Dec. 3, 1929. H. E. IVES 1,738,007

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Filed May 20, 1926 3 Sheets-Sheet 1

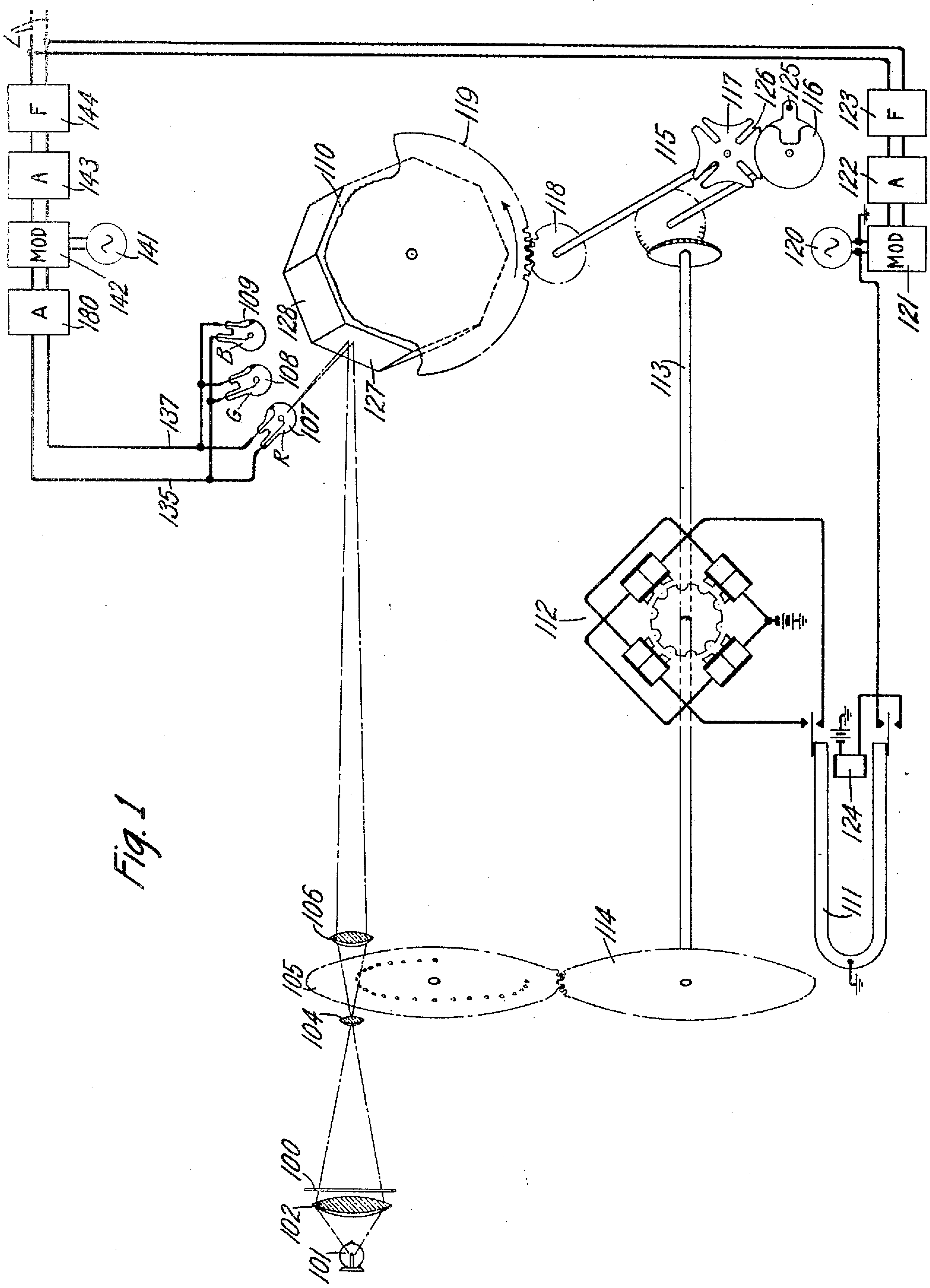

Fig. 1

Inventor:
Herbert E. Ives
by Joel C. R. Palmer Att'y

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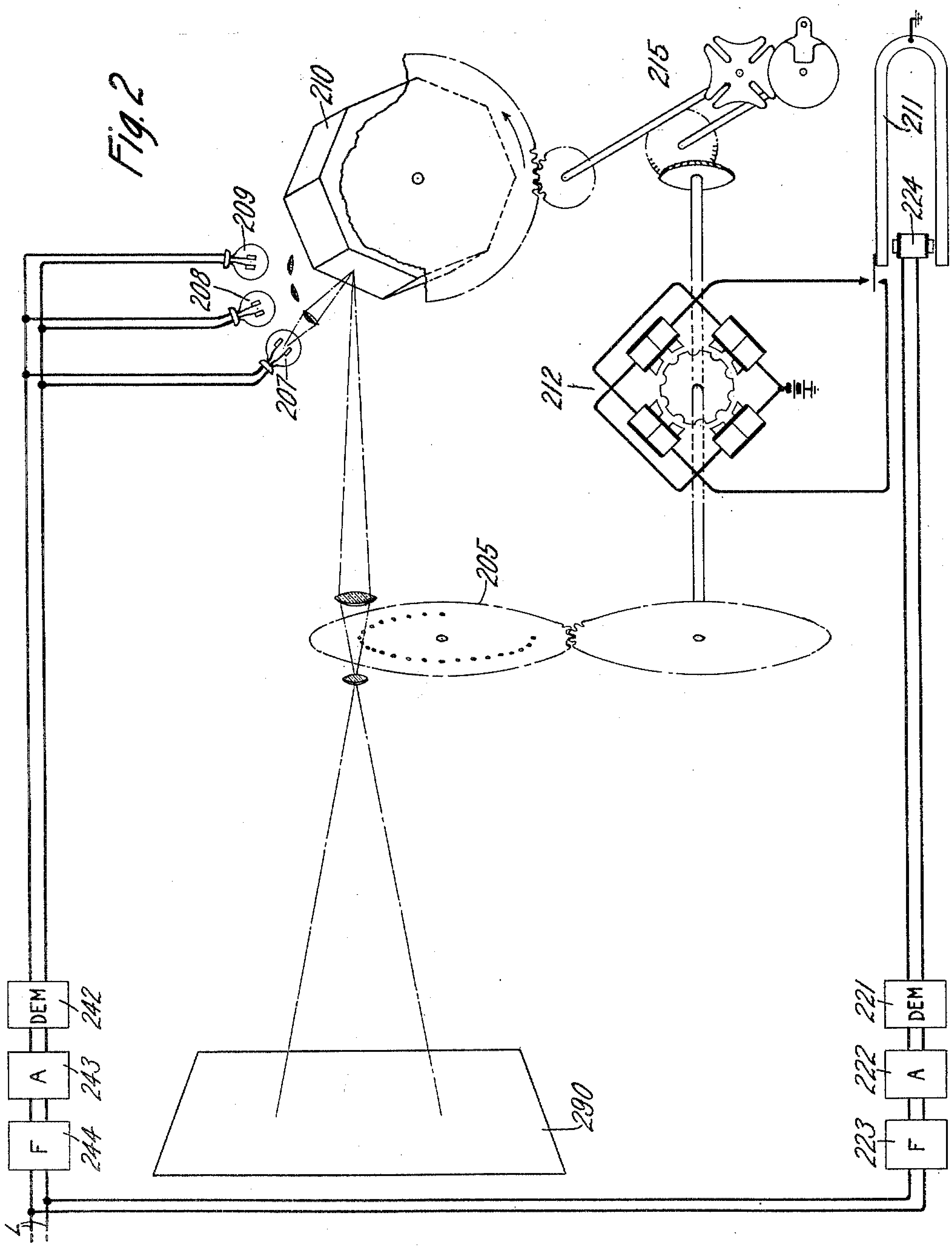
Fig. 2



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by Joel R. Palmer Att'y

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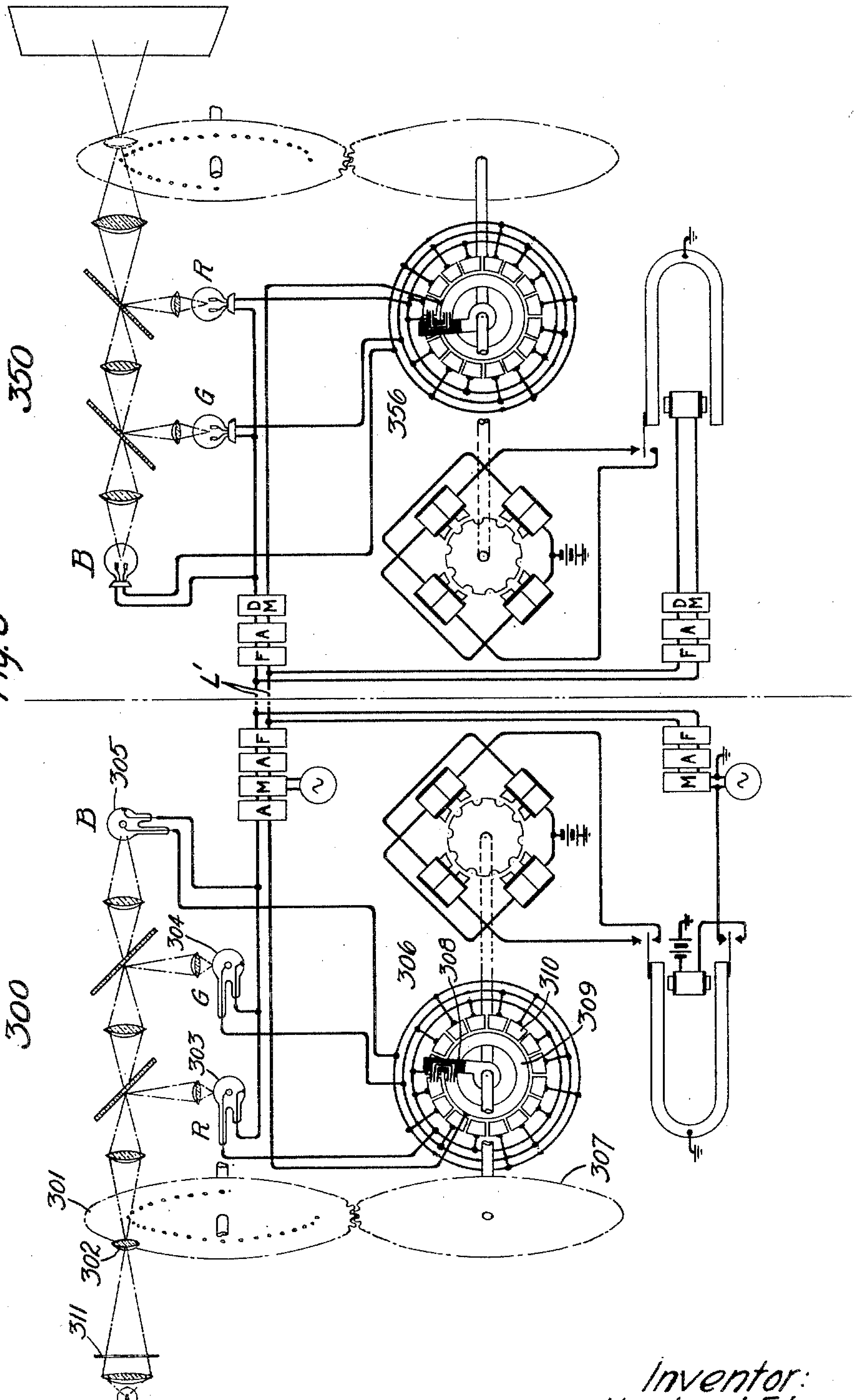
Fig. 3



Inventor:
Herbert E. Ives
by Jul. C. R. Palmer Atty

Patented Dec. 3, 1929 1,738,007

UNITED STATES PATENT OFFICE

HERBERT E. IVES, OF MONTCLAIR, NEW JERSEY, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

TELEVISION

Application filed May 20, 1926. Serial No. 110,378.

This invention relates to the electrical transmission of scenes or pictures and particularly to the reproduction of such scenes or pictures in their natural colors.

It is the principal object of the present invention to improve the scanning of a picture or view being transmitted.

It is well known in the art that pictures may be transmitted by means of an electrical system wherein a photoelectric current, which is generated corresponding to the light intensity of successive small areas of the picture, is used to modulate a carrier current. This current is demodulated at a receiving station to control the intensity of illumination of a lamp or lamps. A variety of scanning means have been proposed, one commonly used consisting of a rotating disc having a plurality of apertures therein arranged in a spiral. In the reproduction of pictures in color it has been customary either to make a record of the color values in the picture and use these records for generating the photoelectric current or to use a plurality of carrier currents for carrying the photoelectric variations where that current is generated directly. In either case the demodulated carrier current has been used to make black and white records which are subsequently used to control the production of the colored picture.

According to the present invention the scene to be transmitted is scanned repeatedly and successively for each of a plurality of primary colors. At the receiving station images are repeatedly produced in each of the primary colors in turn and projected on a screen at such a speed that the eye combines the colors. According to a modification of the invention the object is scanned in strips, successive strips being scanned for different colors and the order of the colors being changed for successive complete scannings. The receiving apparatus is arranged to reproduce the picture in strips of corresponding color and to shift the color in the same order as the transmitting apparatus.

In brief, there is employed, in a system hereinafter described as a specific and illustrative embodiment of the invention, a plurality of photoelectric cells each responsive to a different region of the spectrum with an arrangement of rotating mirrors, each of which directs the light to all of the cells in succession. The picture or view is scanned by means of a rotating disc having spirally arranged apertures therein and the light which passes through the apertures is directed to the rotating mirror. At the receiving end a plurality of lamps each emitting light of a different region of the spectrum, are lighted by current received over the line. A mirror arrangement and scanning disc similar to those at the sending station serve to reproduce the picture on a screen at the receiving station.

In the modified form of the invention a series of lenses and mirrors direct the light from the scanning disc to photoelectric cells which respond to light from different regions of the spectrum. A commutating device connects these cells successively to a carrier wave modulator. The scanning disc and the commutator are driven simultaneously so that each cell is associated with the modulator for only a portion of a revolution of the scanning disc. However, the scanning disc is geared to the driving mechanism of the commutator so as to make slightly more or slightly less than one revolution per revolution of the commutator, thus shifting the order in which the photoelectric cells are connected to the modulator for successive scannings of the object. At the receiving station the commutator and scanning disc are similarly arranged and the image is produced in strips.

In the drawings two modifications of such a system are shown. Figs. 1 and 2 show an organization whereby the picture may be completely scanned for each color in succession. Fig. 3 shows an organization whereby the picture may be scanned in strips.

Referring to the embodiment shown in Figs. 1 and 2, the picture to be transmitted is represented by film 100 which is illuminated in any suitable manner, for example, by lamp 101 and condensing lens 102. Film 100 indicates a single picture which may be one from a strip such as used in projecting a motion picture. Lens 104 produces an image of the film upon the scanning disc 105, and lens 106 focuses a beam of light on the photoelectric cells 107, 108 and 109 after reflection by the rotating mirror 110.

If the object to be transmitted is not a picture but a natural scene, the lens 104 may be used to form an image of the scene directly on the disc. The scanning disc and the rotating mirror are driven simultaneously under th control of tuning fork 111. Tuning fork 111 may be driven by means of the usual self-interrupting circuit or by any other desirable means. The tuning fork in vibrating closes obvious circuits for operating the La Cour motor 112 which turns the shaft 113. The disc 114, rigidly attached to the shaft 113, is geared to scanning disc 105, discs 114 and 105 being of the same size so that a single rotation of the shaft 113 produces a single rotation of the scanning disc. Shaft 113 is also suitably coupled to the Geneva movement 115. From an inspection of the drawing it will be apparent that for each revolution of disc 116, disc 117 will make a quarter turn. The driving disc 118 and driven disc 119, which is rigidly attached to the multi-faced mirror 110, are geared in the ratio of 1 to 6. Therefore scanning disc 105 will make 24 revolutions to one complete revolution of mirror 110.

The tuning fork 111 also serves to control the synchronous movement of the driving apparatus at the receiving station. This driving apparatus comprises a tuning fork 211, a La Cour motor 212 and a Geneva movement 215 and serves to drive a scanning disc 205 and a multi-faced mirror 210 at speeds bearing the ratio of 1 to 24. A source of current 120, a modulator 121 controlled by fork 11, an amplifier 122, and a filter 123 transmit a synchronizing current to the line L. At the receiving station a filter 223, an amplifier 222, and a demodulator 221 cause the energization of a magnet 224 in synchronism with magnet 124 to drive the tuning fork 211. Suitable apparatus for producing and receiving the synchronizing current is described in the patent of Maurice B. Long, No. 1,706,032, issued March 19, 1929.

Considering the optical arrangement in detail for a moment, with the mirror 110 in the position shown, light from the disc 105 will be directed upon photoelectric cell 107. As each aperture of the disc passes across the image of the film, a spot of light of varying intensity will be focused upon cell 107. The apertures in disc 105 do not completely encircle the disc but are arranged to leave a section of the disc solid. The discs of the Geneva movement 116 and 117 are arranged so that pin 125 engages slot 126 and the mirror is moved forward while no apertures are passing the image of the film. The advance of the mirror 110 from the position shown brings face 128 into the path of the beam of light from the scanning disc. However, the angle of incidence of the beam is such as to direct the reflected beam of light on to cell 109 which is responsive to the blue end of the spectrum. The next quarter turn of disc 117 causes face 128 to direct the beam of light on to cell 108 which responds to the green region of the spectrum and the third quarter turn brings face 128 into the position which face 127 occupies in the drawing.

The impedance of the photoelectric cells, particularly when not illuminated, is sufficiently high so that the connection of the dark cells in parallel with the cell receiving the incident light does not materially reduce the photoelectric current. The amplifier 180 amplifies the photoelectric current before its application to modulator 142. As the beam of light is successfully directed upon cells 107, 108 and 109, the photoelectric current will represent the variations of the corresponding color in the image.

Oscillator 141, modulator 142, amplifier 143 and filter 144 serve to transmit a carrier wave modulated by the current in the photoelectric cells to the line L while filter 244, amplifier 243 and demodulator 242 receive the modulated waves and direct the signal current to lamps 207, 208 and 209. Reference is made to the above identified Long application for the disclosure of these elements.

At the receiving end lamp 207 emits light from the red end of the spectrum, lamp 208 from the green region of the spectrum and lamp 209 from the blue end of the spectrum. These lamps are lighted simultaneously but as mirror 210 rotates, light from only one lamp at a time is directed to the disc 205 and an image of the aperture is projected on the screen 290.

To recapitulate, as the mirror 110 rotates under the control of fork 111, disc 105 is rotated and as each successive aperture in the spiral passes across the image formed on the disc, the spot of light focused on one of the photoelectric cells, say 107, varies in intensity in accordance with the brightness of the image being scanned. This spot of light will contain all of the colors but, since cell 107 is responsive to red light only, it will produce a variation of current in the modulating circuit in accordance with the variation of red light in the image. At the next revolution of disc 105 the spot of light will be directed to cell 109 and that cell will produce a current which represents the strength of blue light in the image. Similarly, on the third revolution the current in the modulating circuit will represent the strength of green light in the image. Successive revolutions will cause a modulating current representing the colors in rotation.

At the receiving end the driving apparatus being in synchronism with that at the sending station, the light from lamp 207 will be directed on scanning disc 205 at the same time that light is focused on cell 107. The current leaving the demodulator 242 varies in accordance with the variations in the current reaching modulator 142 and the illumination of lamps 207, 208 and 209 will vary with the strength of the red color in the light focused on cell 107. Since only the light of lamp 207 will be directed on the disc 205, this disc in rotating will cause a spot of light to travel over the screen 290. This spot of light will be red in color and will vary in intensity with the red in the original image. During the second revolution of disc 205 a blue image will be thrown on the screen 290 and on the third revolution a green image. These images will follow one another with such rapidity that the eye of the observer cannot distinguish between them and the resultant effect on the retina will be a picture in the colors of the original.

Referring now to Fig. 3 a system is disclosed in which the picture or scene is scanned in strips, each strip being scanned for a different color and the order of the colors being altered for each complete scanning. For this purpose, the film 311 represents the picture or scene to be scanned, an image of which is formed on the scanning disc 301 by the lens 302. A series of semi-transparent mirrors and lenses serves to direct a portion of the light from the scanning disc 301 to each of the photoelectric cells 303, 304 and 305. These light cells are made responsive to red, green and blue lights respectively by using mirrors which reflect the desired light, by the interposition of color filters or by making the cells themselves responsive only to the color desired.

The scanning disc 301 is driven through the agency of a tuning fork controlled La Cour motor which also drives a commutating arrangement 306. The driving disc 307 bears an unequal ratio to the scanning disc 301, for example, 16 to 15. The fork also sends out impulses which serve to synchronize the driving apparatus at the receiving station 350, which apparatus is a duplicate of that at the sending station 300. The apparatus for transmitting and receiving these synchronizing impulses may be of any desirable type, such as that shown in the above identified Long application.

Referring to the commutating arrangement, brush 308 serves to connect ring 309 with the ring of segments 310. These segments are connected to the photoelectric cells 303, 304 and 305. The sequence of colors for which the picture will be scanned may be readily determined from an inspection of the drawing. With the suggested ratio of 15 to 16 between the driving and scanning discs it will be apparent that the relation between the strip of the picture scanned and the color for which that picture is scanned will be changed at each revolution.

The current produced in each of the cells due to the intensity of the corresponding light in the beam from the scanning disc 301 is transmitted over the line L′ and received in the usual manner. A lamp is provided for each color and a plurality of semi-transparent mirrors and lenses to produce a spot of colored light on the screen. As in the case of the sending station, the color may be controlled either by the color of the lamps or by the color of the mirrors. The driving arrangement at the receiving end is similar to that at the sending station and a commutating arrangement 356 serves to connect the lamps with the line in the same order as the photoelectric cells are by the commutating arrangement 306.

The apparatus shown is of course merely suggestive. For example, a single photoelectric cell may be used and a Geneva movement may be employed to introduce colored filters between the scanning disc and the cell at the sending station and between the lamp and the scanning disc at the receiving station. According to a modification of the arrangement shown in Fig. 3 opaque screens may be used to obscure all but one photoelectric cell and lamp at a time. It is therefore apparent that it may be possible, without departing from the spirit of the invention, to employ equivalents for many parts of the system.

What is claimed is:

1. In a system for the transmission of views, means for repeatedly scanning the view including a plurality of selective light responsive elements and means for illuminating said elements in succession by light of different colors respectively from said view, sources of light of different colors, means for rendering said light responsive elements successively effective for controlling the light from said sources, and means for synthesizing the light from said sources to produce an image.

2. In a system for the transmission of views, a plurality of selective light translating elements, means to repeatedly and successively scan the view for each of a plurality of colors one at a time, and means for reproducing said view in its natural colors by the repeated and successive production of an image for each of said plurality of colors.

3. In a system for the transmission of views, means to repeatedly and successively scan the view for each of a plurality of colors one at a time, means for translating the view into an electrical current proportional successively to the amount of each primary color in said view, means for producing light of

each primary color, means for actuating said light producing means under the control of said electrical current, and means for synthesizing the light produced by said light producing means to reproduce said view.

4. In a system for the transmission of views, means for repeatedly and successively scanning the view for each of a plurality of colors one at a time, a plurality of photoelectric cells, each responsive to a particular color, means for rendering said photoelectric cells effective in a predetermined order, a plurality of lamps, each lamp emitting a particular color, means for varying the illumination of each lamp in accordance with the current produced by the photoelectric cell in response to the corresponding color, and means for synthesizing the colored light from said lamps to reproduce the view in its natural colors.

5. In a system for the transmission of views, means for scanning elementary areas of said view to produce an electric current corresponding to the variation of the light value of a primary color in said elementary areas, means for varying the color for the scanning of successive elementary areas, means for varying the color for successive scannings of the same elementary area, means for transmitting and receiving said current, and means for reproducing elementary areas of corresponding color to produce an image in its natural colors.

6. The method of transmitting and reproducing views in color which consists in scanning successive elementary areas of said image for different colors, changing the order of said colors for successive scannings of said image, transmitting an electric current varying according to the light value of the colors, and at the receiving end reproducing elementary areas of the image in the corresponding colors.

7. The combination in a system for transmitting views of a plurality of photoelectric cells selectively responsive to light of different colors, a disc with spirally arranged apertures therein for scanning the view, a system of mirrors cooperating with said disc for directing light from said view successively and repeatedly to said cells, means for transmitting an electric current varied in accordance with the photoelectric response of said cells, a plurality of lamps each emitting light of a different color, means responsive to the transmitted current for controlling the intensity of the light from said lamps, and means including a disc with spirally arranged apertures and a mirror system for combining the light from said lamps to form an image of the said view in its natural colors.

In witness whereof, I hereunto subscribe my name this 19th day of May, A. D. 1926.

HERBERT E. IVES.