May 5, 1931. F. GRAY 1,803,700

ELECTROOPTICAL SYSTEM

Filed July 25, 1929

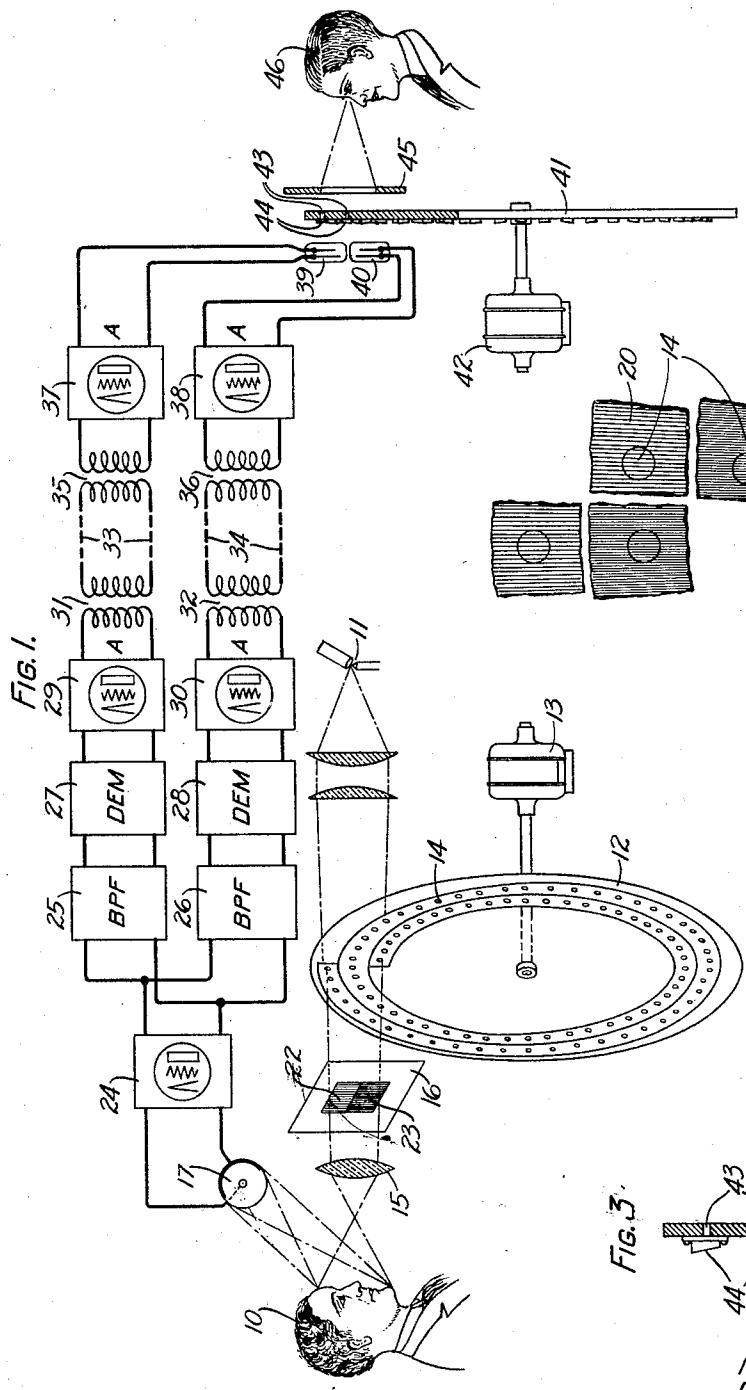


FIG. 1.




FIG. 2.

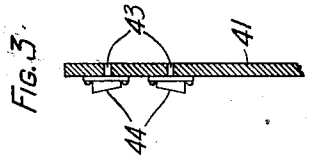


FIG. 3.

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# UNITED STATES PATENT OFFICE

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## ELECTROOPTICAL SYSTEM

Application filed July 25, 1929. Serial No. 380,786.

This invention relates to electro-optical systems and more particularly to a method of and apparatus for producing television images.

An object of the invention is to provide a simple method and means for producing a photo-electric current having components which correspond respectively, to simultaneously scanned elemental areas of a field of view and which can be separated and separately utilized as desired, for example, for multi-transmission line television.

Another object of the invention is to provide novel means for producing a beam of light modulated at a definite frequency.

In a preferred embodiment of the invention, a scanning disc having apertures arranged in the form of a spiral of two convolutions is employed to project two beams of light simultaneously upon the field of view so that the field is scanned by two spots of light moving over different courses. Each of these beams is interrupted or modulated at a distinctive frequency. Light reflected from the field of view may be received upon a single photoelectric cell and the resulting variations impressed upon frequency selective means for separating the components of different constant frequency. The interrupting or modulating of the light beams is preferably accomplished by providing a grating of closely spaced parallel rulings over each of the apertures of the scanning disc, the spacing of the lines being different for one convolution of the spiral than for the other. Separate stationary gratings are provided one for each convolution of the spiral having, respectively, the same spacing of rulings as the apertures of the corresponding convolution of the spiral. The gratings are preferably so designed as to have rulings varying in opaqueness from the center to the edge to produce variations in the light beam in a sinusoidal manner. A large number of beams may, of course, be employed and any suitable means used to direct and modulate the beams. The image current produced as the result of scanning and comprising a plurality of modulated frequency components, are preferably separated by means of filters, demodulated and transmitted over separate transmission lines respectively.

A television system embodying features of this invention is shown diagrammatically in Fig. 1 of the accompanying drawing;

Fig. 2 is an enlarged fragmentary view showing in detail the construction of the scanning disc employed at the transmitting station of the system shown in Fig. 1; and

Fig. 3 is an enlarged sectional view of a portion of the disc employed at the receiving station.

Referring to the drawing, a field of view comprising the subject 10 is scanned by light from a source 11 as it passes through the apertures 14 in the scanning disc 12 which is driven by the motor 13 at the rate of 16 or more revolutions per second. The apertures 14 in the scanning disc are arranged in the form of a spiral of two convolutions although an arrangement employing a spiral having a greater number of convolutions may be employed. As the disc rotates, two separate portions of the subject 10 are scanned simultaneously by means of two moving light beams. The light passing through the apertures of the outer convolution of the spiral is deflected by the lens 15 so as to scan the lower half of the subject 10 and the light passing through the apertures of the inner convolution of the spiral is deflected by the same lens so as to scan the upper half of the subject.

Each aperture of the scanning disc is covered with a grating comprising alternate opaque and translucent lines. The width of the lines of the grating 20 is the same for all of the apertures of the outer convolution of the spiral. The width of the lines of the grating 21 covering the apertures of the inner convolution of the spiral is greater or less than the width of the lines of the grating 20. The screen 16 having an opening therein which defines the field of view is preferably positioned close to the disc 12 either between the disc and the lens 15 or on the opposite side of the disc. The opening in the screen 16 is covered by two gratings, the grating 22 covering the upper half of the opening being similar to the one covering the apertures of

the outer convolution of the spiral in the scanning disc and the grating 23 covering the lower half of the opening being similar to the grating 21 covering the apertures of the inner convolution. The gratings may be made, for example, by the use of an engraving machine or by ruling relatively wide lines and reducing them photographically. Another method of making the gratings is to move a sensitized film slowly in front of a line source of light which is energized by an alternating current of suitable frequency. In this case the opacity of the lines varies gradually so as to produce a sine wave fluctuation of light intensity. However, the sine wave is sufficiently closely approximated for most purposes by the alternate opaque and translucent lines each of which has uniform light transmitting properties throughout their width.

It is thus apparent that each of the light beams which scans the subject 10 is interrupted or changed in intensity periodically at a high frequency, the frequency of interruption being greater for one beam than for the other. Light reflected from the subject 10 impinges on the light sensitive or photoelectric cell 17 and causes the current in the circuit of the cell to vary in accordance with the variations in light intensity. This current has two frequency components, one corresponding to the rate at which the light beam passing through the gratings 20 and 22 is interrupted and the other frequency component corresponding to the rate at which the other light beam is interrupted by the gratings 21 and 23. These light beams illuminate, successively, elemental areas of different portions, respectively, of the subject 10. Each of the frequency components of the photoelectric current is therefore modulated in accordance with the tone values of the successively illuminated elemental areas of one of the portions of the field of view. After being suitably amplified by the amplifier 24, the two modulated frequency components of the image current are separated by the band-pass filters 25 and 26. The two currents which correspond to the two components of the photoelectric current are then demodulated by the demodulators 27 and 28, respectively, and amplified by the amplifiers 29 and 30, respectively. One demodulated current having amplitude variations corresponding to the tone values of successively scanned elemental areas of one portion of the field of view is transmitted through transformer 31 and over the line 33 to the receiving station, where it is transmitted through transformer 35 and amplifier 37 and impressed on the neon glow discharge lamp 39. The other demodulated current having amplitude variations corresponding to the tone values of the successively scanned elemental areas of another portion of the field of view is similarly transmitted over a circuit comprising the transformer 32, transmission line 34, transformer 36 and amplifier 38 to the neon glow discharge lamp 40.

The disc 41 which has the same number of apertures 43 as the disc 12, and similarly arranged in a spiral of two convolutions, is driven by the motor 42 in synchronism with the disc 12. A system such as that disclosed in Patent No. 1,763,909, granted to H. M. Stoller and E. R. Morton, June 17, 1930, may be employed for controlling the speed of the motors 13 and 42 so as to maintain the discs 12 and 41 in synchronism and in phase. A prism 44 is positioned over each aperture 43 in the disc 41 so that light from the lamp 39 is transmitted through the apertures of the outer convolution of the spiral and so that light from the lamp 40 is transmitted through the apertures of the inner convolution of the spiral as the position of the apertures changes with respect to the position of the lamps due to the rotation of the disc 41. A similar arrangement employing prisms over the apertures of the scanning disc is disclosed in a co-pending application of H. E. Ives, Serial No. 291,744, filed July 11, 1928. Since the field of view is completely scanned 16 or more times per second, which is within the period of the persistence of vision, the observer 46, as he looks into the opening in the frame 45, sees an image of the field of view comprising the subject 10 which may be moving or changing.

What is claimed is:

1. A device for scanning a field of view comprising a movable element of opaque material, and a light aperture having alternate sections of relatively opaque and transparent material arranged in said movable element.

2. A device for scanning a field of view comprising a movable element of opaque material, and a plurality of light apertures arranged therein, each aperture comprising a plurality of sections the opacity of which varies gradually from one portion of the section to another.

3. A device for scanning a field of view comprising a movable element of opaque material having a plurality of apertures therein, and a grating of alternate transparent and opaque elements secured to said movable element and positioned over said apertures.

4. A scanning disc comprising a plurality of apertures, and means secured to said scanning disc and associated with each aperture thereof for breaking up the beam of light passing therethrough into a plurality of separate, substantially parallel rays.

5. Means for modulating light comprising a source of light, a cyclically moving member having a plurality of light apertures, a grating for each light aperture and moving therewith, and a stationary grating aligned with said moving element and said source so

that the stationary grating and said source are successively optically aligned with said light apertures.

6. Means for scanning a field of view to produce an image current which comprises a source of light, a movable element having light apertures therein for directing light from said source upon elemental areas of said field of view in succession, means for periodically interrupting the illumination of an elemental area of the field of view, said means comprising a stationary grating in the light path and a grating positioned over the apertures of the scanning disc, and light sensitive means for receiving light from the illuminated elemental area of the field of view to produce an image current.

7. In an electro-optical image producing system a source of light, a scanning disc having a plurality of light apertures therein arranged in a spiral of a plurality of convolutions for scanning a plurality of portions of said field of view simultaneously, means comprising a grating positioned over the apertures of the scanning disc for interrupting the light transmitted by the apertures of different convolutions at different high frequencies respectively, light sensitive means for receiving light from the elemental areas of the field of view and for setting up an image current having components corresponding to the frequencies at which the different light beams respectively are interrupted, and means for producing separate currents corresponding to the different frequency components respectively of said image current for controlling the production of an image of said field of view.

In witness whereof, I hereunto subscribe my name this 24th day of July, 1929.

FRANK GRAY.