised concurrently with the conversion of the optical color images into video signals, and utilizing the developed gain control potential to cyclically vary the extent to which the intensity of the video signals is increased.

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