Aug. 6, 1935. F. GRAY 2,010,543

ELECTROOPTICAL SYSTEM

Filed Jan. 10, 1931 3 Sheets-Sheet 1

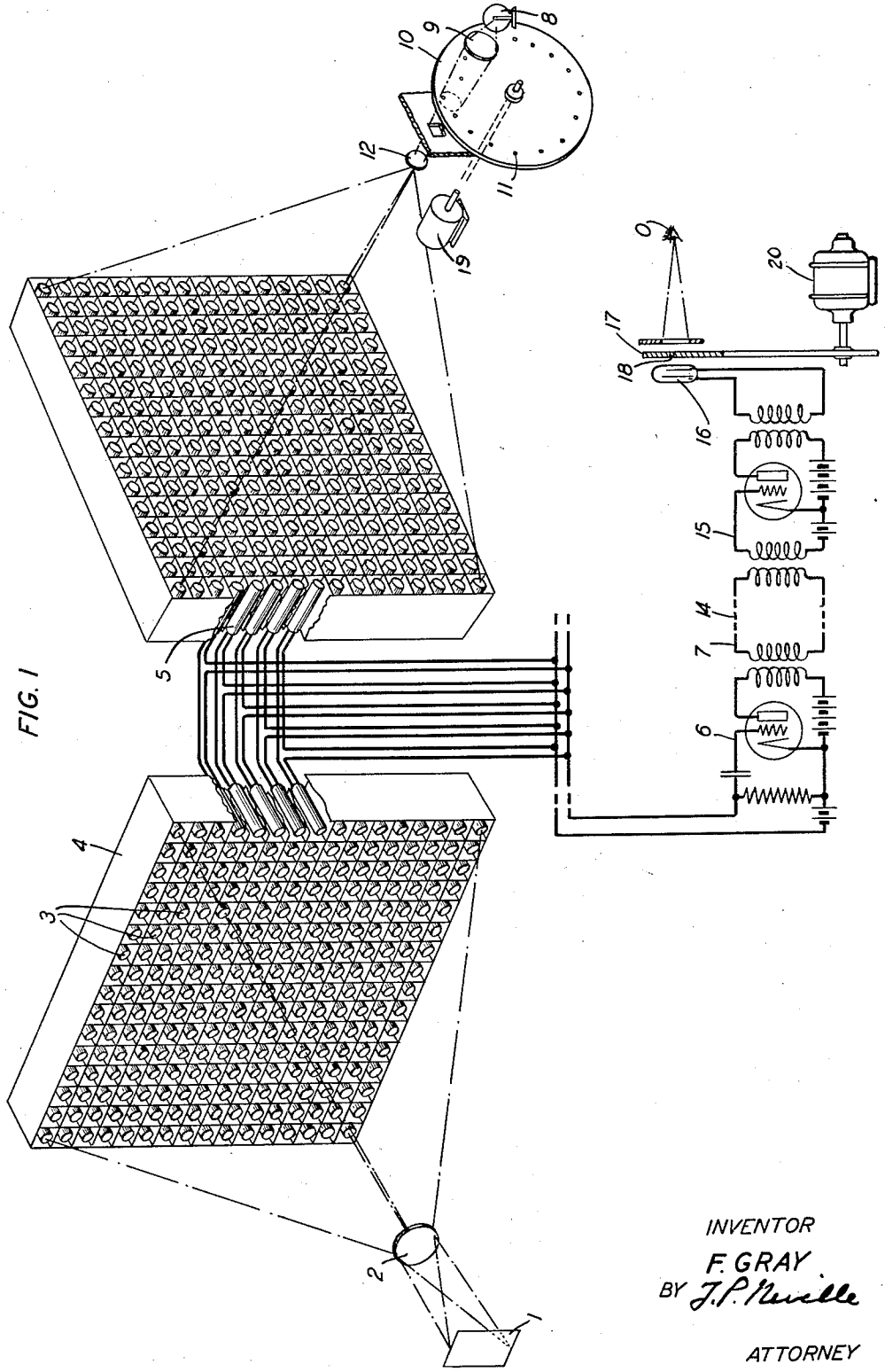

FIG. 1

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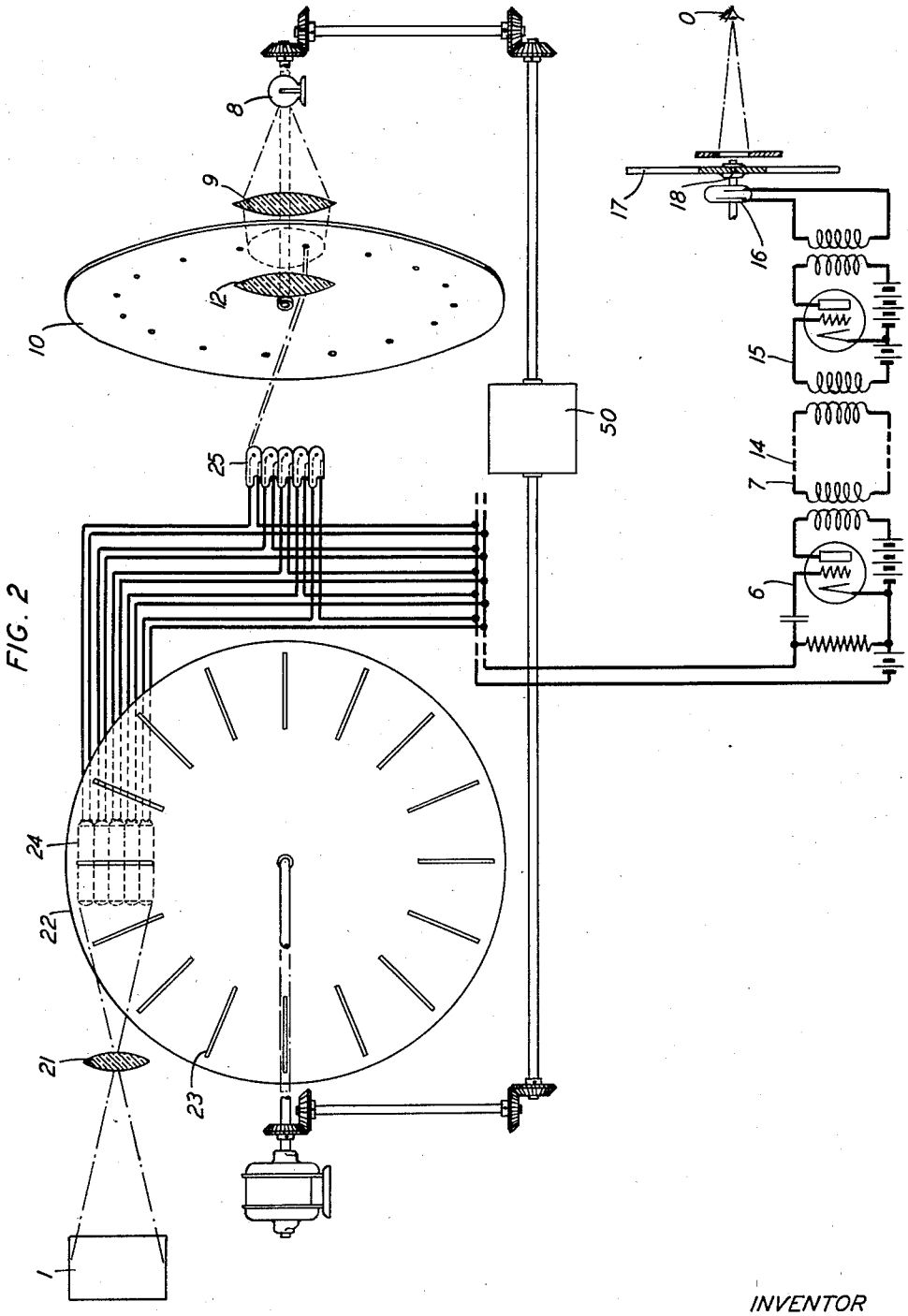

FIG. 2

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FIG. 3

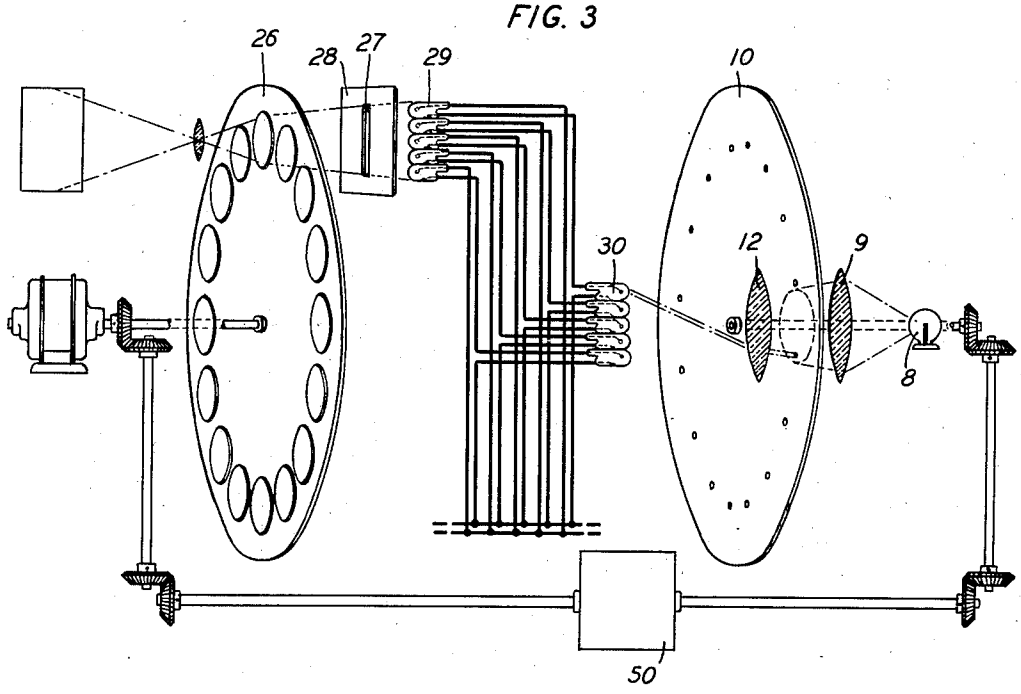
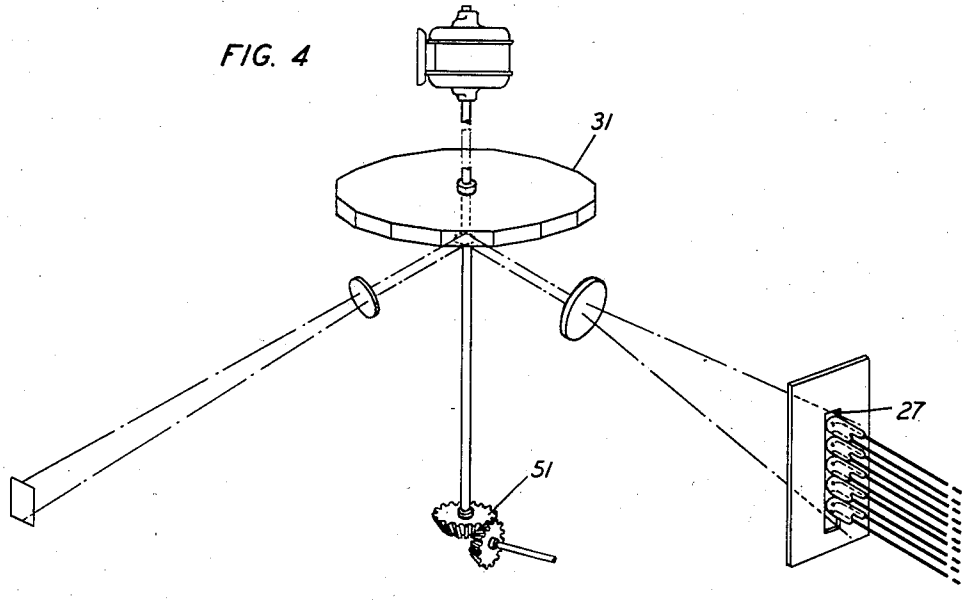


FIG. 4



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UNITED STATES PATENT OFFICE

2,010,543

ELECTROOPTICAL SYSTEM

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Application January 10, 1931, Serial No. 507,799

10 Claims. (Cl. 178—6)

This invention relates to electro-optical systems and more particularly to an image scanning mechanism.

It has been proposed to use a belt provided with slots for projecting an image of successive unit lines of a field of view to be transmitted upon a selenium plate and to scan the elemental areas of each illuminated line by a commutating device, which comprises a pair of selenium elements connected in series with each elemental area of the selenium plate and a moving beam of light which simultaneously illuminates the pairs of elements in succession, to release to a transmission circuit image currents varying in amplitude with the tone values of the successive elemental areas of the image.

A system of the type just described possesses the disadvantage that selenium presents a finite resistance whether illuminated or not, and it does not respond to rapid changes in light values. As a result, leakage current will flow through the circuit including the selenium plate and commutator when a voltage is applied thereto even if the plate and commutator are not illuminated, the system cannot be operated at high speed, because of the lag of the selenium plate and commutating elements, and the image currents will be distorted by the residual resistance of the commutator elements when they are illuminated.

The present invention provides a scanning mechanism which operates in a manner similar to that described above, but which does not embody the disadvantages hereinbefore noted.

An object of the invention is to effect high speed scanning in a system of the type described above, by using a commutating device comprising light sensitive devices activated by a beam of light of constant intensity.

Another object is to produce undistorted image currents.

An additional object is to prevent the flow of leakage currents.

In accordance with one embodiment of the invention, an image of a subject, or field of view, is projected upon a group of photoelectric cells each of which is connected in series with another photoelectric cell. The series-connected cells are arranged to constitute a second group, which are successively illuminated by a beam of light of constant intensity to release image currents, produced in the respective cells of the first group, to a communicating channel. The second group consists of photoelectric cells, each having a current carrying capacity which is greater than the maximum current caused by the activation of any cell of the first group.

An image may be projected upon a bank of photoelectric cells constituting a complete image field, or successive lines of the image may be caused to traverse a row of cells corresponding to a unit line of the image.

A description of the invention follows and is illustrated in the attached drawings, in which

Fig. 1 diagrammatically illustrates a system embodying the invention;

Fig. 2 illustrates a different form of scanning means which may be used in place of that shown in Fig. 1; and

Figs. 3 and 4 show scanning means which may be substituted for that of Fig. 2.

Referring to Fig. 1, there is shown a subject or field of view 1, a lens 2 for projecting an image of the subject upon photoelectric cells 3 corresponding in number to the elemental areas of the image and arranged to constitute a bank 4 of rectangular form, and a second set of photoelectric cells 5, which correspond in number to those of the bank 4. Cells 5 are of such character that no current flows between their electrodes when they are dark, i. e., when they are not illuminated, and are of such current carrying capacity that, when illuminated by a beam of light of predetermined constant intensity, they are activated to cause the production of a current greater than the largest current ever produced by any cell 3 of the first bank when illuminated by an image of the field of view. Each of the cells 5 is connected in series with one of the cells 3 and through a common circuit to an amplifier 6 included in a transmission circuit 7.

A source of light 8 cooperates with an optical system including lens 9, a rotating disc 10 provided with a row of apertures 11 arranged in a spiral line, and a lens 12 to produce a moving beam of light of the desired constant intensity which successively illuminates the cells 5, which are thereby rendered conductive. Image currents, corresponding in amplitude to the tone values of successive elemental areas of the image, caused by the activation of the cells 3, are thereby permitted to flow through the cells 5 to the amplifier 6, which supplies them in amplified form and in succession to the transmission circuit 7. The transmission circuit may include a terminal apparatus consisting of either a repeater adapted to supply the amplified image currents, or a modulator for producing a carrier wave modulated by the image currents, to a communicating channel herein represented, by way of example, as a line

14 over which transmission is effected to a receiving station.

At the receiving station, the incoming image currents are amplified in the device 15 and applied to glow lamp 16 associated with a rotating disc 17 provided with a row of apertures 18 arranged in a spiral line. In accordance with more or less standard practice, the lamp and disc cooperate to produce an image which may be directly viewed by an observer O or may be projected by a suitable optical system on a screen for audience viewing.

To permit production of the image, the disc 10 and 17, driven by the motors 19 and 20, must operate in synchronism and in phase with each other and are driven at such a rate that a complete image field is scanned and an image thereof is produced during each complete revolution thereof and within the period of persistence of vision. A suitable system which may be used to maintain synchronous operation of the discs 10 and 17 is disclosed in U. S. Patent 1,999,376 of H. M. Stoller, issued April 30, 1935. Lamp 16 may be of any suitable type adapted to supply light varying in accordance with the amplitudes of the incoming image currents, for example, it may be a glow lamp of the type disclosed in U. S. Patent 1,918,309 of H. W. Weinhart, issued July 18, 1933.

The apparatus of Fig. 2 comprises a lens 21 for producing an image of a field of view in the plane of disc 22 provided with slots 23 which successively sweep across a series of photoelectric cells 24 each equal in length to a unit line of the image. Cells 24 are each connected in series with a photoelectric cell 25 having a current carrying capacity greater than the maximum current produced by any of the cells 24.

As described in connection with Fig. 1, the cells 25 are non-conductive in the dark, and they are traversed by a moving beam of light of the desired constant intensity to activate them by the optical system 8, 9, 10 and 12, whereby image currents corresponding in amplitude to successive elemental areas of the image are released to the amplifier 6. The image is completely scanned during each revolution of the disc 10 and it is driven by a motor activating the disc 22 to which it is coupled by a gear, indicated at 50, to cause the beam of light to be swept across cells 25 at such a rate that complete scannings occur within the period of persistence of vision. The gearing 50 is of such ratio that the disc 10 is operated at the proper relative speed with respect to the disc 22.

Fig. 3 illustrates a disc 26 provided with a series of lenses which serve to move an image of a field of view across a stationary slot 27 provided in a screen or mask 28 having associated therewith a row of photoelectric cells 29, corresponding in number to the unit lines of the image. Connected in series with each of the cells 29 is a cell 30 which is non-conductive in the dark. Cells 30 are adapted to be illuminated in succession as described above by a movable beam of light of the desired constant intensity supplied through the optical system 8, 9, 10 and 12. As the disc 26 rotates, light from successive unit lines of the image illuminates the cells 29, which are thereby activated to cause the production of image currents corresponding in amplitude to the tone values of elemental areas of the lines. The disc 10 is rotated and the beam of light sweeps across cells 30 at such a rate that image currents corresponding to elemental areas of the complete field of view are released to the amplifier 6 within the period of persistence of vision. The gear 50 serves to couple the motor to the disc 10 so that it is rotated at the desired speed with respect to the disc 26.

As shown in Fig. 4, the lensed disc 26 of Fig. 3 may be replaced by a system of rotating mirrors 31 to sweep successive unit lines of the image across the stationary slot 27. The gearing 51 serves to couple the driving motor for the mirror system to the disc 10, which is thereby rotated at the desired rate relatively to the mirrors.

If desired, a pair of rotating prisms could be used, as disclosed in U. S. Patent 1,647,631 of H. E. Ives, dated November 1, 1927, to cause light derived from successive elemental areas of the image to illuminate corresponding photoelectric cells 3 of the first group of Fig. 1 while those of the second group 5 are successively illuminated by a moving beam of light of the desired constant intensity provided by the optical system 8, 9, 10 and 12, to release image currents, corresponding to the complete field, to the amplifier 6 at a rate within the period of persistence of vision.

In the apparatus of Figs. 2 to 4, the traversal of the movable beam of light should be controlled by the disc 10 to operate in synchronism and in phase with the disc 17 at the receiving station. The synchronizing system disclosed in the above mentioned Stoller application may be used for this purpose.

One advantage of the present system is that it reduces the speed of moving parts and hence permits large images to be scanned at high speed, without causing the flow of leakage currents and without distortion of the image currents supplied to the transmission circuit. As a result large aperture lenses can be used to effect a corresponding gain in the amount of light available to produce image currents.

What is claimed is:

1. A television system comprising a group of photoelectric cells, a second group of photoelectric cells each of greater current carrying capacity than those of the first group and respectively connected in series with a cell of the first group, means for projecting an image of a field of view upon said first group of cells, and means for successively activating the cells of the second group.

2. A television system comprising a group of photoelectric cells, a second group of photoelectric cells each of greater current carrying capacity than those of the first group and respectively connected in series with a cell of the first group, means for projecting an image of a field of view upon said first group of cells, and means for producing a moving beam of light of constant intensity for successively activating the cells of the second group.

3. A television system comprising light sensitive devices, means for projecting an image of a field of view upon said devices, other light sensitive devices each connected in series with one of said first mentioned devices and of greater current carrying capacity than the device with which it is connected, and means for successively activating said other devices.

4. A photoelectric cell assembly for use in a television system comprising a bank of photoelectric cells, the number of cells being equal and their arrangement similar to the desired number and arrangement of elemental areas in a field of view, and a group of photoelectric cells equal in number to those in said bank of cells, each cell of said group having greater current carrying capacity

than the cells of said bank and each respectively connected in series with a cell of said bank.

5. A television system compring a bank of photoelectric cells, the number of cells being equal and their arrangement similar to the desired number and arrangement of elemental areas in a field of view, a group of photoelectric cells equal in number to those in said bank of cells, each cell of said group having greater current carrying capacity than the cells of said bank and each respectively connected in series with a cell of said bank, means to illuminate each cell of said bank with light from the corresponding elemental area of the field of view, and means to successively activate the cells of said group of cells, each cell being activated while the corresponding cell of the bank is illuminated.

6. A television system comprising a bank of photoelectric cells, the number of cells being equal and their arrangement similar to the desired number and arrangement of elemental areas in a field of view, a group of photoelectric cells equal in number to those in said bank of cells, each cell of said group having greater current carrying capacity than the cells of said bank and each respectively connected in series with a cell of said bank, and means to successively illuminate the cells of said group with a moving beam of light of constant intensity.

7. A television system comprising a plurality of elongated photoelectric cells equal in number to the elemental lines of a field of view, means to simultaneously illuminate an elemental portion only of each of said cells, which portions correspond to elemental areas of said elemental lines, a second group of photoelectric cells equal to the number of elongated cells, each cell of this group having a current carrying capacity greater than the maximum current produced by any of said elongated cells and each respectively connected in series with one of said elongated cells, and means for successively activating the cells of said second group.

8. An electro-optical system comprising two cellular structures each having the same number of compartments, a photoelectric cell positioned in each compartment each of said cells having two electrodes one a cathode and the other an anode, a connection common to all of the electrodes of one kind of the cells in one structure, another connection common to all of the electrodes of the other kind of the cells in the other structure, conductors individual to pairs of cells one of which is in each structure, each said conductor joining the not commonly connected electrodes of the said pairs of cells, a source of current energizing said cells through said common connections, and means to energize the cells of one structure in succession with an energy carrying beam.

9. An electro-optical system comprising two cellular structures each having the same number of compartments, a photoelectric cell positioned in each compartment each of said cells having two electrodes one a cathode and the other an anode, a connection common to all of the electrodes of one kind of the cells in one structure, another connection common to all of the electrodes of the other kind of the cells in the other structure, metallic conductors individual to pairs of cells one of which is in each structure, each said conductor joining the not commonly connected electrodes of the said pairs of cells, a source of current energizing said cells through said common connections, and means to energize the cells of one structure in succession with a moving beam of light.

10. An electro-optical system comprising two cellular structures each having the same number of compartments, a photoelectric cell positioned in each compartment each of said cells having two electrodes one a cathode and the other an anode, a connection common to all of the electrodes of one kind of the cells in one structure, another connection common to all of the electrodes of the other kind of the cells in the other structure, conductors individual to pairs of cells one of which is in each structure, each conductor joining the not commonly connected electrodes of the said pairs of cells, a source of current energizing said cells through said common connections, and means to energize the cells of one structure in succession with an energy carrying beam, the cells in the successively energized structure each having a greater current carrying capacity than the corresponding cell in the other structure.

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