Jan. 5, 1932. A. WEAVER ET AL 1,839,361

IMAGE PRODUCING SYSTEM

Original Filed Dec. 19, 1923 2 Sheets-Sheet 1

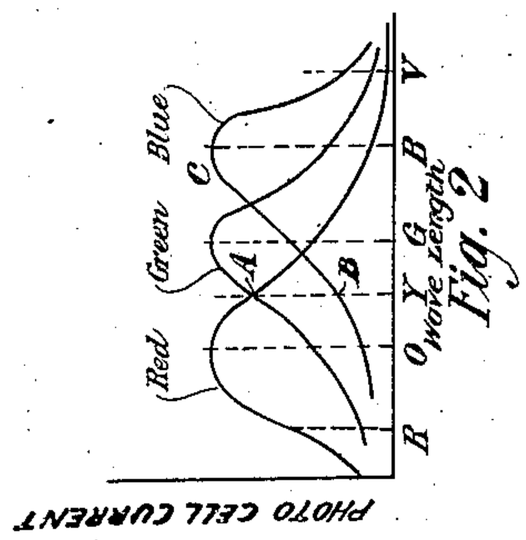

Fig. 2

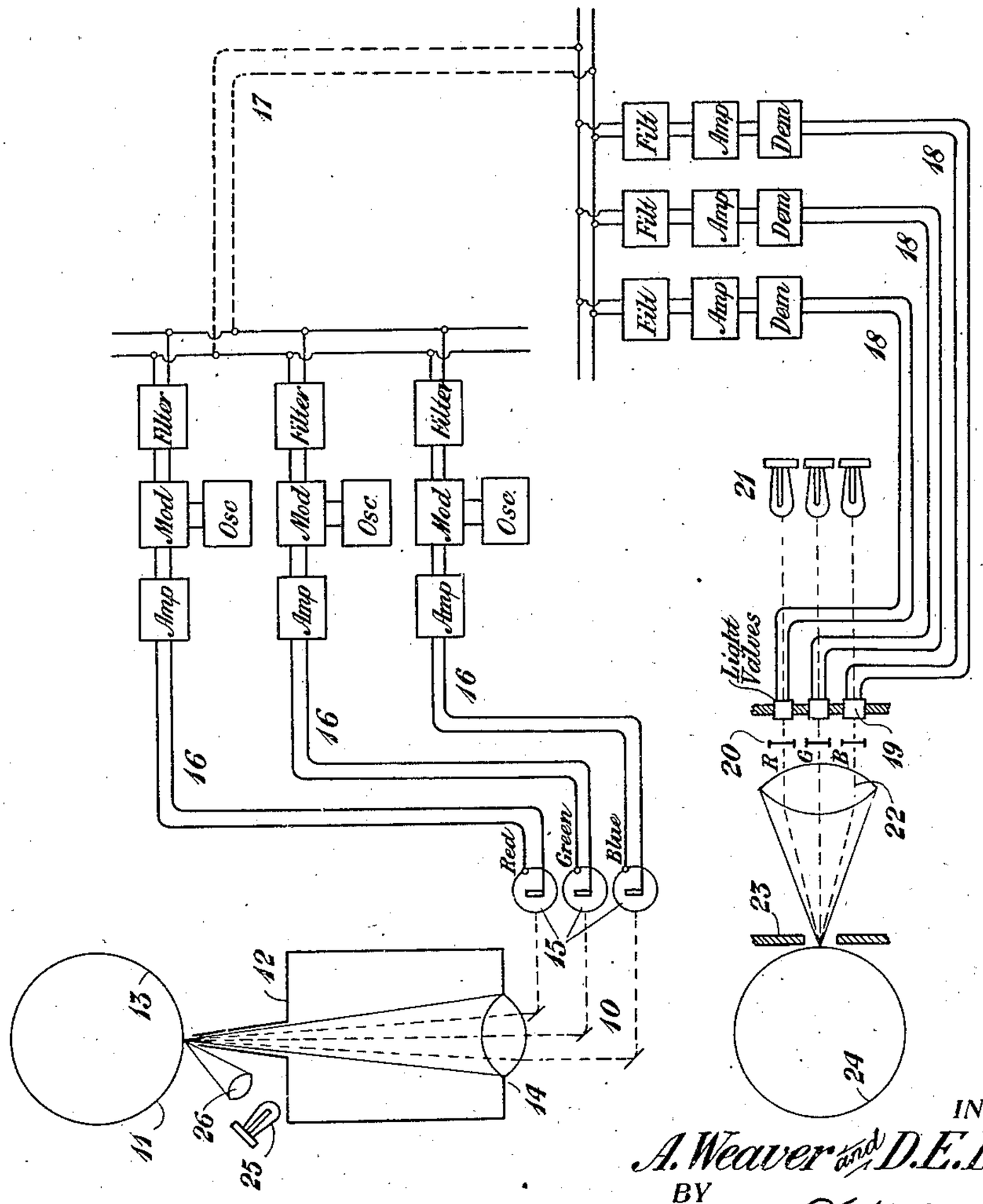

Fig. 1

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IMAGE PRODUCING SYSTEM

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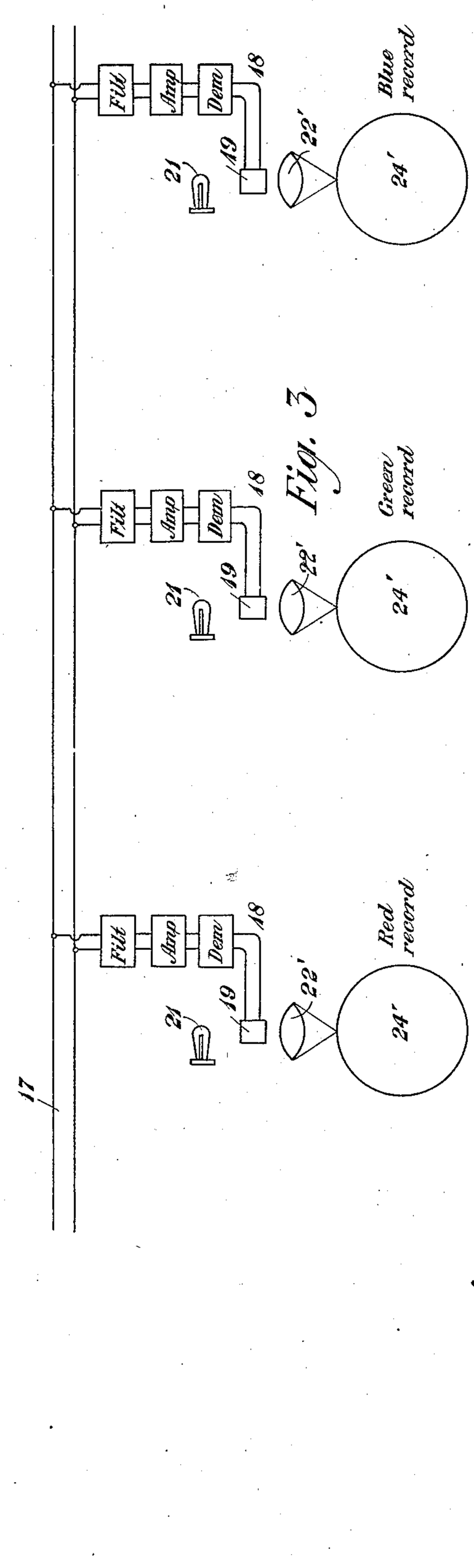

Fig. 3

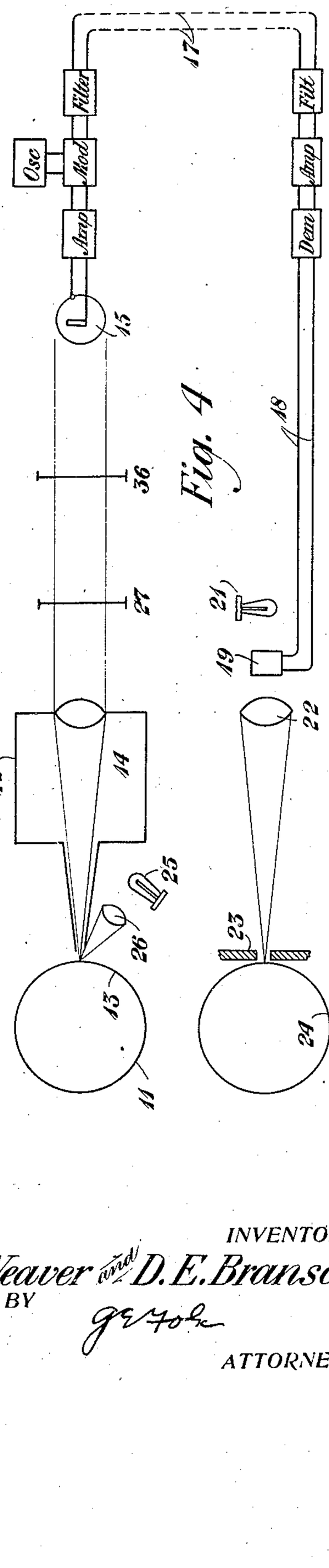

Fig. 4

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UNITED STATES PATENT OFFICE

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IMAGE PRODUCING SYSTEM

Application filed December 19, 1923, Serial No. 681,593. Renewed June 26, 1930.

The principal object of our invention is to provide a new and improved electro-optical system for producing images in natural color. Another object of our invention is to provide for analyzing the successive elements of a picture into their true colors at the transmitting end, modulating carrier currents accordingly, and at the receiving end synthesizing a ray of light by the received currents and applying it to reproduce the picture approximately in its true colors. These and other objects of our invention will become apparent on consideration of a limited number of specific examples of practice in accordance with the invention. It will be understood that the invention is defined in the appended claims and that the following description applies to these examples, which are presented by way of illustration.

Referring to the drawings, Figure 1 is a symbolic diagram of suitable apparatus for the practice of our invention; Fig. 2 is a curve diagram showing the intensities of the component lights involved and the relative responses of the several photoelectric cells; and Figs. 3 and 4 are respective diagrams of modified receiving apparatus.

Referring to Fig. 1, the colored picture 11 is wrapped upon drum 13 placed before an opening in the box 12. White light from lamp 25 is focussed by lens 26 to illuminate an element of the picture. The colored light from this element is reflected to lens 14 and thence in parallel rays to the three small mirrors 10, where the rays will be reflected to the respective photoelectric cells 15. The photoelectric cells 15 are especially designed or equipped so that one of them is sensitive only to a band of light in which red predominates, another to a band in which green predominates and another to a band in which blue predominates. The three cells are designed to respond in intensity of current in accordance with the characteristics shown in Fig. 2. This figure shows characterstic curves for each of the cells 15 (or the cells with their associated filters), the abscissæ representing the wave length of the light incident upon the cells and ordinates representing the photoelectric response. It will be observed that these curves correspond substantially to well known curves representing the color sensitivities of the human eye. These curves also represent the light transmission characteristics of the filters 20 at the receiving station. The photoelectric cells and light screens can readily be given these characteristics either by special design of the cells themselves or by using appropriate light filters.

Accordingly, the currents in the respective circuits 16 to the amplifiers will vary in magnitude in accordance with the intensity of the light of the corresponding color. The amplified currents will go to respective modulators where they will modulate carrier currents generated by the respective oscillators. The currents will then be passed through band filters and put on the line 17. At the receiving station they will be separated by the respective band filters and amplified and demodulated, so that in the circuits 18 there will be generated electric currents corresponding to those in the circuits 16 at the transmitting end. These currents in the circuits 18 will control respective light valves 19 so that the quantity of light passing from each source 21 will be proportional to the intensity of the respective current. The light passed by the light valves 19 goes through the light filters 20 to the lens 22. These filters 20 have the same characteristic curves, respectively, as shown in Fig. 2. The lens 22 synthesizes at the opening of the screen 23 the rays received thereon from the filters 20. On the drum 24 there is a film adapted to develop in colors, which is moved by means not shown in the drawings so as to synchronize the exposed point with the point that is scanned in the picture 11.

Instead of receiving the picture as indi-

cated in connection with Fig. 1, the separate lenses 22′ may be employed as in Fig. 3, each directing its corresponding beam of light on a respective synchronized film 24′. These films 24′ may be ordinary films that develop in black and white. The received picture will then be made by directing light through the three films separately and through three color filters each associated with its proper film, so that the light will register on a single receiving surface where the colors will combine to give the picture as at the transmitting end.

Another modification is shown in Fig. 4. Here instead of sending the color components simultaneously in three channels, they are sent successively in one channel. The photoelectric cell 15 is combined with light filter 36 so that the resultant characteristic of the cell is pan-chromatic. A filter 27, passing a certain color, say blue, in accordance with the corresponding curve of Fig. 2, is interposed as shown and the entire picture is analyzed, element by element, for blue. The light valve 19 at the receiving end will then allow light from source 21 to pass to film 24 according to the amount of blue there is in the picture. A film will therefore be produced with the amount of silver deposit determined by the amount of blue in the picture. Likewise, other films will be formed for other colors, each with its corresponding filter at 27. When three primary colors are used the picture will eventually be reproduced in colors as in the original. To accomplish this, the films may be used to reproduce the complete picture as explained heretofore in connection with Fig. 3.

The three films, each shaded in accordance with a respective primary component color, may be used to determine the application of the colored inks in a three-color printing process, so that the color synthesis will be effected when the printing of a picture is completed.

We claim:

1. The method of transmitting and reproducing a picture in substantially its original colors, which consists in filtering the light from successive points of the picture substantially according to the color sensitivity of the human eye, applying the component rays of primary colors to modulate respective carrier currents, and at the receiving end applying each of said currents to control one of a plurality of light valves to synthesize rays of light of the respective colors.

2. The method of recording a picture in substantially its original colors as transmitted by carrier currents for the respective colors, which consists in passing respective rays of light through filters having light transmission characteristics corresponding substantially to the color sensitivity of the eye, to get those colors, controlling those rays of light by respective light valves actuated by said carrier currents, and synthesizing the rays of light transmitted by the filters to get the picture in substantially is original colors.

3. A picture transmitting system comprising a plurality of photoelectric cells at the sending end, each sensitive to light of a particular primary color, the relative sensitivity of said cells to light of different color corresponding to the color sensitivity of the eye, means for directing the light from successive elements of the picture on said cells, means for modulating carrier currents by said cells, and a plurality of light controlling devices at the receiving end for synthesizing the picture from such currents.

4. In a picture transmitting system, means to transmit modulated carrier currents in accordance with the component colors of the successive points of a picture to be transmitted, a plurality of light valves at the receiving end each controlled by one of said carrier currents, means to pass a beam of light through a light filter through each such light valve, each filter having light transmission characteristics corresponding to the color sensitivity of the human eye, and means to synthesize the transmitted light element by element to reproduce the picture in colors.

5. In a system for transmitting a picture in substantially its original colors, a plurality of photoelectric cells each having a light response corresponding substantially to the color sensitivity of the human eye, a plurality of sources of carrier current one for each cell, means for applying the currents from said cells to modulate the respective carrier currents, a receiving station, a plurality of light sources at said station corresponding in number to the number of cells at the sending station, a photographic recording device common to said light sources, a light filter between each light source and said device, each filter having a light transmission characteristic similar to the characteristic of a corresponding cell at the transmitting station, a light valve associated with each filter controlled by the corresponding received carrier current for varying the transmitted light in accordance with the modulations of the corresponding carrier currents.

6. In a system for transmitting pictures in substantially their original and true colors, the combination of a plurality of photoelectric cells one for each of the primary colors, means for causing light from each elementary area of the picture to control the output of each of said cells, a receiving station, means for transmitting the currents from said cells to said receiving station, a plurality of light valves at said receiving station one for each of said cells, a light filter associated with each light valve each filter having light transmission characteristics similar to the light response characteristics of the corresponding cell, a photographic

recording device common to said valves, and means for synthesizing the light passed by said filters upon said recording device.

7. The method of recording a picture in substantially its original colors as transmitted by carrier currents for the respective colors, which consists in passing respective rays of light through filters to obtain those colors, each filter having light transmission characteristics corresponding substantially to the color sensitivity of the human eye, causing said rays to be controlled by respective light controlling devices, and integrating the controlled rays to obtain a record of the picture in substantially its proper colors.

8. The method of producing an image of an object in substantially the natural colors of the object which comprises illuminating elemental areas of the object in succession with a single beam of light of different colors, diffusely reflecting light from said areas, simultaneously receiving light reflected from each elemental area upon a plurality of stationary color selective means, selecting light of different colors by said means, and separately utilizing the selected light of different colors to set up electric currents.

9. Means for successively illuminating elemental areas of an object with a single beam of composite light and receiving means for receiving a portion of said composite light reflected from each of said areas, said receiving means comprising means for selecting different and overlapping bands of wave lengths of said composite light and separately utilizing said selected bands to set up electric currents.

10. Means for successively illuminating elemental areas of an object with a beam of composite light, and receiving means for receiving a portion of said composite light reflected from each of said areas, said receiving means comprising means for selecting overlapping bands of wave lengths of said composite light and for separately utilizing said selected bands to set up electric currents.

11. Means for producing an image of an object substantially in the same colors as the object comprising means for successively illuminating elemental areas of an object with a single beam of composite light, receiving means for receiving a portion of said composite light reflected from each of said areas, said receiving means comprising three separate means for selecting different overlapping bands of wave lengths of said composite light, and separately utilizing said bands to set up electric currents, and means for separately amplifying and transmitting said currents.

12. Image producing apparatus comprising means for successively illuminating the elemental areas of an object with composite light, and a plurality of stationary devices for receiving light reflected from said object and controlling the production of electric current, each of said devices differently discriminating with respect to color in said reflected light.

13. Means for producing an image of an object substantially in the same colors as the object, comprising three light receiving means for setting up current variations, said means being selectively responsive to different wide and overlapping bands of wave lengths of light, and means for simultaneously impressing upon said means composite light from an elemental area of the object and from aligned elemental areas in succession.

14. Means for producing an image of an object substantially in the same colors as the object, comprising three light receiving means for setting up current variations, said means being selectively responsive to different wide and overlapping bands of wave lengths of light, means for simultaneously impressing upon said means composite light from an elemental area of the object and from aligned elemental areas in succession, and means for separately impressing the current variations produced by said light receiving means upon channels individual thereto respectively for transmission to the point where the image is produced.

15. Means for producing an image of an object substantially in the same colors as the object, comprising three light receiving means for setting up current variations, said means being selectively responsive to different wide and overlapping bands of wave lengths of light, and means for simultaneously impressing upon said means composite light from an elemental area of the object and from aligned elemental areas in succession, the sensitivity of said light receiving means being greatest in the center of said bands and the maximum sensitivities being respectively near the center and the two ends of the visible spectrum.

16. Means for producing an image of an object substantially in the same colors as the object, comprising means for illuminating elemental areas of the object in succession and light receiving means for receiving light reflected from said object comprising at least three light selective elements for setting up currents and for receiving reflected light at different angles from said object, certain ones of said means being selective of different wide overlapping bands of wave lengths of light.

17. Means for producing an image of an object substantially in the same colors as the object, comprising means for illuminating elemental areas of the object in succession, light receiving means for receiving light reflected from said object comprising three light selective elements for setting up currents, said means being selective of different wide overlapping bands of wave lengths of light, and means at a receiving station con-

trolled respectively by said light receiving means and each comprising a source of light and a light filter for setting up a beam of light having wave lengths within the band in which the corresponding light receiving means is selective.

In testimony whereof, we have signed our names to this specification this 18th day of December, 1923.

ALLAN WEAVER.
DAVID E. BRANSON.