

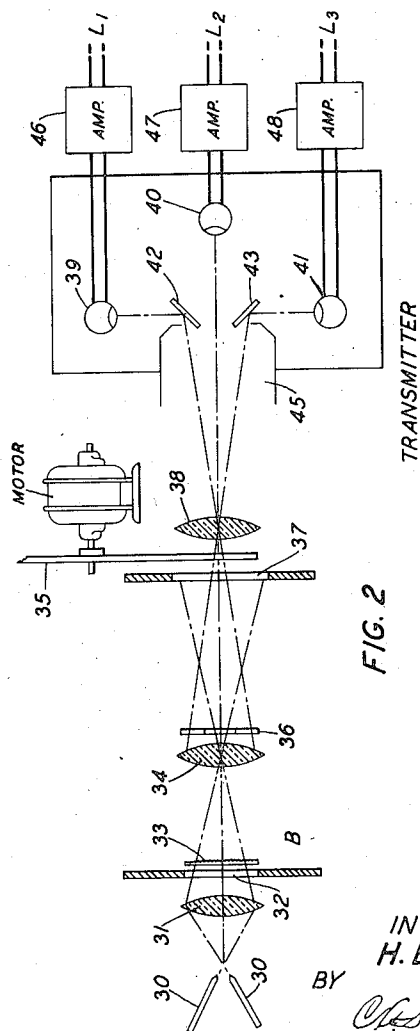
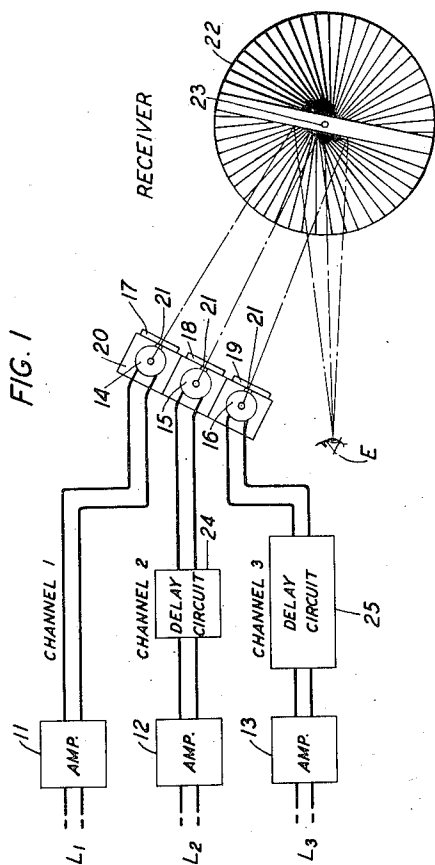
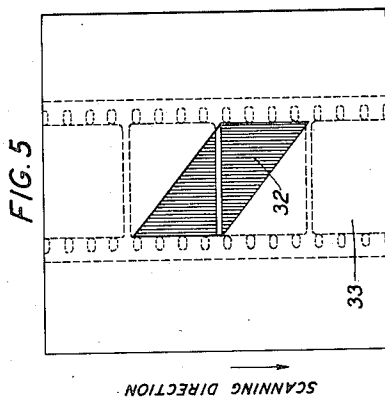
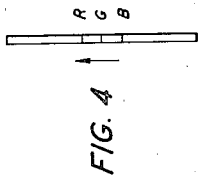
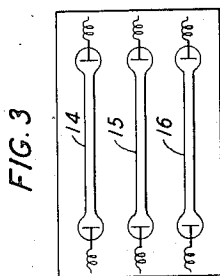
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H. E. IVES

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ELECTROOPTICAL SYSTEM

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INVENTOR
H. E. IVES

BY

C. Sprague

ATTORNEY

UNITED STATES PATENT OFFICE

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ELECTROOPTICAL SYSTEM

Herbert E. Ives, Montclair, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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5 Claims. (Cl. 178—6)

This invention relates to electro-optical systems and more particularly to television.

An object of the present invention is to provide novel means for producing television images in natural colors.

In order to produce a television image in natural colors, it is necessary to combine light of the so-called primary colors modulated in accordance with the light tone characteristics of the elemental areas of the object or field of view, an image of which is to be produced, the several beams of modulated light to be simultaneously effective with the synthesizing apparatus at the receiving station. It has already been proposed to do this with a mirror helix as the synthesizing means by mixing the several beams of modulated light of primary color in a so-called "mixing box" and using the mixed light with the helix as though it came from a single strip light source. This arrangement is wasteful of light.

In accordance with this invention, the use of the mixing box is avoided, the light sources being used to supply light separately and simultaneously to the helix. Each elemental area of the object or field of view is scanned for each of the primary colors and the resulting plurality of image signals for the same elemental area are given a phase difference with respect to each other just sufficient to compensate for the spacing of the light sources at the receiver and makes unnecessary any optical mixing means. This difference is produced by using appropriate electrical means, such as delay networks, in all except one of the circuits including the image signals.

In the preferred embodiment of the invention, an object or field of view which, for example, may be a lenticular film, is scanned and the transmitted light beam separated into three parts, each part being focused upon and adapted to actuate a photoelectric cell. The resulting image currents corresponding respectively to different primary colors of the spectrum as, for example, red, green and blue, are transmitted over separate communication channels to energize strip light sources in each channel, respectively. Inserted in two of the channels are delay networks to produce the necessary phase differences between the three image signals corresponding to the same elemental area in order to compensate for the spacing of the light sources at the receiver. Appropriate filters are used with these three light sources to produce red, green and blue light, respectively, as in a system using a mixing box. Without the use of the delay means, the

image seen by the observer in the mirror helix will consist of a red, a green and a blue image slightly displaced with respect to each other because of the physical displacement of the red, green and blue strip light sources from each other. Because of the introduction of the delay networks into the circuits controlling two of the sources, the images produced by these two sources are sufficiently delayed so that all three images are superimposed.

This invention is preferably adapted to reception of images televised from a lenticular kodachrome film, but is not necessarily limited to such for it could be used with a colored object or film if appropriate filters are used at the transmitter.

The invention will be more readily understood by referring to the following description taken in connection with the accompanying drawing forming a part thereof, in which:

Fig. 1 is a schematic diagram of a receiving system in which delay means are used for viewing an image in color;

Fig. 2 shows a transmitting system for televising from a lenticular film over a plurality of channels;

Fig. 3 is a detail view of the strip light sources used in the receiving system of Fig. 1;

Fig. 4 shows a single element of the mirror helix used at the receiver in a situation where delay means are not used; and

Fig. 5 is a detail view showing the shape of the aperture for vertical scanning of the lenticular film used at the transmitter.

Referring more particularly to the drawing, Fig. 1 shows a receiver for a color television system. Image currents from the transmitter, corresponding respectively to red, green and blue portions of the original object, are sent over line or carrier channels L_1 , L_2 , and L_3 to the amplifiers 10, 11 and 12, respectively, one of which is located in each channel. While three channels have been shown, it is to be understood that this invention is not limited to the use of that specific number. Channel 1 is connected to a light source 14 which is preferably equipped with an appropriate filter 17; channel 2 to a light source 15 preferably equipped with an appropriate filter 18; and channel 3 to a light source 16 preferably equipped with an appropriate filter 19. In practice, the source 14 may be a neon lamp, with its filter 17 equipped to give red light, and the sources 15 and 16 may be mercury lamps. In this latter case, the filters 18 and 19 are appropriate to give green and blue light, respectively. Other appropriate light sources may be used, such as, for example, a

helium light with appropriate filter to give a green light bluer than the mercury green light which is somewhat too yellow. If light sources are used which inherently produce light radiations of the different wave lengths or colors, the filters are not necessary. For a more complete description of suitable light sources and filters for the receiving station, reference may be made to an article on "Television in colors by a beam scanning method" by H. E. Ives and A. L. Johnsrud in the Journal of the Optical Society of America, January 1930, pages 11 to 22.

The light sources 14, 15, and 16 are preferably mounted in the same plane, as shown in Fig. 3, in individual compartments of a light-proof receptacle 20. The receptacle 20 has tiny apertures 21 (one for each light source) so that three parallel strip light sources are produced.

The light from these three sources is directed on a mirror helix 22 having a horizontal axis 23. This helix comprises a number of rectangular strips threaded on the shaft 23 and progressively annularly displaced. This helix is constructed in accordance with the disclosure in Patent No. 1,964,580 issued June 26, 1934 to H. E. Ives. The reflecting faces of the mirror elements of the mirror helix 22 are preferably made concave cylindrical surfaces as described in this patent. In this way the light sources 14, 15 and 16 may be located closer to the mirror helix 22 for a given position of the observer's eye E than in the case where the reflecting surfaces are plane mirrors.

If it is assumed that the signals in the connecting lines L_1 , L_2 , and L_3 are in phase and there are no delay means at the receiver, the eye E of the observer will see a red, a green and a blue image slightly displaced with respect to each other. If, however, delay circuits 24 and 25 are introduced into channels 2 and 3, the images produced by the lamps 15 and 16 can be delayed sufficiently so that identical signals are seen in the mirror helix image when the reflected images of the lamps occupy the same positions with respect to the eye E.

The method of operation of the delay circuits is shown in greater detail in Fig. 4 where a single element of the mirror helix 22 is shown. The mirror spiral is supposed to rotate in such a way on a horizontal axis that the reflected images of the capillary lamps 14, 15, and 16 move upward in the direction of the arrow. If it is imagined that the red image is seen without delay at R, then the green and blue images would be seen at G and B, respectively, in the same phase as the image at R. At some previous time, however, the red image has occupied the positions G and B in turn and if the delay circuits are properly calculated the green and blue images can be put in the phase of the red image when it occupied these positions. The three images will then be identical and superposed. In practice, the green image is delayed a period of time of the order of 165 micro-seconds and the blue image delay is of the order of 330 micro-seconds. Of course, this value depends on the construction of the mirror helix, the number of frames scanned per second, the spacing of the lamps 14, 15, and 16 from each other, and their distance from the mirror helix 22. The specific time delays mentioned above correspond to a mirror helix of forty-eight mirror elements, and a film scanned twenty frames per second.

Any well-known transmitter may be used with this receiving system provided the image is

scanned to give separate image currents corresponding to green, blue and red components of the original object, in phase with each other and that each image is transmitted over a separate communication channel. In Fig. 2, there is shown a suitable transmitter for use with the receiver shown in Fig. 1. In this transmitter, a lenticular film having a photographic record, that is, prepared by the well-known Kodacolor or similar process, is continuously moved across a slot which is illuminated by light supplied from a source through a condensing lens. Each line illuminated through the slot is scanned through an aperture in a rotating disc to project a three-part light beam produced by the lens system including the lenticular element of the film. The three parts of the light beam are applied to three light sensitive cells each of which is in a separate communication channel. The lenticular film is preferably scanned in a vertical direction inasmuch as a horizontal axis mirror helix is used at the receiving end. Of course, it will be understood that it is within the scope of this invention to scan in a horizontal direction at the transmitter and use a vertical axis mirror helix at the receiver.

Referring more particularly to the transmitter in Fig. 2, the light source 30 supplies light to a condensing lens system 31 which projects the beam of light through an aperture 32 and a lenticular film 33. The film 33 is a finished motion picture film which may be produced by the Kodacolor process, or film of similar type, i. e., provided on one surface with a continuous series of lenticular elements, and, on its other surface, with a photographic emulsion which has been exposed through a lens having associated therewith a three-color filter and afterwards developed in accordance with well-known practice. The image carried by the film is black and white but comprises a triple linear mosaic produced by the lenticular ridges on the film. The light beam passes through the aperture 32 (the shape of which will be more fully described below) and the film 33 to lens 34 which focuses the beam on a scanning disc 35 the film 33 and the disc 35 being at conjugate foci of the lens 34.

Between the lens 34 and the scanning disc 35 is a light divider 36 for separating the beam of light into three parts, and an aperture 37 which is the reverse of aperture 32. The shape of this aperture 32 which is shown in greater detail in Fig. 5 is necessary because of the continuous movement of the film during the scanning period. The elemental areas of the film scanned by the scanning disc 35 are projected by means of the lens 38 in a three-part beam to the photo cells 39, 40, and 41, respectively. The middle part of the light beam is applied to the cell 40 directly while the two other parts of the beam are respectively reflected to the two other cells 39 and 41 by means of mirrors 42 and 43, respectively. Cells 39, 40, and 41 do not need to be color selective, no color filters need be employed, and the light preferably employed is white, although any ordinary light source may be used. The cells and the mirrors are contained in a light-tight box 44 having an opening 45 therein for the entrance of the three-part light beam.

Films 39, 40, and 41 are thereby each activated to cause the production of an image current, each current corresponding respectively to a different primary color of the original object as, for example, red, green or blue. The three image cur-

rents after amplification in the devices 46, 47, and 48, respectively, are transmitted over separate communication channels L_1 , L_2 , and L_3 to a receiver such as the one shown in Fig. 1. Channels L_1 , L_2 , and L_3 may be separate conductive circuits or separate channels of a carrier line or radio system.

Fig. 5 is an enlarged view of the scanning aperture or window 32 showing its relation to the film 33. The shape of this aperture 32 is necessary because of the movement in an upward direction of the continuously moving film 33 during the time it takes to scan one frame of the picture. If the disc 35 is of a sufficient diameter the shape of the aperture constitutes approximately a parallelogram but if a smaller disc is used, the vertical sides of the aperture tend to be arcuate and the scanning done in arcs of circles rather than in straight vertical lines. With the discs generally employed, however, the scanning is substantially in straight vertical lines and the corresponding sides of the aperture are approximately parallel to each other. For a more complete disclosure of this type of vertical scanning, reference should be made to application Serial No. 700,413 of H. E. Ives filed December 1, 1933.

The operation of the transmitting system is as follows: The lenticular film 33 is scanned vertically to produce a three-part beam, each part of which energizes one of the photoelectric cells 39, 40, and 41. These cells transmit three image currents over the transmission line or carrier channels L_1 , L_2 , and L_3 to the receiving amplifiers 11, 12, and 13, respectively. Up to this point the image currents in channels 1, 2, and 3 are in phase with each other. To compensate for the spacing of the strip light sources 14, 15, and 16 from each other, it is necessary to delay the signals in channel 2 by a certain short period of time and the signals in channel 3 by a short period of time which is approximately twice that of channel 2. This delay is caused by the delay circuits 24 and 25. Thus, by means of these delay circuits and appropriate light sources 17, 18, and 19, a superposed image in red, green and blue (which combine to form one image in natural color) is reflected by the mirror helix 22 and observed by the eye E. It should be noted that the light from the three sources 14, 15, and 16 is not superposed. It is rather the image of these light sources as reflected from the mirror helix 22 that is superposed.

While the delay circuits have been described and shown as being in the receiving circuit, it is, of course, obvious that it is within the scope of this invention to insert these delay circuits at the transmitter or at any point in the transmission lines. In the case of radio or wire broadcasting, it is especially desirable to have the delay networks at the transmission end so that only one set of networks is used instead of the many which would be necessary where a number of receivers are operating with a single transmitter. It is obvious also that the means for producing the out-of-phase relationship between the image currents generated by the light sensitive elements may take some other form than electrical networks as, for example, magnetic or other temporary storage elements.

While this invention has been described for use in connection with a mirror helix, it is obvious that any other suitable rotating scanning device having a plurality of light directing means, each of which simultaneously cooperates with a

plurality of fixed, separated light sources for producing a composite image in color may be used as well as, for example, a lensed disc.

Various other modifications may obviously be made without departing from the spirit of the invention, the scope of the invention being defined by the appended claims.

What is claimed is:

1. An electro-optical system comprising a rotating scanning device having a plurality of light directing elements equal in number to the number of elemental lines of the image, a plurality of light sources simultaneously cooperating with each of said light directing elements in turn, said light sources being such that when light from the different sources is mixed in different proportions, the various colors of the spectrum are produced, and electrical means including transmission channels and delay networks in at least one of said channels for producing and impressing on said sources, respectively, a plurality of independent out-of-phase image currents respectively representative of the light tone values of the elemental areas of a field of view taken in succession along parallel elemental strips thereof but for different primary colors corresponding, respectively, to the light from said sources, the difference or differences in phase of said currents being of such value as to compensate for the separation of said sources, whereby a plurality of complete images of said field are set up by said rotating scanning device in cooperation with said sources, which images are substantially superimposed to produce a composite image in natural colors.

2. An electro-optical system for producing images in natural color comprising at a receiving station a mirror helix and a plurality of strip light sources such that when light from the different sources is mixed in different proportions, the various colors of the spectrum are produced, said sources being parallel to the axis of rotation of said mirror helix and having their long axes in different planes intersecting in said axis, and electrical means including transmission channels and delay networks in at least one of said channels for producing and impressing on said sources, respectively, a plurality of independent out-of-phase image currents respectively representative of the light tone values of the elemental areas of a field of view taken in succession along parallel elemental strips thereof but for different primary colors corresponding, respectively, to the light from said sources, the difference or differences in phase of said currents being of such value as to compensate for the separation of said sources, whereby a plurality of complete images of said field are set up by said helix in cooperation with said sources which are substantially superimposed to produce a composite image in natural colors.

3. An electro-optical system as described in claim 1 in which said delay networks are inserted in the circuits including all of the light sources except one.

4. An electro-optical system for producing images in natural color comprising at a receiving station a rotating scanning device having a plurality of light directing elements equal in number to the number of elemental lines of the image, a plurality of light sources simultaneously cooperating with each of said light directing elements in turn, said light sources being such that when light from the different sources is mixed in different proportions, the various colors of the

spectrum are produced, means for producing a plurality of independent in-phase image currents respectively representative of the light tone values of the elemental areas of a field of view
5 taken in succession along parallel elemental strips thereof but for different primary colors corresponding, respectively, to the light from said sources, means for impressing said currents on
10 different channels, respectively, means including delay networks and electrical input and output circuits therefor for making each of said currents out of phase with the other or others, and means for impressing said out-of-phase currents on said

sources, the difference or differences in phase of said currents being of such value as to compensate for the separation of said sources, whereby a plurality of complete images of said field are set up by said rotating scanning device in cooperation
5 with said sources which are substantially superimposed to produce a composite image in natural colors.

5. An electro-optical system, as described in claim 5, in which said delay networks are inserted
10 in the circuits transmitting current to all of the light sources except one.

HERBERT E. IVES.