Aug. 30, 1932. H. E. IVES 1,874,191

ELECTROOPTICAL SYSTEM

Filed Oct. 4, 1930 2 Sheets-Sheet 1

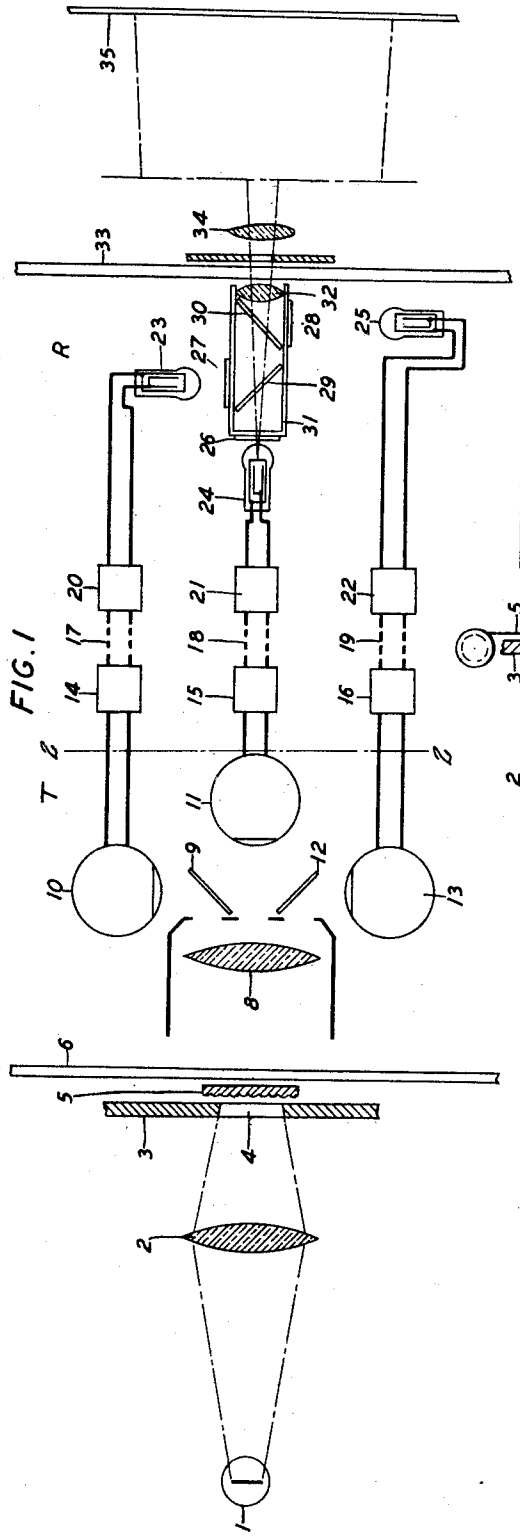

FIG. 1

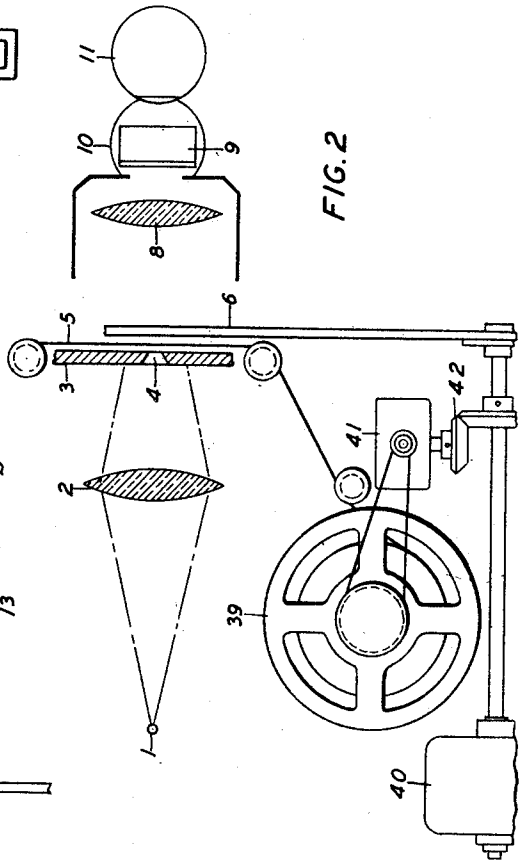

FIG. 2

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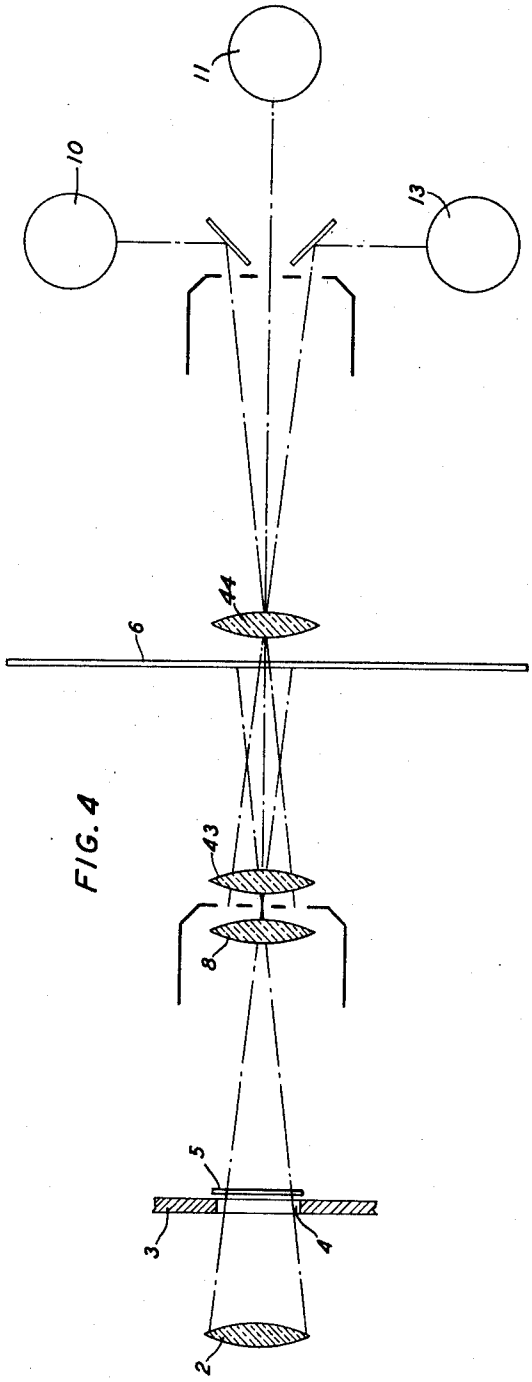

FIG. 4

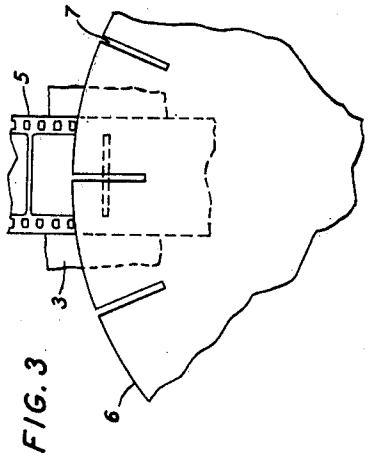

FIG. 3

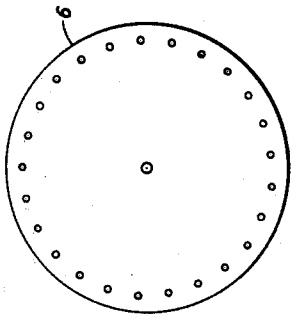

FIG. 5

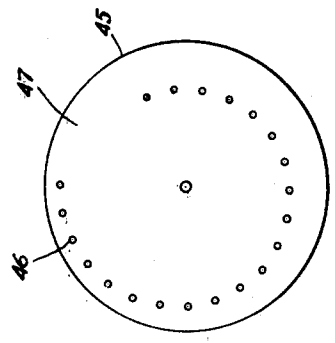

FIG. 6

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UNITED STATES PATENT OFFICE

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ELECTROOPTICAL SYSTEM

Application filed October 4, 1930. Serial No. 486,363.

This invention relates to electro-optical systems and more particularly to the production of colored images.

The prior art discloses systems for electrically producing images in color from a colored record.

An object of the present invention is to utilize a non-color record for electrically producing images in color.

By way of illustration a limited number of embodiments will be described. In one embodiment, a lenticular film having a photographic record, i. e., prepared by the Kodacolor 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 by an aperture in a rotating disc to project a three-part light beam produced by the lens system including the lenticular elements of the film. One part of the light beam is applied to a light sensitive cell directly, while the two other parts of the beam are respectively reflected to two other cells. These cells do not need to be color selective, since no color filters are employed and the light preferably employed is white, although any ordinary light source may be used. The image currents, respectively resulting from the activation of the three cells, are separately transmitted to the receiving station where they control light sources adapted to cooperate with a filter to supply, respectively, red, green and blue light radiations which are combined by semi-transparent mirrors to produce a composite light beam which passes through apertures in a scanning disc and an optical system to produce an image in color which may be projected upon a screen or which may be directly observed. Suitable systems for so utilizing the image currents are disclosed in the application of H. E. Ives, Serial No. 218,631, filed September 10, 1927, and in an application of H. E. Ives, Serial No. 488,304, filed Oct. 13, 1930.

Fig. 1 is a schematic illustration of a system embodying the invention, the transmitting apparatus being shown in plan;

Fig. 2 is a view in elevation of the transmitting apparatus of Fig. 1 at the left of section line 2—2, one of the photoelectric cells being omitted;

Fig. 3 is a detail illustrating features of the scanning mechanism of Fig. 1;

Fig. 4 is a schematic illustration of an alternative arrangement of the scanning apparatus;

Fig. 5 shows a scanning disc for use in the system of Fig. 4; and

Fig. 6 illustrates a scanning disc which may be used when the film is intermittently driven.

Referring now to Fig. 1 there is shown a television system having a transmitter T and a receiver R. The transmitter comprises a constant light source 1, and a lens 2 for projecting the light radiations supplied by the source 1 upon a mask 3 provided with a slot 4. Adjacent the mask is a photographic record 5 moving in a direction transversely of the slot, a rotating disc 6 provided with slots 7 and a lens 8.

The record is a finished motion picture film which may be produced by the Kodacolor process, or a film of similar type, i. e., provided on one surface with a continuous series of lenticular elements and, on its other surface, with 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.

Light passes through the slot 4 and successive lines of the film, as it passes thereacross and through the cross-slot resulting from the cooperation of the stationary slot 4 with movable slots 7 in the rotating disc 6, to produce a moving beam of light comprising three parts corresponding to the respective colors of the filters through which the record is made.

The three part beam is projected by the lens 8, one part upon a mirror 9 which directs it to a photoelectric cell 10, a second part directly upon a photoelectric cell 11, and the third part upon a mirror 12 which directs it to a photoelectric cell 13.

Cells 10, 11 and 13 are thereby each activated to cause the production of an image current. The three image currents after amplification in the devices 14, 15 and 16, respectively, are transmitted over separate communicating channels 17, 18 and 19. In this manner, an image current, corresponding to the color of each filter through which the record is made is produced and separately transmitted to a receiver R. Channels 17, 18 and 19 may be separate conductive circuits or separate channels of a carrier line or radio system.

At the receiving station R, the currents transmitted over the three channels are respectively supplied to the amplifiers 20, 21 and 22. The amplified currents are respectively supplied to the light sources 23, 24 and 25, which may comprise lamps of the type disclosed in an application of H. W. Weinhart, Serial No. 441,792, filed April 5, 1930. Light emitted from these lamps passes respectively through color filters 26, 27 and 28 to produce the primary colors red, green and blue, which when combined in the proper amounts produce a good quality of white light. Any other suitable known light sources may be substituted for those herein shown.

After passing through the color filters, the light supplied by the three sources is directed into a common path by means of the transparent mirrors 29 and 30 in the chamber 31. The composite or mixed beam of light comprising the three primary colors, is transmitted through the lens 32, apertures in the scanning disc 33 and lens 34 to a screen 35.

In accordance with well known practice, a spiral row of apertures is provided in the scanning disc 33, which is driven in synchronism and in phase with the scanning disc 6 at the transmitter. A suitable system for this purpose is disclosed in an application of H. M. Stoller, Serial No. 442,564, filed April 8, 1930.

Discs 6 and 33 are rotated at such a speed that a complete frame of the film is scanned at the transmitter and a complete image thereof is produced at the receiver during each revolution of the discs and at a rate within the period of persistence of vision, to produce an image upon the screen 35.

While the successive frames of the film are scanned line by line at the transmitter, the spiral of apertures of disc 33 serves to spread the lines out at the receiver to constitute a complete image of each of the frames scanned at the transmitter.

By properly adjusting the gain of the respective amplifiers, supplying image currents to the lamps 23, 24 and 25, and by using filters 26, 27 and 28 of suitable densities, the amount of red, green and blue light, respectively, may be regulated to produce a composite beam of white light which is modified to correspond in color to the color characteristics of the successive elemental areas of the film being transmitted.

Fig. 2 shows the light source 1, lens 2, mask 3, with its slot 4, film 5, scanning disc 6, lens 8, two photoelectric cells 10 and 11 and one mirror 9. For the sake of clarity, the mirror 12 and cell 13, have been omitted. The motion picture film is carried by a reel (not shown), passes over the rollers and is wound on the reel 39.

The scanning disc 6 is driven at the desired rate by a suitable motor, herein shown as an electric motor 40. The film is unwound from the carrying reel and wound upon the reel 39 by a driving unit 41. For proper operation, the film must travel continuously at a constant rate of speed definitely related to the rate of rotation of the disc 6. This may be accomplished by providing a driving unit 41, connected to the reel 39 by a belt and a slip clutch, as in standard motion picture practice, coupled to the shaft of motor 40 by a gearing 42 having the desired gear ratio.

As shown in Fig. 3, the slots 7 in the disc 6 sweep across the slot 4 in the mask 3 to produce a continuously moving aperture through which light, illuminating successive elemental areas of each line of the frame of film 5, passes to the photoelectric cells.

If color fringes are to be avoided, the apparatus described above requires that the slot 4, film 5 and disc 6 be placed as close together as possible or substantially in contact with each other. This condition offers some difficulty, since both the film and disc are moving at high speed and in different directions. To overcome this difficulty, the transmitter of Fig. 4 may be used as a substitute for that shown in the system of Fig. 1.

Referring to Fig. 4, light is supplied by a source (not shown) through a lens 2, to a mask 3, provided with a slot 4, continuously moving film 5, scanning disc 6, lens 8 and photoelectric cells 10, 11 and 13. As in Fig. 1, the cells are adapted to be respectively connected through amplifiers, 14, 15 and 16 to communicating channels 17, 18 and 19. In addition, this transmitter comprises a lens 43 positioned between the lens 8 and the scanning disc 6 for producing a magnified image of the illuminated slot 4 in the plane of scanning disc 6, which is provided with a row of apertures arranged in a circle as illustrated in Fig. 5. The apertures sweep across the magnified image of slot 4 to provide a continuously moving three-part beam of light, the respective parts of which are projected by an optical system including lens 44 upon and activate the photoelectric cells 10, 11 and 13.

By means of the lens 43, the image may be placed accurately in the plane of the disc and color fringes are avoided. Its use permits the disc to be mounted in a position remote

from the moving film, whereby these rapidly moving elements may be separated and hence liability of damage to the film is eliminated. Again, whereas in the system of Fig. 1 a very small image is scanned and therefore a small scanning disc provided with slots must be used, the alternative arrangement permits the use of a disc of convenient size, which is provided with apertures.

Instead of moving the film continuously as described above, the film may be driven intermittently, frame by frame, in accordance with standard practice in motion picture projection.

To provide for intermittent operation, the systems of Figs. 1 and 4 are modified by providing a mask 3 having an opening 4 commensurate with the size of a picture frame, and the scanning disc 6 is replaced by the disc 45 shown in Fig. 6.

Disc 45 is provided with a row of apertures 46 arranged in a spiral, the initial and last apertures being spaced apart to provide a blank sector 47, corresponding to the period of time required to shift from one frame of the film to the next, and a similar disc must be used at the receiver. As in the systems previously described, the discs 45 must be driven at a rate of speed such that each frame is completely scanned and the image produced within the period of persistence of vision, and they must be operated in synchronism.

If transmission is effected over a carrier line or radio system, the picture currents supplied by the amplifiers 14, 15 and 16, respectively, are each combined with a carrier wave of fixed frequency. In accordance with standard practice the frequencies of the waves used in the respective channels will be different. At the receiver the various picture current modulated carrier waves are separated and detected to each yield the picture currents individual to the channels, which are respectively supplied to the amplifiers 20, 21 and 22. A suitable system for carrier transmission is disclosed in U. S. Patent 1,313,483, August 19, 1919, to Heising.

The invention is not confined to the use of ridged lenticular film. Other types of lenticular or like emulsion carrying material may be used. The term "film" is used herein to denote, not only the well known celluloid film, but also forms of emulsion carrying material other than celluloid film, provided the lenticular elemental structure is retained.

While it is stated that filters 26, 27 and 28 transmit red, green and blue light, respectively, a more correct statement is that each of the filters transmits a band in which the primary color is present.

What is claimed is:

1. An apparatus for producing image currents for controlling the production of images in color comprising light sensitive electric elements, a record representative of an object or view having unlike portions corresponding to different color characteristics of the same part of the object or view, means for successively scanning elemental areas of said record, and means for directing light simultaneously from said portions to different ones respectively of said light sensitive electric elements to produce separate image currents.

2. An apparatus for producing image currents for controlling the production of images in color comprising light sensitive electric elements, a record representative of an object or view having unlike portions corresponding to different color characteristics of the same part of the object or view, means for successively scanning elemental areas of said record, and means comprising lenticular elements for directing light simultaneously from said portions to different ones respectively of said light sensitive electric elements to produce separate image currents.

3. An apparatus for producing image currents for controlling the production of images in color comprising light sensitive electric elements, a record representative of an object or view having unlike portions corresponding to different color characteristics of the same part of the object or view, means for successively scanning elemental areas of said record, and means comprising lenticular areas unitary with said record for directing light simultaneously passing through said portions respectively to a different one of said light sensitive elements.

4. An apparatus for producing image currents for controlling the production of images in color comprising light sensitive electric elements, a lenticular photographic record representative of an object or view having unlike portions corresponding to different color characteristics of the same part of the object or view, means for successively scanning elemental areas of said record, and means including the lenticulations of said record for directing light simultaneously from said portions to different ones respectively of said light sensitive electric elements to produce separate image currents.

5. An apparatus for producing image currents for controlling the production of images in color comprising light sensitive electric elements, a record representative of an object or view having unlike portions corresponding to different color characteristics of the same part of the object or view, means for successively scanning elemental areas of said record, and means including light deflecting elements for directing light simultaneously passing through said portions respectively to certain of said light sensitive elements.

6. An apparatus for producing image currents for controlling the production of images in color comprising light sensitive electric

elements, a lenticular record representative of an object or view having unlike portions corresponding to different color characteristics of the same part of the object or view, means for successively scanning elemental areas of said record, and means including the lenticulations of said record and a plurality of light simultaneously deflecting means for directing light from said portions to different ones respectively of said light sensitive electric elements to produce separate image currents.

7. An apparatus for producing image currents for controlling the production of images in color comprising light sensitive electric elements, a record representative of an object or view having unlike portions corresponding to different color characteristics of the same part of the object or view, cyclically moving means remote from said record for successively scanning elemental areas of said record, and means for directing light simultaneously from said portions to different ones respectively of said light sensitive electric elements to produce separate image currents.

8. An apparatus for producing image currents for controlling the production of images in color comprising a lenticulated record representative of an object or view having unlike portions corresponding to different color characteristics of the same part of the object or view, means for continuously moving said record, a source of light, a light baffle having a slot therein transverse to the length of said record, a cyclically moving scanning member having openings therein, a plurality of light sensitive electric elements, light deflecting means associated with said last mentioned elements, and means including the lenticulations of said record and said light deflecting means for causing light from said source to pass through said slot, said record and the openings of said cyclically moving members so that the light passing through said unlike portions of said record falls upon different ones of said light sensitive electric elements.

9. An apparatus for producing image currents for controlling the production of images in color from a color record in the form of a lenticulated photographic film comprising a source of light and a plurality of light sensitive electric elements, and an optical system therebetween comprising light condensing means, a slotted baffle, the photographic record, a second light condensing means, a cyclically moving scanning member having apertures therein, a third light condensing means and light deflecting means whereby light passing through different juxtaposed small portions of said film is directed respectively to said light sensitive electric elements.

10. An apparatus for producing image currents for controlling the production of images in color comprising a lenticular photographic film, means for continuously moving said film, a slotted baffle past which said film moves, a slotted scanning disc cooperating with said slotted baffle to scan said film, a plurality of light sensitive electric means, and means including the lenticulations of said film for simultaneously directing light from different portions of said film to said light sensitive electric elements respectively to produce separate image currents.

In witness whereof, I hereunto subscribe my name this 30th day of September, 1930.

HERBERT E. IVES.

DISCLAIMER

1,874,191.—*Herbert E. Ives*, Montclair, N. J. ELECTROOPTICAL SYSTEM. Patent dated August 30, 1932. Disclaimer filed October 19, 1935, by the assignee, *Bell Telephone Laboratories, Incorporated.*

Hereby enters this disclaimer to the said claims of said Letters Patent which are in the following words, to wit:

"1. An apparatus for producing image currents for controlling the production of images in color comprising light sensitive electric elements, a record representative of an object or view having unlike portions corresponding to different color characteristics of the same part of the object or view, means for successively scanning elemental areas of said record, and means for directing light simultaneously from said portions to different ones respectively of said light sensitive electric elements to produce separate image currents.

"2. An apparatus for producing image currents for controlling the production of images in color comprising light sensitive electric elements, a record representative of an object or view having unlike portions corresponding to different color characteristics of the same part of the object or view, means for successively scanning elemental areas of said record, and means comprising lenticular elements for directing light simultaneously from said portions to different ones respectively of said light sensitive electric elements to produce separate image currents."

"5. An apparatus for producing image currents for controlling the production of images in color comprising light sensitive electric elements, a record representative of an object or view having unlike portions corresponding to different color characteristics of the same part of the object or view, means for successively scanning elemental areas of said record, and means including light deflecting elements for directing light simultaneously passing through said portions respectively to certain of said light sensitive elements."

"7. An apparatus for producing image currents for controlling the production of images in color comprising light sensitive electric elements, a record representative of an object or view having unlike portions corresponding to different color characteristics of the same part of the object or view, cyclically moving means remote from said record, for successively scanning elemental areas of said record, and means for directing light simultaneously from said portions to different ones respectively of said light sensitive electric elements to produce separate image currents."

[*Official Gazette November 12, 1935.*]