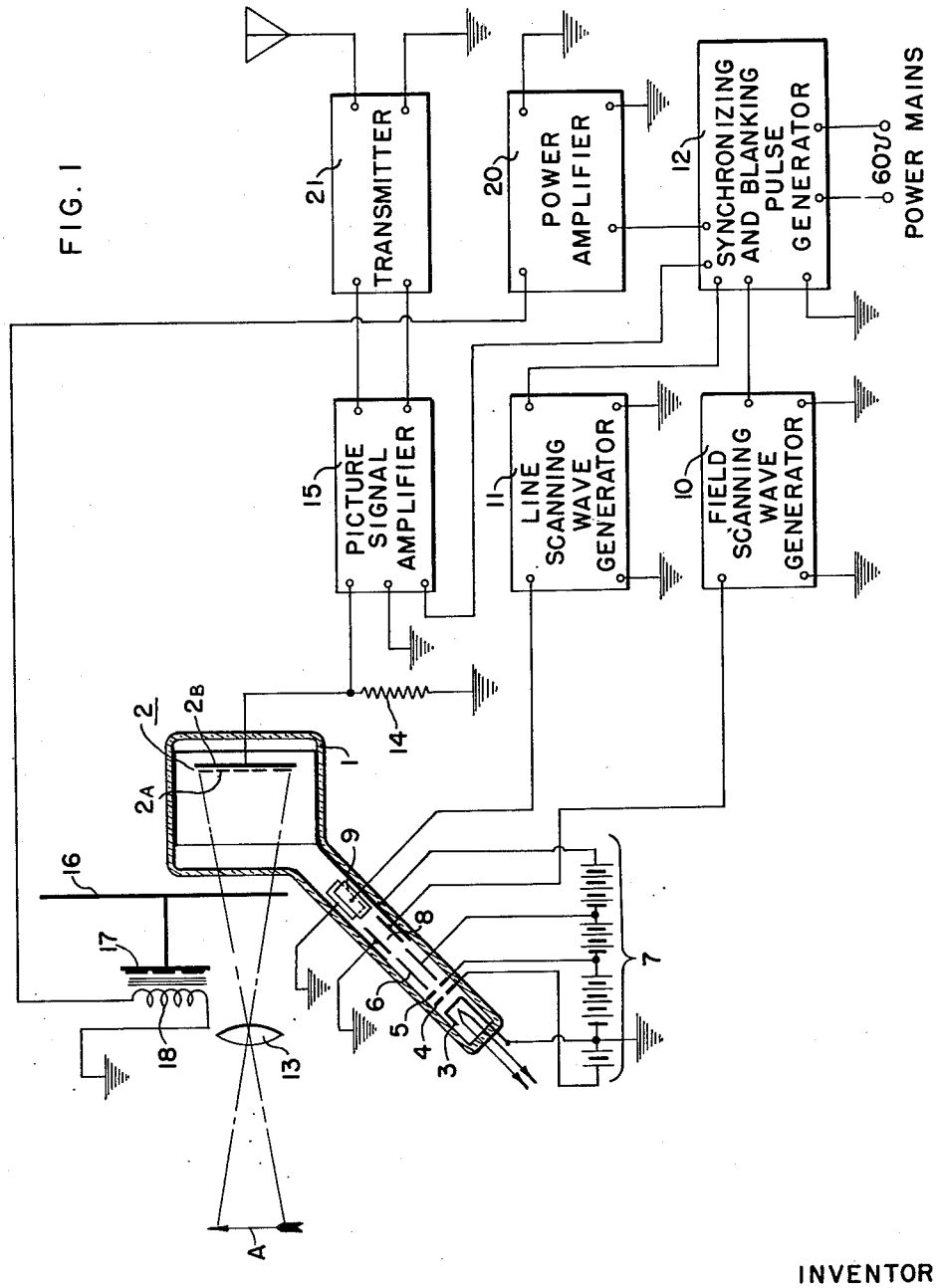
March 9, 1943. M. CAWEIN 2,313,224

COLOR TELEVISION SYSTEM

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FIG. 1



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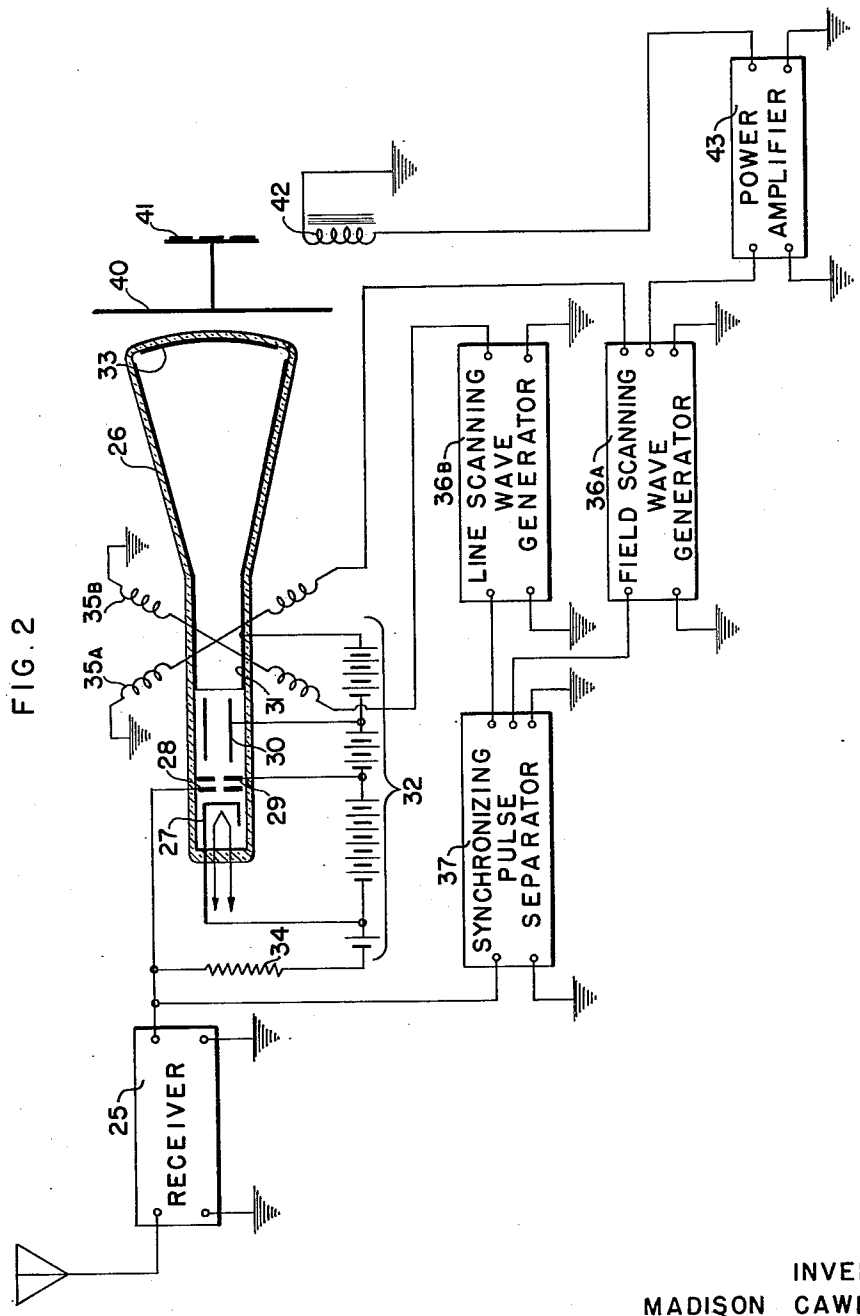


FIG. 2

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FIG. 3

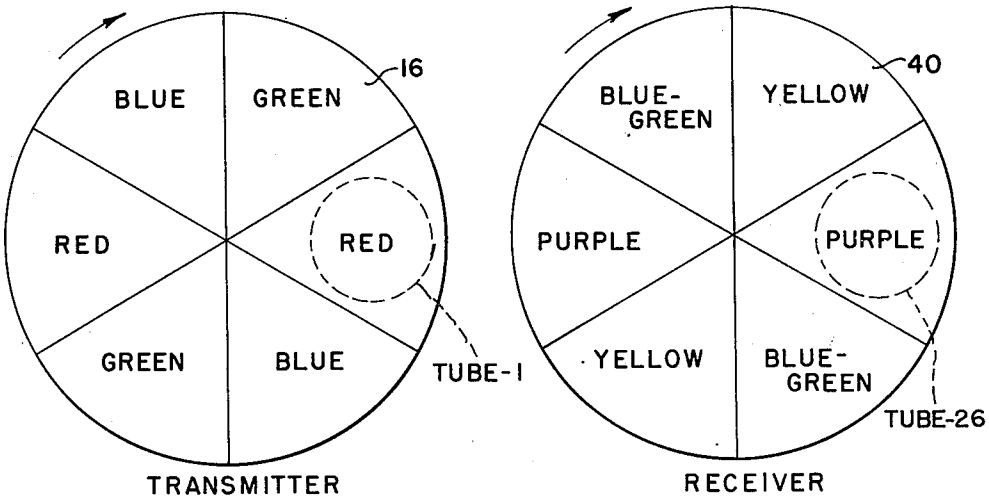


FIG. 4

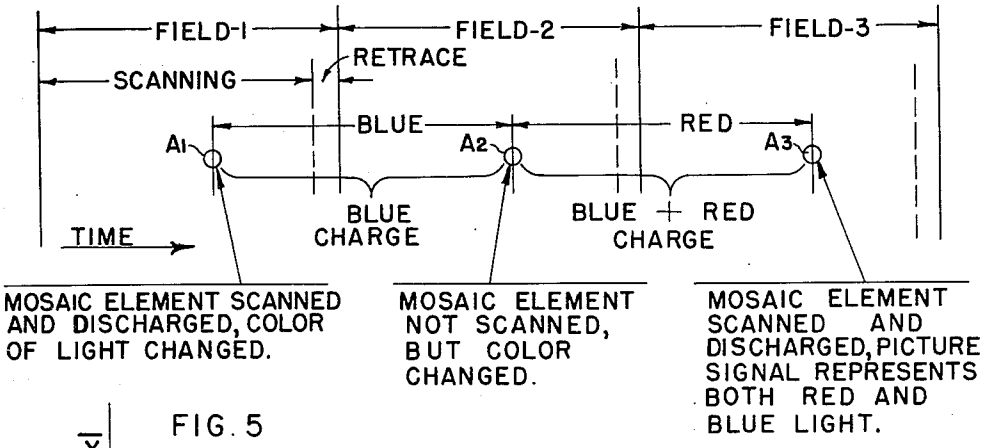
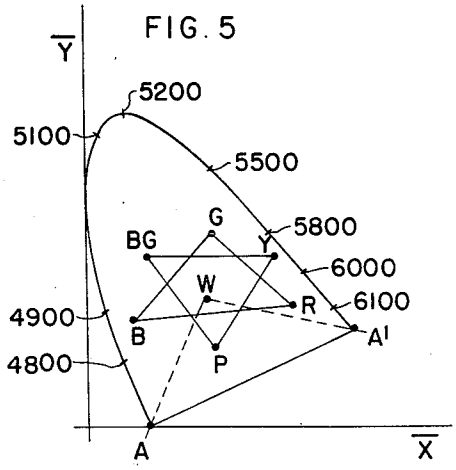


FIG. 5



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2,313,224

UNITED STATES PATENT OFFICE

2,313,224

COLOR TELEVISION SYSTEM

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Application August 15, 1941, Serial No. 406,953

8 Claims. (Cl. 178—5.4)

This invention relates to a method of and means for transmitting and receiving television pictures in natural colors and particularly relates to a color television system employing a charge storage tube as a picture signal generating tube.

In conventional color television systems, three primary colors, such as red, green and blue, are used, by mixture of which various colors as well as white can be reproduced. Usually, the color of the light of the optical image projected on the photosensitive member of a picture signal generating tube is changed after the completion of each field scanning cycle, so that picture signals successively representative of three different color components are transmitted during successive scanning field intervals.

It is also conventional in television to employ so-called interlaced scanning, in which an electron scanning beam describes a predetermined field pattern of parallel lines during one field scanning interval and describes a similar pattern of lines lying in the interstices of the first lines during the successive field scanning interval. It will be noted that each individual picture element is scanned only during alternate fields.

If, now, a charge storage electrode, comprising a mosaic of mutually insulated photoelectric elements, is employed in the picture signal generating tube of the types used in the well-known iconoscope and if the color of the image light incident upon individual mosaic elements of the storage electrode is changed substantially immediately after the scanning thereof, it is evident that the mosaic elements carry charges due to light of a plurality of different colors, if these colors are present in the image light. In a system using the colors red, green and blue, wherein each color component is effective over one field scanning interval of a double interlaced scanning pattern, the mosaic elements carry charges due to light of two different colors, if these are present in the image light. A picture signal developed in accordance with such a charge would, therefore be representative of two color components which cannot be separated from each other. Hence, if red, green and blue filters are also used at the receiver for reproducing the picture element corresponding to the mosaic elements carrying charges representing color mixtures, a falsification of color values would occur. In order to avoid such a falsification, it has been proposed to decrease the effective storage time of the storage electrode by introducing a leakage path between individual mosaic elements thereof so that charges, corresponding to a single color component only, are effectively employed to develop picture signals. This method, however, has the serious disadvantage of considerably decreasing the sensitivity of the picture signal generating tube, which is entirely based on the storage of electrical charges, due to light incident over a considerable period of time.

It is an object of the present invention, therefore, to provide a new and improved method of and system for transmitting and receiving television pictures in natural colors, in which signal generating tubes of the charge storage type can be employed with substantially their maximum sensitivity.

In accordance with the invention, there is provided a method of and a system for transmitting and receiving television pictures in natural colors, comprising a photosensitive member and means for projecting an optical image of the object to be transmitted upon said member. Means are provided cooperating with the photosensitive member for developing picture signals representative of the light characteristics of successive elemental areas of the object to be transmitted, in accordance with cyclically recurring scanning field patterns. A first color filtering means is disposed in the optical path between the projecting means and the photosensitive member for successively selecting different color components from the light emanating from predetermined areas of the object to be transmitted, thereby correspondingly to change the color of the image light incident upon the photosensitive member. There are also provided means for transmitting and receiving the picture signals, as well as means for reproducing the television picture in substantially white light, in accordance with the received picture signals. Finally, second color filtering means are disposed between the picture of white light and an observer, this color filtering means being adapted successively to select from the image of white light predetermined color components differing from those selected by the first color filtering means.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description, taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the accompanying drawings, Figs. 1 and 2 show transmitting and receiving apparatus respectively, embodying the present invention, while Fig. 3 shows color filtering discs used at the trans-

mitter and receiver. Figs. 4 and 5 serve to explain the invention.

Referring now particularly to Fig. 1 of the drawings, there is shown transmitting apparatus comprising a picture signal generating tube 1 of the conventional iconoscope type, comprising an evacuated envelope housing a charge storage electrode generally indicated at 2, comprising a mosaic of mutually insulated photoelectric particles 2A and a signal plate 2B insulated therefrom, and an electron gun comprising a cathode 3, a control electrode 4 and first and second anodes 5 and 6, respectively, for developing an electron beam directed against the charge storage electrode 2. Operating potentials are applied to the electrodes of the electron gun by means of a battery arrangement generally indicated at 7. For the purpose of deflecting the electron beam across the photosensitive mosaic 2A, there are provided two pairs of electrostatic deflecting plates 8 and 9, energized by a field scanning wave generator 10 and a line scanning wave generator 11, both adapted to supply voltage waves of sawtooth wave form having frequencies of 60 cycles and 15,750 cycles, respectively, so that the electron beam describes an interlaced pattern having 525 lines and 30 complete frames per second, as is well known in the art. For synchronizing the field and line scanning wave generators 10 and 11, there is provided a synchronizing and blanking pulse generator 12, synchronized in the conventional manner from the power mains and adapted to supply synchronizing pulses to the generators 10 and 11, as is customary in the art.

For projecting an optical image of an object indicated by the arrow A upon the photosensitive mosaic 2A, there is provided an optical system schematically indicated at 13. For deriving picture signals from the signal plate 2B of the charge storage electrode 2, there is provided an output resistor 14, connected to the input of a picture signal amplifier 15, to which synchronizing and blanking pulses are also applied from the synchronizing and blanking pulse generator 12, for the purpose of developing a composite television signal comprising picture signals and synchronizing and blanking pulses.

In order successively to select different color components from the light emanating from predetermined areas of the object A, there is provided a color filter disc 16 disposed between the optical system 13 and the photosensitive mosaic 2A and as close to the latter as possible so that a sufficiently sharply defined boundary between image areas of different color is obtained in the plane of the mosaic. The disc 16 is shown more in detail in Fig. 3 and comprises 6 sections of equal area adapted to transmit red, green and blue light, exclusively.

For driving the color disc in synchronism and in phase with the scanning motion of the electron beam in the tube 1 and at a speed of 10 R. P. S., there is provided a phonic wheel arrangement comprising a rotor 17 and a stator 18, as schematically indicated, the latter being energized by 60-cycle signals derived from the pulse generator 12 and amplified by a power amplifier 20.

If the rotor 17 of the phonic wheel arrangement is provided with three pole pieces and the stator with six pole pieces, suitably spaced, a 60-cycle wave applied to the stator will cause the rotor 17 and the color disc 16, rigidly connected thereto, to rotate at a speed of 10 R. P. S. This speed is suitable to effect a change of color of the light incident upon the photosensitive mosaic 2A at the end of each field scanning interval, which occupies 1/60 second. For the purpose of phase adjustment, the stator 18 is preferably supported in such fashion that it can be rotated through an appreciable angle.

The output of the picture signal amplifier 15 is applied to a wireless transmitter 21, in which the composite television signal from the amplifier 15 is modulated upon a carrier which is radiated into space.

Fig. 2 shows receiving apparatus adapted to cooperate with the transmitting apparatus shown in Fig. 1. The receiving apparatus comprises a radio receiver 25 adapted to receive the modulated carrier wave transmitted by the wireless transmitter 21 and to develop at its output the demodulated composite television signal. For the purpose of reproducing a television picture composed of white light, in accordance with the received picture signals, there is provided a cathode ray reproducing tube 26, comprising an electron gun including a cathode 27, a control electrode 28, a first anode 29, a second anode 30 and a conductive wall coating 31, all energized by means of a battery arrangement 32 and adapted to develop an electron beam directed at a fluorescent screen 33, capable of developing white fluorescent light upon electron impact therewith.

For modulating the electron beam in accordance with received picture signals, the control electrode 28 of the electron gun is connected to the receiver 25 and is provided with a grid leak resistor 34.

For scanning the electron beam across the fluorescent screen 33, in accordance with a 525 line interlaced scanning pattern, there is provided a pair of deflecting coils 35A and 35B, energized by a field scanning wave generator 36A and a line scanning wave generator 36B, respectively. For synchronizing the motion of the electron beam in tube 26 with the motion of the electron beam in the tube 1 of the transmitting apparatus, there is provided a synchronizing pulse separator 37, connected to the output of the receiver 25 for separating the synchronizing pulses of the composite television signals from the picture signals and for applying the separated synchronizing pulses to the field and line scanning wave generators 36 and 37, respectively.

For successively selecting predetermined color components from the image of white light produced by the fluorescent screen 33, there is provided a color disc 40 positioned opposite the end of the reproducing tube 26, closely adjacent to the fluorescent screen 33, and comprising six sections of substantially equal area adapted to transmit different color components. In contrast to the color components transmitted by the color disc 16 in the transmitting apparatus, which were red, green and blue, the color components transmitted by the color disc 40 are purple, blue-green and yellow, as indicated in Fig. 3 of the drawings. For the purpose of driving the color disc 30 in synchronism and phase with the color filter disc 16 at the transmitting apparatus, there is provided a phonic wheel arrangement comprising a rotor 41 rigidly connected with the color filter disc 40 and a stator 42. For the purpose of energizing the phonic wheel arrangement, there is provided a power amplifier 43 adapted to amplify 60-cycle pulses derived from the field scanning generator 36, which, after amplification, are applied to the stator 42. The phonic wheel arrangement is of substantially the same construction as that at the transmitting apparatus. The stator 42 is also preferably rotatably

mounted in order to enable adjustment of the phase of the color disc **40**, to correspond to that of the filter disc **16** at the transmitting apparatus.

In operation, an optical image of the object A is projected by means of the optical system **13** on the photosensitive mosaic **2A**. The individual photosensitive elements accumulate electrical charges corresponding to the brightness of the elemental areas of the image focused thereon. The electron beam generated by the electron gun comprising the cathode **3** and electrodes **4**, **5** and **6** is scanned across the photosensitive mosaic **2A** by means of the electrostatic fields developed between the two pairs of deflecting plates **8** and **9**, to describe a 525 line interlaced scanning pattern at a rate of 60 fields per second and 30 frames per second. The two pairs of deflecting plates **8** and **9** are energized by the field and line scanning wave generators **10** and **11**, respectively, synchronized by the synchronizing and blanking pulse generator **12**, as is customary in the art. In accordance with the well-known operation of the signal generating tube of the storage or iconoscope type, picture signals corresponding to the light characteristics of successively scanned elemental areas of the mosaic **2A** are developed across the output resistor **14** and applied to the picture signal amplifier **15**. To this amplifier are also applied synchronizing and blanking pulses from the generator **12**, in order to produce thereat an amplified composite television signal comprising picture signals and blanking and synchronizing pulses. The amplified composite television signal is applied to the transmitter **21**, in which it is modulated upon a carrier wave and radiated into space.

The color disc **16** is driven at a rate of 10 R. P. S. by means of 60-cycle pulses derived from the pulse generator **12**, amplified by the power amplifier **20** and applied to the stator **18** of the phonic wheel arrangement, whereby the position of the stator **18**, with respect to the rotor **17**, is so adjusted that a change in the color of the image light incident upon any element of the mosaic **2A** is effected substantially immediately after the scanning thereof. Hence, the boundary line between differently colored areas of the image on the mosaic **2A** closely follows the vertical motion of the scanning beam.

Fig. 4 illustrates the accumulation of electrical charges by a mosaic element between successive scannings thereof. This figure shows three successive field scanning intervals each comprising a scanning portion, during which picture signals are generated, and a retrace portion. Point A_1 illustrates a mosaic element which has just been scanned and discharged for the purpose of producing a picture signal. Substantially immediately thereafter, the color of the image light incident upon this mosaic element is changed and may be changed to blue, as indicated in the figure, so that the mosaic element accumulates an electrical charge representative of the blue color component of the light emanating from the corresponding picture element of the object during the following interval of $\frac{1}{60}$ second, at the end of which the scanning beam again passes the vicinity of the mosaic element. The end of this interval is indicated in the figure by the point A_2, at which time the same mosaic element is not scanned since the scanning pattern is interlaced and the same elements are scanned only in alternate scanning fields. However, the color of the image light incident upon the mosaic element is changed, since the boundary between different colored image areas follows the vertical motion of the scanning beam and the light color may be changed to red, as indicated in the figure. During the following interval of $\frac{1}{60}$ second, the mosaic element accumulates an electrical charge corresponding to the red color component of the light emanating from the corresponding elemental area of the object. At the end of this interval, indicated by the point A_3, the mosaic element has accumulated charges corresponding to both the blue and red incident thereon. At this time, the mosaic element is scanned and discharged and a picture signal is developed representing both the red and blue color components of the light emanating from the corresponding elemental area of the object. This is, likewise, true of other picture elements and other successive fields and it is evident that picture signals are produced which correspond to a mixture of blue and red, red and green, and green and blue light for a color filter disc successively transmitting red, green and blue light.

The modulated carrier waves are received by the wireless receiver **25** of Fig. 2, which develops at its output the demodulated composite television signal, which is applied to the control element **28** of the electron gun of the cathode ray picture reproducing tube **26**, for control thereof, and to the synchronizing pulse separator **37**. The electron beam produced by the electron gun comprising the cathode **27**, the control element **28**, the anodes **29** and **30** and the wall coating **31**, all energized by means of the battery arrangement **32**, is directed toward the fluorescent screen **33** and scanned thereacross by means of a pair of deflecting coils **35A** and **35B**, to reproduce a television picture in white light, in accordance with the received picture signals. The deflecting coils **35A** and **35B** are energized by field and line scanning wave generators **36A** and **36B**, respectively, which are synchronized by the synchronizing pulses derived from the synchronizing pulse separator **37**, in which the synchronizing pulses are separated from the composite television signal.

The color disc **40** is driven by means of 60-cycle pulses derived from the field scanning wave generator **36A**, which are amplified by the power amplifier **43** and applied to the stator **42** of the phonic wheel arrangement. The stator **42** can be rotated with respect to the rotor **41** until proper phasing with the color disc **16** at the transmitting apparatus is obtained, which can readily be determined by observation of the reproduced television picture.

The color disc **40** is so phased with respect to the color disc **16** that the purple filter of disc **40** is effective when mosaic elements carrying blue and red charges are being scanned. The yellow filter of disc **40** is effective when mosaic elements, carrying charges representing red and green light, are being scanned; and the blue-green filter of disc **40** is effective when mosaic elements carrying charges representing green and blue light are being scanned. When the fluorescent screen **33** is viewed through the color filters of disc **40** a television picture in natural colors is seen.

The effect of the mixture of different color components will now be explained more in detail. Since light entering the pupil of a human eye can be considered as a stimulus, the charges

on a mosaic element can be considered as stimuli which are recorded. The picture signal produced by such charges is, therefore, representative of one or more stimuli, that is, one stimulus, if the charges are produced by light of a single color; two or more stimuli, if the charges are produced by light of two or more different colors.

In the case of charges accumulated by an element of the mosaic 2A of the iconoscope tube 1 scanned in accordance with an interlaced pattern, these charges can be due to light of a single color only, which is the case when a uni-colored area of one of the colors of the color filter is transmitted, or they can be due to light of two different colors. Hence, there can be recorded on an element of the mosaic a single stimulus or two stimuli.

First, consider the case of two stimuli. The presence of a charge on a mosaic element representative of two stimuli indicates that light is emanating from the subject matter being transmitted containing at least the colors of two filter sections. Since these stimuli are inseparably combined in the charge on a mosaic element, a single signal is transmitted for both stimuli and this signal, in accordance with the invention, is used to reproduce at the receiver the color which the eye of the observer sees, had both stimuli been independently effective thereon. Since only one such color can be chosen at the receiver to reproduce the mixed color corresponding to the mixture of the two stimuli, it is necessary to assume or fix an arbitrary ratio of the two stimuli. Preferably, the assumption is made that the two stimuli are of equal intensity. If the light emanating from various elemental areas of the object to be transmitted contains light of mixed colors, such as red and green, green and blue, blue and red, and if equal amounts of these color components are present, then the stimuli recorded on the mosaic 2A for successive scanning fields of successive frames are then given by the following:

Frame 1	Field 1	Blue plus red
Frame 1	Field 2	Red plus green
Frame 2	Field 1	Green plus blue
Frame 2	Field 2	Blue plus red
Frame 3	Field 1	Red plus green
Frame 3	Field 2	Green plus blue

In this table, the first color indicates the stimuli recorded on the mosaic element during the first half of the interval between successive scansions of the element, while the second color indicates the stimulus recorded during the second half of this interval. The color sensation produced by the recorded stimuli, if directly effective on the eye of an observer, would have been blue plus red which equals purple; red plus green, which equals yellow, and green plus blue which equals blue-green. Since these are the colors chosen for the receiver color filter disc 40, the reproduced colors are approximately those which would have been produced by the recorded stimuli, if they had been directly effective on the eye of an observer. For one specific ratio of the intensities of the stimuli, the reproduced color will be exactly correct; for all others, it will be an approximation, which, however, is not objectionable.

In the case of a uniformly colored area, from which light emanates having a color transmitted by one of the color filter sections of the filter disc 16 at the transmitting apparatus and having no other colors, a single stimulus only is recorded on the elements of the mosaic 2A. Assume that this color be red. For multicolored light, red is usually represented by the charges on the mosaic elements in combination with blue and green, as recorded stimuli, and the picture signals derived from such charges successively produce at the receiver the colors purple and yellow. For red light, therefore, a picture signal is transmitted during all field scanning intervals, except each third one, during which signals corresponding to green and blue light only are developed. Hence, an intermittent series of successive purple and yellow light flashes is produced at the receiver since the fluorescent screen 33 of the reproducing tube 26 is bombarded by the scanning beam only during the intervals in which the purple and yellow sections of the color filter disc 40 are effective. Therefore, an intermittent series of purple and yellow stimuli is effective on the eye of an observer, which results in a sensation of red.

The same holds true for uni-colored green and blue areas, so that the following table can be shown:

Transmitter	Receiver
Light color of unicolored area of object	Rapid succession of—
Red	Purple and yellow=red.
Blue	Dark green and purple=blue.
Green	Dark green and yellow=green.

While the invention has been described in connection with specific color filters at the transmitting and receiving apparatus, it will now be shown that there are a multitude of other equally suitable color components.

Fig. 5 shows the well-known color triangle, in accordance with the Young-Helmholtz theory of colored light. According to this theory, the human eye includes three different mechanisms, predominantly responsive to red, green and blue light, respectively. The proportion in which these mechanisms are stimulated determines the sensation, that is, the color which an observer believes he is seeing. This theory also states that any combination of primary colors adapted to exert certain stimuli can be replaced by a second set of primary colors, different from the first set, which, if properly proportioned, can reproduce exactly the same stimuli as produced by the first set of primary colors. If the stimuli exerted by a first set of primary colors be X, Y and Z and produce a predetermined color sensation E, the stimuli exerted by a different set of primary colors $\overline{X}'$, $\overline{Y}'$ and Z' can, if properly proportioned, produce the same color sensation E.

In accordance with the theory set forth above, it is possible to draw the well-known color triangle, as shown in Fig. 5, in which the parameters X and Y are plotted on rectangular coordinates. These parameters are:

$$\overline{X}=\frac{X}{X+Y+Z}$$

$$\overline{Y}=\frac{Y}{X+Y+Z}$$

$$\overline{Z}=\frac{Z}{X+Y+Z}$$

each of which represents the ratio between one stimulus and the sum of the three. It is evident that only two of the parameters must be known

in order to determine the third, since the sum of the three is always unity. The curved line between A and A' indicates the positions of the saturated colors of the visible spectrum, whereby the wave lengths are roughly indicated in Angstrom units. The point W indicates the stimuli resulting in the sensation of white light, and the area enclosed by the triangle WAA' includes all non-spectral purple colors. Points on a straight line connecting the point W with a point on the curved line corresponding to a certain wave length indicate the stimuli required to produce the sensation of color of that wave length with different degrees of saturation, whereby the degree of saturation increases with increasing distance from the point W. The points R, G and B represent the colors of the light transmitted by the individual filter sections of the color filter disc **16** at the transmitting apparatus. According to the Young-Helmholtz theory, a system employing these filters is able to record stimuli on the mosaic **2A** indicative of any color within the triangle RGB. Likewise, a mixture of light of two different colors, for example, the red indicated by the point R, and the green indicated by the point G, will result in light of a color indicated by a point on the connecting line between points R and G. If the intensity of the red and green stimuli are equal, the point indicative of the resulting stimulus is half way between points R and G and, therefore, lies in the yellow region. Hence, the point Y is obtained. The same is true for combinations of green and blue, as indicated by points G and B, and a combination of blue and red, as indicated by points B and R; hence, points BG and P, indicating blue-green and purple, are obtained. Applied to the receiving apparatus illustrated by Fig. 2, this means that, if the filter sections are chosen to select yellow, purple and blue-green, as indicated by points Y, P and BG, from the white light produced by the fluorescent screen **33**, which may be indicated by the point W of Fig. 5, all colors corresponding to points enclosed by the triangle Y, P and BG can be reproduced.

From this elementary theoretical consideration of this system, it appears:

First, that a falsification of the colors takes place, since the color triangle, determined by the transmitter color filters, is not the same as that determined by the receiver color filters. The triangles, however, do coincide over considerable portions thereof.

Second, that, for the filter colors assumed in Fig. 5, combined stimuli, that is, light comprising a mixture of the colors of the transmitter color filter disc **16**, is reproduced with an increased degree of saturation, while a single stimulus, that is, the primary colors of the transmitter filter, are less saturated in the reproduced image than in the original. However, it must be kept in mind that the above theoretical considerations were all made on the basis of monochromatic light and, since it is not practically feasible to make monochromatic filters, that is, filters transmitting light of one specific wave length only, it is obvious that the distinction between recorded colors and reproduced colors is considerably less severe than in the theoretical consideration.

From the above, it will be evident to all skilled in the art that the system can be reversed by placing at the transmitter purple, yellow and blue-green filters and by placing red, green and blue filters at the receiver. Likewise, it is also obvious that any other combination of primary colors can be selected, as long as the color triangles produced by the transmitter and receiver filter colors, respectively, coincide over a substantial portion thereof and as long as the selected primary colors of one filter can be obtained by a mixture of the colors of the other filter. In the choice of the color filters, care must be taken so to choose their transmissivity, that is, their light loss characteristics, that the point W of the color diagram corresponding to white light is in the center of gravity of the triangles, assuming the intensity of the stimuli to be represented as masses positioned in the corners of the color triangles.

While the invention has been described in connection with a picture signal generating tube of the iconoscope type, it is obvious that any other tube employing the charge storage principle can be used equally well.

While there has been described what is at present considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A system for transmitting and receiving television pictures in natural colors comprising a photosensitive member, means for projecting an optical image of the object to be transmitted on said member, means cooperating with said photosensitive member for developing picture signals representative of the light characteristics of successive elemental areas of said image in accordance with cyclically recurring scanning field patterns, first color filtering means comprising a plurality of transparent color filters disposed in the optical path between said projecting means and said photosensitive member for successively selecting different color components from the light emanating from predetermined areas of said object, thereby correspondingly to change the color of the image light incident upon said photosensitive member, means for transmitting said picture signals, means for receiving said picture signals, means for reproducing the television picture in substantially white light in accordance with the received picture signals, second color filtering means disposed between said picture of white light and an observer, said second color filtering means comprising a plurality of transparent color filters and being adapted successively to select from said image of white light predetermined color components differing from those selected by said first color filtering means in such manner that the light of elemental areas of the reproduced image apparent to said observer is of substantially the same color as the color of corresponding elemental areas of the object under transmission.

2. A system for transmitting and receiving television pictures in natural colors comprising a photosensitive member, means for projecting an optical image of the object to be transmitted on said member, means cooperating with said photosensitive member for developing picture signals representative of the light characteristics of successive elemental areas of said image in accordance with cyclically recurring scanning field patterns, first color filtering means comprising a plurality of transparent color filters dis-

posed in the optical path between said projecting means and said photosensitive member for successively selecting different color components from the light emanating from predetermined areas of said object, thereby correspondingly to change the color of the image light incident upon said photosensitive member, means for transmitting said picture signals, means for receiving said picture signals, means for reproducing the television picture in substantially white light in accordance with the received picture signals, second color filtering means disposed between said picture of white light and an observer, said second color filtering means comprising a plurality of transparent color filters and being adapted successively to select from said image of white light predetermined color components, each of said last-named color components being a mixture of a plurality of said color components successively selected by said first color filtering means.

3. A system for transmitting and receiving television pictures in natural colors comprising a photosensitive member, means for projecting an optical image of the object to be transmitted on said member, means cooperating with said photosensitive member for developing picture signals representative of the light characteristics of successive elemental areas of said image in accordance with cyclically recurring scanning field patterns, first color filtering means comprising a plurality of transparent color filters disposed in the optical path between said projecting means and said photosensitive member for successively selecting different ones of a first set of primary colors from the light emanating from predetermined areas of said object, thereby correspondingly to change the color of the image light incident upon said photosensitive member, means for transmitting said picture signals, means for receiving said picture signals, means for reproducing the television picture in substantially white light in accordance with the received picture signals, second color filtering means disposed between said picture of white light and an observer, said second color filtering means comprising a plurality of transparent color filters and being adapted successively to select from said image of white light predetermined ones of a second set of primary colors, said second set of primary colors differing from those selected by said first color filtering means.

4. A system for transmitting and receiving television pictures in natural colors comprising a charge storage electrode, means for developing on said electrode an electrical charge image corresponding to an optical image of the object to be transmitted on said member, means cooperating with said charge storage electrode for developing picture signals representative of the light characteristics of successive elemental areas of said image in accordance with cyclically recurring scanning field patterns, first color filtering means comprising a plurality of transparent color filters disposed in the optical path between said projecting means and said photosensitive member for successively selecting different color components from the light emanating from predetermined areas of said object, thereby correspondingly to change the color of the light of said optical image, said picture signals incidentally being representative of more than one of said color components selected by said color filtering means, means for transmitting said picture signals, means for receiving said picture signals, means for reproducing the television picture in substantially white light in accordance with the received picture signals, second color filtering means disposed between said picture of white light and an observer, said second color filtering means comprising a plurality of transparent color filters and being adapted successively to select from said image of white light predetermined color components, each of said last-named color components being a mixture of the color components which are represented by said picture signals.

5. The method of transmitting and receiving television pictures in natural colors comprising the steps of projecting an optical image of the object to be transmitted on a photosensitive member, utilizing the electron emission from said photosensitive member to develop picture signals representative of the light characteristics of successive elemental areas of said image in accordance with cyclically recurring scanning field patterns, successively selecting different color components from the light emanating from predetermined areas of said object, thereby correspondingly to change the color of the image light incident upon said photosensitive member, transmitting said picture signals, receiving said picture signals, reproducing the television picture in substantially white light in accordance with the received picture signals, and successively selecting from said image of white light predetermined color components differing from those selected by said first color filtering means.

6. The method of transmitting and receiving television pictures in natural colors comprising the steps of projecting an optical image of the object to be transmitted on a photosensitive member, utilizing the electron emission from said photosensitive member to develop picture signals representative of the light characteristics of successive elemental areas of said image in accordance with cyclically recurring scanning field patterns, successively selecting different color components from the light emanating from predetermined areas of said object, thereby correspondingly to change the color of the image light incident upon said photosensitive member, transmitting said picture signals, receiving said picture signals, reproducing the television picture in substantially white light in accordance with the received picture signals, and successively selecting from said image of white light predetermined color components, each of said last-named color components being a mixture of a plurality of said color components successively selected from the light emanating from predetermined areas of said object.

7. The method of transmitting and receiving television pictures in natural colors comprising the steps of projecting an optical image of the object to be transmitted on a photosensitive member, utilizing the electron emission from said photosensitive member to develop picture signals representative of the light characteristics of successive elemental areas of said image in accordance with cyclically recurring scanning field patterns, successively selecting different ones of a first set of primary colors from the light emanating from predetermined areas of said object, thereby correspondingly to change the color of the image light incident upon said photosensitive member, transmitting said picture signals, receiving said picture signals, reproducing the television picture in substantially white light in accordance with the received picture signals, and

successively selecting from said image of white light predetermined ones of a second set of primary colors, the color components of said second set of primary colors differing from the color components of said first set of color components.

8. The method of transmitting and receiving television pictures in natural colors comprising the steps of projecting an optical image of the object to be transmitted on a photosensitive member, utilizing the electron emission from said photosensitive member to develop an electrical charge image corresponding to said optical image, utilizing said charge image to develop picture signals representative of the light characteristics of successive elemental areas of said image in accordance with cyclically recurring scanning field patterns, successively selecting different color components from the light emanating from predetermined areas of said object, thereby correspondingly to change the color of the image light incident upon said photosensitive member, said picture signals incidentally being representative of more than one of said color components, transmitting said picture signals, receiving said picture signals, reproducing the television picture in substantially white light in accordance with the received picture signals, and successively selecting from said image of white light predetermined color components, each of said last-named color components being a mixture of the color components which are represented by said picture signals.

MADISON CAWEIN.

CERTIFICATE OF CORRECTION.

Patent No. 2,313,224. March 9, 1943.

MADISON CAWEIN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, second column, line 57, for "colors $\bar{X}'$, $\bar{Y}'$ and Z'" read --colors X', Y' and Z'--; line 62-63, for "parameters X and Y" read --parameters $\bar{X}$ and $\bar{Y}$--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 18th day of May, A. D. 1943.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)