Dec. 1, 1942. E. I. ANDERSON 2,303,898

TELEVISION TRANSMITTER

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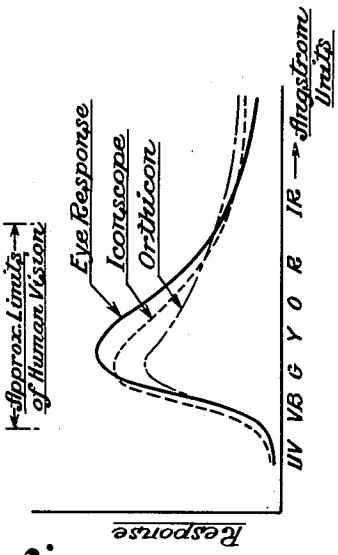


Fig. 2.

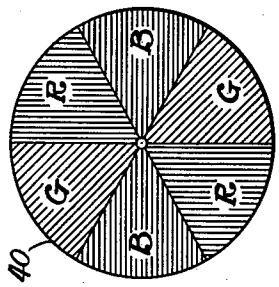


Fig. 3.

Fig. 1.

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TELEVISION TRANSMITTER

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14 Claims. (Cl. 178—5.4)

This invention relates to a television transmitter and more particularly for the transmission of television pictures in color.

Ordinarily in the transmission of color images by television it is customary to transmit separate images or television frames in succession, the successive images or frames transmitted being representative of a particular color of the subject matter being transmitted. The transmitted signals are received at a television receiver and are then used to produce successive black and white images which are viewed through different color filters, the different filters used being rotated or placed in front of the television receiver in rapid succession in synchronism with the transmission of the separate images and in synchronism with the movement of corresponding filters in the television transmitter.

At the transmitter a single television transmitting tube is used and optical images of the subject matter to be transmitted are projected upon the light sensitive electrode or photo-sensitive mosaic in the transmitting tube through color filters so that each successive scanning cycle in the television transmitting tube will produce picture signals corresponding in intensity to the light values of a particular color in the subject matter transmitted.

The light responsive electrode or the photosensitive mosaic which is used in the television transmitting tubes does not have completely uniform response in so far as color is concerned or in so far as the wave length of the light projected thereon is concerned.

Accordingly, in the absence of some correcting means, the signals representing one color or either too strong or too weak in comparison with the signals representing another color to permit the production of a natural and desirable balance of color in the composite images produced at the television receiver. In a three-color television system it is generally customary to use red, blue and green filters and in order to compensate for the response of the television transmitting tube at these particular colors, separate amplifying channels have been used for each of the three colors together with electronic switching means for connecting the output of the television transmitting tube to the one or another of the three amplifying channels in succession and in synchronism with the scanning cycles in the transmitting tube. Furthermore, it is possible to use a single amplifying channel and to alter the gain of the amplifier by electronic means in synchronism with the scanning of the differently colored light images. Such systems, however, are not wholly desirable because of the necessity of using electronic switching means for controlling the application of the signals to the separate amplifying channels or for controlling the gain of a single amplifier, and furthermore, the use of three separate amplifying channels is not entirely desirable in view of the obvious necessary complications in the circuits involved.

Normally in presently used television transmitting systems where sequential color images are transmitted in three colors, Wratten filters A, B and C_5 are used. These filters do not have the same percentage of light transmission at their center frequencies and, accordingly, the overall intensity of light which is transmitted through the filters and projected upon the mosaic electrode is not uniform and not truly indicative of the light values of the various colors in the object to be transmitted. Accordingly, this lack of identical transmission in the various filters results in an inaccurate proportioning of the color in the received image. Through the use of the present invention it is possible to compensate for this lack of uniformity in light transmission of the various filters so that a properly blended color image can be reproduced at the television receiver.

In television transmitting studios the particular type of lighting used also affects the proper balance of the color at the receiver since some lighting sources may have a preponderance of light in the red portion of the spectrum whereas other sources of light may have a preponderance of light in the blue or violet portion of the spectrum. Accordingly an improper balance of color in the received image will result by reason of the particular light source used in the studio and through the use of the present invention it is possible to compensate for the non-linearity in the source of light used in the studio.

It is a purpose of the present invention, therefore, to provide a television transmitting system wherein color images may be transmitted and wherein a single amplifying channel may be used without the necessity of associating therewith an electronic switching device.

Another purpose of the present invention resides in the provision of means, for compensating for the lack of uniformity in the response of the light responsive electrode in the television transmitting tube.

Another purpose of the present invention resides in the provision of means for compensating for the lack of uniformity in the percentage of

light transmission of the various color filters used with the television transmitting camera.

Still another purpose of the present invention resides in the provision of a simple and convenient means whereby a lack of balance in color as a result of the particular source of illumination used in the studio may be fully compensated for.

Still another purpose of the present invention resides in the provision of a simple and convenient system whereby the strength of the signals produced by the television transmitting tube for the differently colored images may be so altered as to produce the desired color balance at the television receiver without the necessity of using electronic switching means and without the necessity of using a plurality of separate amplifying channels.

A still further purpose of the present invention resides in the provision of means whereby the degree of compensation may be varied at will so that proper color balance may be maintained by a simple and convenient monitor means at the television transmitter.

Various other purposes and advantages of the present invention will become more apparent to those skilled in the art from the following specification, particularly when considered in conjunction with the drawing wherein:

Fig. 1 shows a schematic representation of a television transmitter incorporating one application of the present invention.

Fig. 2 shows color response curves of television transmitting tubes and

Fig. 3 shows the color disc which is provided with the various color filters.

Referring now to Fig. 1, there is shown schematically a television transmitter which includes a transmitting tube **10**. This transmitting tube as shown in an iconoscope but it is to be understood that an orthicon or similar television transmitting tube could as well be used. The iconoscope or television transmitting tube **10** includes a cathode **12**, a control electrode **14**, a first accelerating anode **16** and a second accelerating anode **18**. When proper potentials are applied to these electrodes from a power supply unit or from a potentiometer **20** connected across a power supply unit, a focused beam of electrons will be produced. The produced beam of electrons may be deflected in vertical and horizontal directions by means of the deflecting coils **22** and **24**, respectively, which are energized by the vertical deflection generator **26** and the horizontal deflection generator **28**. Normally, the horizontal deflection generator operates at a much higher frequency than does the vertical deflection generator since the former determines the number of lines scanned per second whereas the latter determines the number of complete fields scanned per second.

Also included in the television transmitting tube is a light responsive electrode **30** with which is associated a signal plate which is connected to ground by way of load resistance **32**. A collector electrode **34** is also included in the tube and is normally connected to the second accelerating anode **18**. The collector electrode operates to collect the photo electrons which are emitted from the mosaic electrode **30** when a light image is projected thereon.

The image to be transmitted is represented by the arrow **36** and through the use of a lens system **38** an optical image of the object **36** may be projected and brought to focus upon the mosaic electrode **30**.

Interposed in the optical axis of the television transmitting tube is a color disc **40** (shown in detail in Fig. 3) which includes a plurality of segments each of which is provided with a color filter which will transmit a predetermined wave length of light. In a three-color television transmitting system the filters normally used are colored red, green, and blue and as the color disc is rotated by means of the motor **42**, optical images of different colors are projected upon the mosaic electrode in accordance with the color of the filter interposed in the optical path at the particular instant. The motor **42** is shown connected to the vertical deflection generator since it is necessary that the motor be driven in synchronism with the vertical deflection of the cathode ray beam. In some instances, however, the power for the motor may be derived from an entirely separate source and impulses from the vertical deflection generator may be used in synchronizing the motor or in controlling its speed.

Connected across a load resistance **32** of the television transmitting tube is an amplifier **44** the output of which is supplied to a modulator and transmitter **46** which supplies energy to the transmitter antenna.

The modulator and transmitter also receive energy from the vertical and horizontal deflection generators in order that synchronizing impulses of desired wave form may be transmitted along with the picture signals for use at the receiver to maintain the television receiver in proper synchronous operation with the television transmitter.

In the operation of the transmitter as so far described, the cathode ray beam which is generated in the television transmitting tube is deflected horizontally at a rapid rate and vertically at a relatively slow rate in order to scan the mosaic electrode **30**. When an optical image of the object **36** is projected on the mosaic **30** through one of the color filters, for example red, a charge image is produced on the mosaic in proportion to the intensity of the light values projected thereon and in accordance with the response of the mosaic at the wave length of red light. The mosaic electrode is then scanned by the cathode ray beam in order to produce a series of picture signals corresponding to these light values and immediately following the vertical scanning cycle or the vertical deflection of the cathode ray beam, the blue filter is interposed in the light path so that the charge image which is produced on the mosaic electrode prior to the next scanning cycle will be in proportion to the light values of the image projected through the blue filter and in accordance with the response of the tube at that particular color. The mosaic electrode is again scanned to produce picture signals representative of these light values. The same cycle is repeated with an optical image of the object **36** being projected through the green filter on to the mosaic electrode.

With the transmitting system as shown the color image produced at the television receiver would not be perfectly balanced and would not be entirely satisfactory since the response of the mosaic electrode of the television transmitting tube is not uniform for all colors and may vary in a manner such as shown by the curves in Fig. 2. In this figure are shown three curves, one showing the normal eye response, another the color response of the iconoscope, and the third the color response of the orthicon. The curves for the iconoscope and the orthicon are

only shown by way of example and are not to be taken as representative of all iconoscopes and orthicons since many factors influence the color response of television transmitting tubes and actual response curves may vary widely. In the curve shown for the iconoscope, for example, it will be seen that the response of the tube is fairly high in the green and yellow region but is comparatively low for red and blue light. Accordingly, in the absence of any corrective networks the detail of the green portions of the picture would be considerably better or accentuated over the details present in the red portions of the picture. Furthermore the produced picture may have some degree of haziness in view of the response of the mosaic to infra-red light. In order to eliminate the effects of the infra-red light an infra-red filter **48** is preferably placed in the optical axis of the television transmitting tube in order to remove all light having a wave length greater than approximately 8,000 Angstrom units.

In order to compensate for the lack of linearity of color response of the television transmitting tube, three sources of light of different colors are provided. The red source of light is shown at **50**, the green at **52** and the red at **54**. These sources may be ordinarily incandescent lights with filters placed thereover in order to filter out light of all wave lengths except those desired. The three lamps are energized through a common source of potential **56** but in series with each lamp are provided rheostats **60**, **62** and **64** which are associated respectively with lamps **50**, **52** and **54**. By varying the amount of resistance by an adjustment of the movable contact along the resistors of the rheostats, it is possible to vary the intensity of the differently colored light beams individually.

The separate light sources for supplying the blue, green, and red light are preferably positioned in front of the television transmitter camera and on the object side of the color disc **40**. These lamps are continuously illuminated at a certain desired intensity and project their light through the color disc **40** onto the mosaic of the transmitter tube to illuminate the mosaic uniformly over its entire area at a predetermined intensity. It is necessary that the light from the sources **50**, **52** and **54** be projected through the color disc **40** so that light from only one of the sources is effective to illuminate the mosaic at any particular time depending upon which of the filters of the color disc are in registry with the optical axis of the transmitting tube.

If, for example, at the time an image of the object **36** is projected on the mosaic **30** through the green filter of the color disc the entire mosaic is also flood lighted by a small amount because of the presence of light from the source **52**. The signal strength available from the television transmitting tube is somewhat increased, however, the mosaic electrode will accumulate charges of less relative intensity since a smaller variation in light intensity will be present over the surface of the mosaic. Accordingly, the variations in the alternating current component of the picture signals will be reduced even although the average value of the picture signals may be increased. The direct current component, however, is lost in the amplifier **44** since normally a resistance-capacity coupled amplifier is used which is effective only for the transmission and amplification of the alternate current component. Accordingly, the signal strength available at the output of the amplifier **44** is reduced when the mosaic has projected thereon a small amount of uniform light from the source **52**. The intensity of the source **52** is therefore varied by an adjustment of the rheostat **62** in order to bring the response of the television transmitting tube to green light down to a point corresponding to the response of the tube at, for example, the wave length of red light.

Similarly, simultaneous with the projection of an optical image on the mosaic **30** through the blue filter a certain amount of light is projected uniformly over the entire area of the mosaic from the source of blue light **62**. Here again the intensity of the source **62** is so adjusted that the variation in amplitude of the picture signals at the output of the amplifier **44** may be brought to a desired level whereby, when the signals produced by scanning red, green, and blue images are used to produce images at the receiver, the combined color images will have the desired proper balance of color.

As stated above, the intensity of the light source **50**, **52** and **54** may be varied independently by means of the rheostats **60**, **62** and **64**, respectively, in order to bring about the desired balance of color and this adjustment is preferably made by the monitor at the control board where the signals transmitted are completedly monitored. An adjustment of the brilliance of the light sources **50**, **52** and **54** is also desirable in view of the fact that different television transmitting tubes have different color response, as explained above, and accordingly it is often necessary to readjust the brilliance of the three light sources when transmitting tubes are changed or replaced.

It is to be understood that the amount of light which is supplied by the three separate sources **50**, **52** and **54** is relatively small in comparison to the amount of light projected on the mosaic from the object to be televised but in each instance the intensity of the colored beams of light must be adjusted to bring about the desired balance of color in the received picture.

The use of the system described above is also particularly advantageous since it is recognized that the necessary dark spot correction may not be identical for differently colored images projected on the mosaic electrode. Even though the dark spot produced by a television transmitting tube of the iconoscope type is considerably influenced by the secondary electron response of the mosaic electrode, still some change in the required dark spot correction may be necessary when differently colored images are projected on the mosaic. The use of the flood lighting produced by the sources **50**, **52** and **54**, which are principally for the purpose of producing a proper balance of color, however, will tend to make the required dark spot correction more nearly the same for each different color image and, accordingly, the injection of the dark spot correction signal is materially simplified.

As stated above, the light from the three separate sources **50**, **52** and **54** must be projected on the mosaic electrode through the color disc **40**. As a modification, however, it is possible to use a separate color disc for the three light sources, provided, of course, that the separate color disc is rotated in synchronism with the object color disc **40**. Furthermore, it is to be understood that lenses, or mirrors, or both may be used to properly project the colored beams of light upon the mosaic **30** although in the drawing

no lenses or mirrors are shown for the sake of simplicity.

From the foregoing it may be seen that a decided improvement has been made in television transmitters where sequential color transmission is used and the necessary circuits have been materially simplified since a single amplifying channel may be used without the necessity of providing electronic switching means as has heretofore been necessary. Through the use of the present invention proper and adequate balance of color can be accomplished by merely adjusting the intensity of the separate red, green, and blue sources **50**, **52** and **54**, which can very conveniently be done by the monitor in charge of the television transmission. Furthermore, nonlinearity in the spectrum of the light used in the studio and variations in the light transmitting qualities of the color filters are compensated for.

Although incandescent lamps are shown and described as used for the sources of the differently colored light beams, it is also equally possible to use other sources of light provided, however, that the sources are constant and provided the intensity of the sources may be manually varied.

Various other alternations and modifications of the present invention may become apparent to those skilled in the art and it is desired that any and all such modifications be considered within the preview of this invention except as limited by the hereinafter appended claims.

1. A television transmitting system including a transmitting tube having a light responsive electrode, an optical system for projecting an optical light image upon the light responsive electrode along an optical axis, a plurality of differently colored light filters, means for successively interposing the light filters in the optical axis, and a plurality of sources of light of different colors positioned to simultaneously project light through the filters onto the light responsive electrode to supplement the light of the optical image.

2. A television transmitting system for sequential color transmission including a transmitting tube having a light responsive electrode, an optical system for projecting an optical light image of an object upon the light responsive electrode along an optical axis, a plurality of differently colored light filters, means for successively interposing the light filters in the optical axis of the television transmitting tube, and a plurality of sources of light of different colors corresponding to the colors of the filters positioned on the object side of the color filters for simultaneously projecting light on the light responsive electrode to supplement the light of the optical image.

3. A television transmitting system for sequential color transmission including a transmitting tube having a light responsive electrode, an optical system for projecting an optical light image of an object upon the light responsive electrode along an optical axis, a plurality of differently colored light filters, means for successively interposing the light filters in the optical axis of the television transmitting tube, a plurality of sources of light of different colors corresponding to the colors of the filters positioned on the object side of the color filters to simultaneously project light along the optical axis onto the light responsive electrode to supplement the light constituting the optical image, and means for independently controlling the intensity of each of the different sources of colored light.

4. A television transmitting system comprising a television transmitting tube having a light responsive electrode, a lens system for projecting an optical image of the object to be transmitted upon the light responsive electrode, a plurality of color filters, means for moving the color filters in order that the color filters may be sequentially and successively placed in the optical axis, and a plurality of sources of light of different colors positioned to simultaneously project light uniformly over the entire light responsive electrode through the color filters to supplement the light constituting the optical image.

5. A television transmitting system for transmitting color images comprising a television transmitting tube having a light responsive electrode, a lens system for projecting an optical image of the object to be transmitted upon the light responsive electrode along an optical axis, a color disc having a plurality of color filters, means for rotating the color disc in the optical axis of the television transmitting tube in order that the color filters may be sequentially and successively placed in the optical axis, and a plurality of sources of light of different colors positioned to simultaneously project light uniformly over the entire light responsive electrode through the color filters.

6. A television transmitting system for transmitting color images comprising a television transmitting tube having a light responsive electrode, a lens system for projecting an optical image of the object to be transmitted upon the light responsive electrode along an optical axis, a color disc having a plurality of color filters, means for rotating the color disc in the optical axis of the television transmitting tube in order that the color filters may be sequentially and successively placed in the optical axis, a plurality of sources of light of different colors corresponding to the colors of the filters positioned to simultaneously project light uniformly over the entire light responsive electrode through the color filters, and means for independently controlling the intensity of the separate color light sources.

7. A television transmitting system including a transmitting tube having a light responsive electrode, means in said tube for generating a focused beam of electrons, means for deflecting the beam in horizontal and vertical directions at different rates in order to cyclically scan the light responsive electrode, an optical system for projecting an optical image on the light responsive electrode along an optical axis, a plurality of filters of different colors, means for moving the color filters so that a different color filter is interposed in the optical axis for each scanning cycle of the cathode ray beam, and a plurality of sources of light each of a different color positioned to uniformly illuminate substantially the entire light responsive electrode by projection of light through the color filters, the intensity of the effective light from each of the sources being independently controllable.

8. A color television transmitting system including a transmitting tube having a light responsive electrode, means in said tube for generating a focused beam of electrons, means for deflecting the beam in horizontal and vertical directions at different rates in order to cyclically scan the light responsive electrode, a lens sys-

tem for projecting an optical image on the light responsive electrode, a color disc having a plurality of filters of different colors, means for rotating the color disc so that a different filter is interposed in the optical axis for each vertical deflection cycle of the cathode ray beam, and a plurality of sources of light of different color corresponding to the colors of the filters, said sources of light being positioned to simultaneously project light through the color filters to uniformly illuminate substantially the entire light responsive electrode.

9. A color television transmitting system including a transmitting tube having a light responsive electrode, means in said tube for generating a focused beam of electrons, means for deflecting the beam in horizontal and vertical directions at different rates in order to cyclically scan the light responsive electrode, a lens system for projecting an optical image on the light responsive electrode, a color disc having a plurality of filters of different colors, means for rotating the color disc so that a different filter is interposed in the optical axis for each vertical deflection cycle of the cathode ray beam, a plurality of sources of light each of a different color corresponding to the colors of the filters, said sources of light being positioned to uniformly illuminate substantially the entire light responsive electrode when light from the sources is projected through the filter of the corresponding color, and means for independently controlling the intensity of the differently colored light sources.

10. A television transmitting system wherein color television images are sequentially transmitted and wherein there is a lack of uniformity in color sensitivity of the light responsive electrode comprising an optical system for projecting an optical image of an object upon the light responsive electrode along an optical axis, a plurality of filters of different colors adapted to be sequentially positioned in the optical axis, a plurality of sources of differently colored light, and means for positioning the differently colored light sources so that light from the sources may uniformly illuminate substantially the entire area of the light responsive electrode through the filters whereby the lack of uniformity of response and sensitivity of the light responsive electrode may be compensated for.

11. A television transmitting system wherein color television images are sequentially transmitted and wherein the sensitivity of the light responsive electrode is not uniform for all colors comprising a lens system for projecting an optical image of an object upon the light responsive electrode along an optical path, a plurality of filters of different colors adapted to be successively positioned in the optical path, a plurality of sources of differently colored light corresponding to the colors of the filters, means for positioning the differently colored light sources on the object side of the filters so that light from the sources may uniformly illuminate substantially the entire area of the light responsive electrode when light from the sources is projected through the filters, and means for independently varying the intensity of the differently colored light sources, whereby the lack of uniformity of response and sensitivity of the light responsive electrode may be compensated for.

12. A television transmitting system wherein nonlinearity of color response exists comprising a television transmitting tube having a light sensitive electrode, means including an optical system for projecting an optical light image upon the electrode along an optical path, a plurality of filters of different colors arranged to be sequentially interposed in the optical path, and a plurality of light sources of different colors, said light sources being positioned so that the light from the sources may be simultaneously projected through the filters onto the light responsive electrode whereby the auxiliary lighting of the light responsive electrode may compensate for the lack of linearity in color response of the system.

13. A television transmitting system wherein non-linearity of color response exists comprising a television transmitting tube having a light sensitive mosaic electrode, means including a lens system for projecting an optical light image upon the mosaic electrode along an optical axis, a plurality of filters of different colors arranged to be sequentially interposed in the optical axis, and a plurality of light sources of different colors corresponding to the colors of the filters, said light sources being positioned such that the light from the sources may be simultaneously projected through the filters onto the mosaic electrode, whereby the auxiliary lighting of the mosaic electrode may compensate for the lack of linearity in color response of the system.

14. A television transmitting system wherein non-linearity of color response exists comprising a television transmitting tube having a light sensitive mosaic electrode, means including a lens system for projecting an optical light image upon the mosaic electrode along an optical axis, a plurality of filters of different colors arranged to be sequentially interposed in the optical axis of transmitting tube, a plurality of light sources of different colors corresponding to the colors of the filters, said light sources being positioned such that the light from the sources may simultaneously be projected through the color filters onto the mosaic electrode, and means for individually controlling the intensity of the separate light sources of different colors whereby the auxiliary lighting of the mosaic electrode may compensate for the lack of linearity in color response of the system.

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