Feb. 25, 1936. F. GRAY 2,031,598

ELECTROOPTICAL SYSTEM

Filed Dec. 27, 1930 2 Sheets-Sheet 1

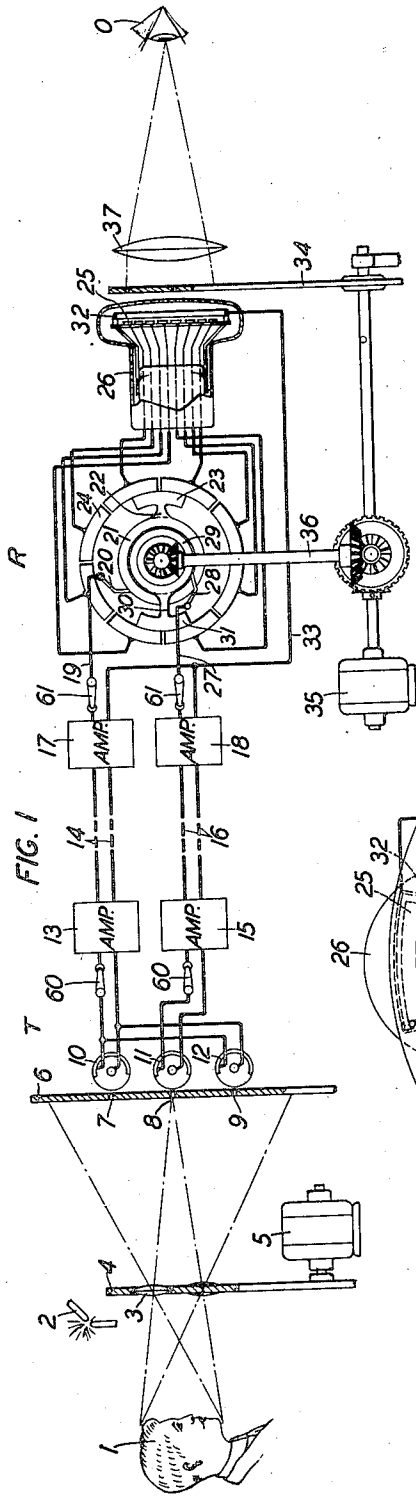

FIG. 1

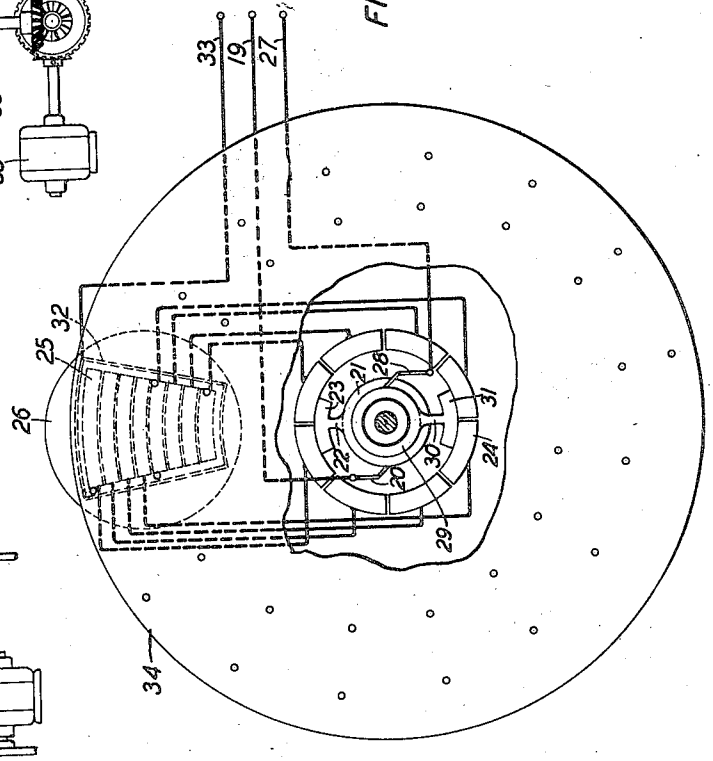

FIG. 2

INVENTOR
F. GRAY
BY J. P. Linville

ATTORNEY

Feb. 25, 1936. F. GRAY 2,031,598

ELECTROOPTICAL SYSTEM

Filed Dec. 27, 1930 2 Sheets-Sheet 2

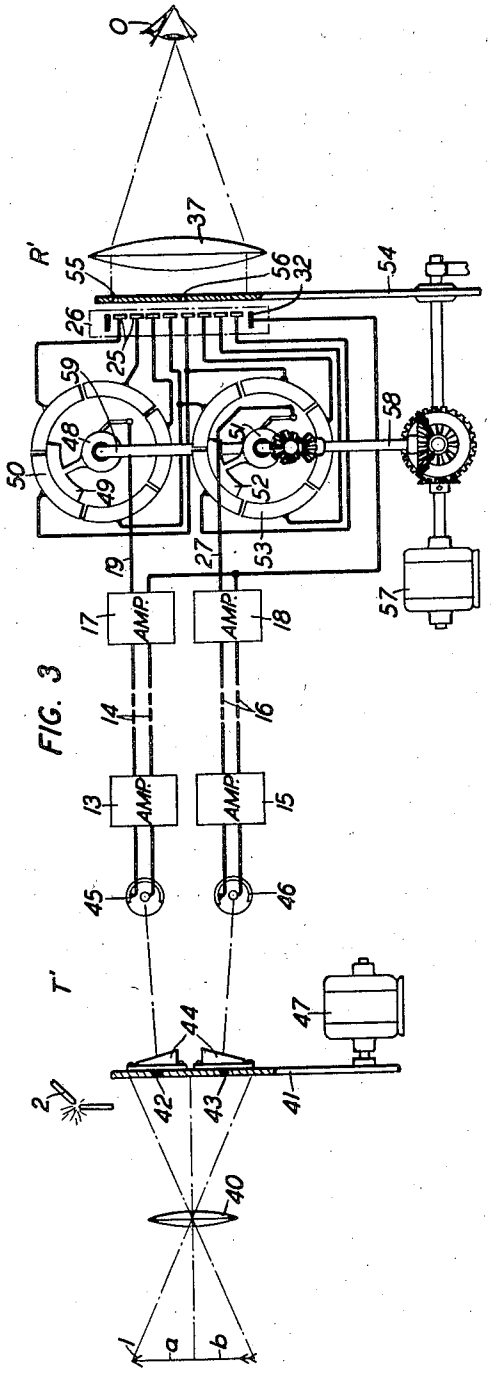

FIG. 3

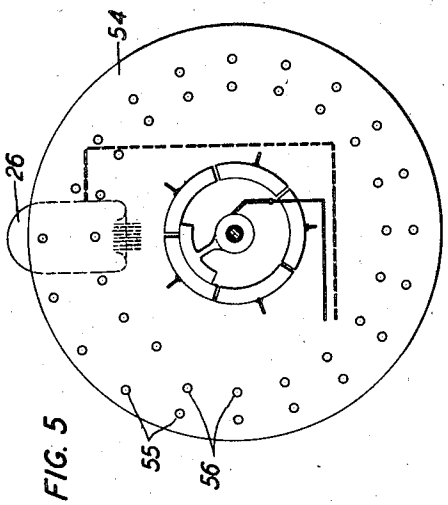

FIG. 5

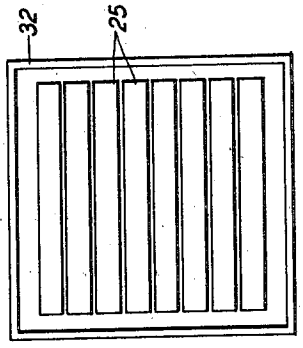

FIG. 4

INVENTOR
F. GRAY
BY J. P. Mueller

ATTORNEY

Patented Feb. 25, 1936 2,031,598

UNITED STATES PATENT OFFICE

2,031,598

ELECTROOPTICAL SYSTEM

Frank Gray, New York, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application December 27, 1930, Serial No. 505,069

14 Claims. (Cl. 178—6)

This invention relates to electro-optical systems and more particularly to plural-channel reception.

The prior art discloses plural-channel television systems provided with image producing apparatus comprising light sources supplied with image currents received over the respective channels to produce illuminated areas equal in size to complete sections of the image field, and movable members cooperating to produce, or one or more members having, a plurality of rows of apertures for simultaneously scanning the respective areas in parallel lines.

It has also been proposed to provide a plural-channel system including a movable member carrying a plurality of strip light sources and commutators through which the image currents received over the respective channels are simultaneously supplied to strip light sources included in separate groups and successively to the sources in each group, and means for simultaneously scanning successive elemental areas of the energized sources comprising a rotating element cooperating with a stationary element to produce a plurality of moving apertures, or itself having a plurality of spiral rows of apertures, through which successive elements of the image may be viewed or light therefrom may be projected to trace an image upon a screen.

An object of this invention is to provide a system of the latter type including stationary strip light sources for producing a bright image.

Another object of this invention is to simplify the apparatus used in plural-channel reception.

According to one embodiment of this invention, a unitary glow lamp structure is provided with an anode and a number of strip shaped cathodes to constitute an image field, image currents transmitted over respective channels are supplied through commutators to the anode and simultaneously to cathodes in different sections of the field and to the cathodes of each section in succession, and moreover, the commutators connect each channel to all of the cathodes in succession. Associated with the lamp is a rotating scanning disc, having two rows of apertures, each row arranged in a spiral, to permit the simultaneously energized glow areas to be viewed or light from these glow areas to be projected upon a screen to trace an image. In this embodiment, the image currents transmitted over the respective channels are used to control the simultaneous production of different sections of the image, and to produce these sections in succession.

In another embodiment, incoming currents, respectively corresponding to different sections of the image field, are repeatedly transmitted over different channels and are simultaneously supplied to the successive cathodes in each group.

A detailed description of the invention follows and is illustrated in the attached drawings.

Fig. 1 diagrammatically illustrates a television system including the invention;

Fig. 2 illustrates a front view of the scanning disc and light source included in the system of Fig. 1;

Fig. 3 diagrammatically illustrates a different arrangement for practicing the invention; and

Figs. 4 and 5 are details of Fig. 3.

A plural-channel television system comprising a transmitting terminal apparatus T and a receiving terminal apparatus R is shown in Fig. 1.

The field of view or subject 1 to be transmitted is illuminated by light supplied by a constant light source, herein shown as an arc lamp 2. Any other suitable artificial light source (or daylight) may be used in place of the lamp 2.

Lenses 3 mounted in a spiral line on a rotating disc 4, which is driven by a motor 5, cause an image of the subject 1 to move across a mask 6 provided with three small apertures 7, 8 and 9, with which are respectively associated light sensitive devices 10, 11, and 12, herein shown as photoelectric cells. Cells 10 and 12 are connected together and to an amplifier 13 the output of which is associated with a communication channel 14. Cell 11 is connected to an amplifier 15 having its output circuit associated with a channel 16. As disc 4 rotates, one section of the image traverses aperture 7 and simultaneously therewith a second section traverses the aperture 8; then the first section traverses the aperture 8 and, at the same time, the second section traverses the aperture 9. In other words, the whole image is caused to traverse aperture 8 and also apertures 7 and 9.

Cells 10 and 11, respectively, are simultaneously activated by light from successive elemental areas of two sections *a* and *b* of the image to cause the production of image currents corresponding to the tone values of these areas, and then, cells 11 and 12, respectively, are simultaneously activated by light from the successive elemental areas of the two sections *a* and *b* to cause the production of image currents corresponding to the tone values of these areas. Thus cell 11 and also cells 10 and 12 are activated by light from the successive elemental areas of sections *a* and *b*, i. e., all of the elemental areas of a complete image. Image currents corresponding to successive ele-

mental areas of the complete image are therefore transmitted over channel 14 and also over channel 16.

For a more complete disclosure of the apparatus thus far described, reference may be made to an application of F. Gray, Serial No. 502,087, filed Dec. 13, 1930.

During each revolution of disc 4 the image is completely scanned twice, and the disc is driven at a rate such that each complete scanning is effected within the period of persistence of vision. In other words, if this period is $\frac{1}{16}$ of a second, the disc makes eight revolutions per second.

At the receiving station the image currents supplied over channel 14 are amplified by the device 17, while those transmitted over channel 16 are amplified by the device 18. One terminal of amplifier 17 is connected by the conductor 19, brush 20, slip ring 21, conductive element 22, brush 23 and the segments of commutator 24 to successive cathodes 25 of glow discharge lamp 26. Similarly, one terminal of amplifier 18 is connected by conductor 27, brush 28, slip ring 29, conductive element 30, brush 31 and the segments of commutator 24 to the successive cathodes 25 of the lamp 26. Associated with the cathodes 25 within the lamp 26 is an anode 32 which is connected by a common conductor 33 to the other terminals of the amplifiers 17 and 18. For the sake of clarity only eight cathodes are illustrated, i. e., four in each section. While the number of cathodes should preferably be greater than eight, it is undesirable to use more cathodes than the number of scanning lines.

Associated with the lamp 26 is a disc 34 provided with two rows of apertures each row arranged in a spiral. Motor 35 drives disc 34 in synchronism and in phase with the disc 4 at the transmitter. Motor 35 is also connected to the commutator brushes 23 and 31 and slip rings 21 and 29, constituting a unit, by a gearing 36 having a desired ratio, whereby the brushes are driven, to engage the successive segments of the commutator, at a predetermined rate of speed with respect to that of disc 34. A suitable means for maintaining the discs 4 and 34 in synchronism with each other is disclosed in an application of H. M. Stoller, Serial No. 442,564, filed April 8, 1930.

As the disc 34 rotates, two sections of the image will be simultaneously produced and may be viewed by an observer O through an optical system, indicated by the lens 37, or, if desired, the optical system may project the image upon a screen,

Since the incoming image currents are used to produce a glow area corresponding to a relatively narrow strip of the image instead of a glow area corresponding to a complete image section, an extremely bright image will be produced.

Where a large number of cathodes 25, for example fifty, are included in the lamp 26 there is danger that dark streaks may appear in the image presented to view, unless the apertures in the disc 34 are very accurately positioned and extreme care is exercised in the adjustment and operation of the cooperating elements of the scanning mechanism of the receiver associated with the lamp. This undesirable condition may be avoided and a receiver provided which does not require more than ordinary care in its design and operation, by using brushes 23 and 31 of sufficient length to engage two adjacent segments of the commutator, whereby image currents corresponding to each unit line of each section are supplied to the anode and to adjacent cathodes in each group simultaneously, and an image area is produced in each section of the field of view which is somewhat wider than the line scanned by each aperture.

Fig. 2 illustrates an end elevation of the lamp 26, associated with the scanning disc 34 and the rotating commutator-slip-ring unit.

By displacing the photoelectric cells 10 and 12 and the apertures 7 and 9 with respect to cell 11 and its associated aperture 8, or the latter with respect to the former, a distance equal to one unit line of the image field scanned at the transmitter, similarly adjusting either brush 23 or 31 a similar distance and rotating the discs 4 and 34 at a rate within the period of persistence of vision, the system described above may be used to simultaneously scan and produce alternate lines of the image.

Again by opening switches 60 and 61 in either channel 14 or 16, the system may be used for single-channel operation.

Fig. 3 illustrates a system, including transmitter terminal apparatus T' and receiver terminal apparatus R', in which the different sections of the image field are repeatedly scanned and the image currents corresponding thereto are simultaneously transmitted over different channels to control the ligth supplied by successive glow areas in different groups, which are simultaneously scanned.

The transmitting apparatus is shown associated with a field of view or subject 1 comprising two sections *a* and *b*, the successive elemental areas of which are adapted to be scanned.

An image of the object, illuminated by a source 2, is projected by an optical system, indicated by a lens 40, in the plane of a rotating disc 41, provided with two rows of apertures 42 and 43. Each aperture has a light directing means, herein indicated as a prism 44, applied thereto and each row of apertures is arranged in a spiral line. Mirrors may be used in place of the prisms 44.

The prisms associated with apertures 42 direct the light passing through them from successive elemental areas of section *a* to a light sensitive device 45, shown as a photoelectric cell, adapted to be connected to the amplifier 13, and those associated with apertures 43 direct the light passing through them from successive elemental areas of section *b* to the light sensitive device shown as a photoelectric cell 46, connected to the amplifier 15.

As the disc 41 is rotated by the motor 47, successive elemental areas of section *a* will be scanned by the apertures 42 and light will be applied to cell 45, which is thereby activated to cause the production of image currents corresponding in amplitude to the tone values of the areas. These image currents will be amplified by device 13, transmitted over channel 14, amplified by device 17 and distributed through conductor 19, slip ring 48, brush 49 and the segments of commutator 50 to the successive cathodes 25, associated with anode 32, in the upper half of glow lamp 26. Section *a* will be completely scanned during each complete revolution of disc 41 and this scanning will be repeated for each succeeding rotation of the disc at a rate equal to twice the period of persistence of vision.

In a similar manner, for each complete revolution of disc 41, the successive unit areas of section *b* will be scanned by the row of aper-

tures 43 and light passing therethrough will illuminate cell 46, which is thereby actuated to cause the production of image currents corresponding in amplitude to the tone values of the areas. These currents are amplified by device 15 and transmitted over channel 16, and after amplification by device 18, they are distributed through conductor 27, slip ring 51, brush 52 and the segments of commutator 53 to the successive cathodes 25, in the lower half of lamp 26, and anode 32. Since the image currents of the corresponding successive elemental areas of unit lines of the respective sections *a* and *b* are simultaneously transmitted, the corresponding cathodes 25 in the upper and lower sections of the lamp will be simultaneously energized to cooperate with its anode, whereby there will be produced two glow areas, which occupy positions corresponding to the unit lines of sections *a* and *b* of the field scanned at the transmitter.

Associated with the lamp 26 is a rotating disc 54 provided with two rows of apertures 55 and 56, the apertures in each row being arranged in a spiral. Disc 54 is driven in synchronism and in phase with the disc 41 by the motor 57, which rotates the discs at a rate equal to that of disc 41. The system disclosed in the above mentioned Stoller application may be used to maintain discs 41 and 54 in synchronism and in phase with each other.

As in the system of Fig. 1, the brushes 49 and 52 and slip rings 48 and 51 constitute a unit which is rotated by the motor 57 through a gearing 58 having the desired gear ratio. The slip rings and brushes are mounted on a shaft 59. For the reasons given above, brushes 49 and 52 simultaneously engage two adjacent segments of the commutators 50 and 53, whereby two contiguous cathodes in the upper and lower groups, respectively, and the anode are supplied with image current at the same time.

One row of apertures is displaced angularly with respect to the other. As shown in Figure 5, the row of apertures 56 is displaced approximately 72° with respect to the row of apertures 55.

This precaution is desirable to prevent confusion in the reproduced image due to the fact that, as the mid-section of the image is reproduced, the lower cathode of the upper group and the upper cathode of the lower group are simultaneously supplied at one instant with image currents from channel 14 and at another instant with image current transmitted over channel 16.

Lamp 26 comprises a bulb, charged with any suitable gas, as, for example, one of the noble gases, neon, helium, etc. at a suitable low pressure. The charge may also include a small percentage of hydrogen to improve the operation of the lamp as disclosed in application Serial No. 442,481 of F. Gray, filed April 8, 1930. A face view of the electrode assembly, used in lamp 26, is shown in Fig. 4, and the relative positions of the lamp 26 and disc 54 together with that of the two rows of apertures therein are illustrated in Fig. 5.

From the preceding description it will be apparent that the present invention provides a television system including a unitary glow lamp providing a number of strip glow areas, the unit areas of which are successively scanned to produce a bright image.

While a simple form of transmitter scanning apparatus has been disclosed, any other well known apparatus may be used for this purpose. For example, apparatus of the type disclosed in application, Serial No. 380,786 of F. Gray, filed July 25, 1929, now Patent No. 1,803,700, granted May 5, 1931, or of the type disclosed in application, Serial No. 312,761 of Hartley, filed October 16, 1928, now Patent No. 1,786,652, granted Dec. 30, 1930, may be used to effect simultaneous scanning of a plurality of sections of the subject by means of a corresponding number of moving beams of light. In this case the position of the light source and light sensitive devices, with respect to the subject scanned, would be reversed. Any form of amplifier may be used, but those including space discharge devices are preferred.

What is claimed is:

1. Image producing apparatus comprising a plurality of stationary strip light sources, terminal means for a plurality of image current channels, and means for distributing image currents simultaneously from said terminal means to respective groups of said light sources and from each of said terminal means to all of said sources in succession.

2. Image producing apparatus comprising a plurality of stationary strip light sources, terminal means for a plurality of image current channels, means for distributing image currents simultaneously from said terminal means to respective groups of said light sources and from each of said terminal means to all of said sources in succession, and scanning means cooperating with said light sources.

3. Image producing means for use in multichannel systems comprising a plurality of stationary strip light sources each corresponding to an elemental line of the receiving field of view, and means for energizing groups of said light sources simultaneously from different channels and all of said sources from each channel in succession, all portions of each light source emitting light when the source is energized.

4. Image producing means for use in multichannel systems comprising a plurality of stationary strip light sources, means for energizing groups of said sources in succession from the respective channels and all of said sources in succession from each channel, and scanning means cooperating with said sources for simultaneously scanning a plurality of said sources.

5. Television image producing apparatus comprising a plurality of parallel stationary strip light sources, a plurality of transmission channels, and means for distributing the current received over one channel to a plurality of said light sources one at a time, means for simultaneously distributing the current received over another channel to others of said light sources simultaneously with the said first distribution each said distributing means supplying current received over each channel to all of said sources in succession, and an apertured rotating element cooperating with said light sources for producing the image.

6. A glow lamp comprising a single structure having a series of strip shaped electrodes, and means for simultaneously and completely energizing a plurality of adjacent electrodes and a cooperating electrode to constitute a strip light source and for sequentially energizing the electrodes of the series one after the other while maintaining simultaneous and complete ener-

gization of the same number of adjacent electrodes and said cooperating electrode.

7. Television image producing apparatus comprising a lamp bank including separate groups of parallel linear elements each corresponding to a line of elemental areas of the field of view whose image is to be produced, and means for causing non-adjacent elements of the different groups respectively to become simultaneously effective and the elements of each group successively effective each element being simultaneously effective throughout its length when energized.

8. The method of controlling a stationary lamp to produce a television image which comprises causing elemental portions of the lamp corresponding to line series of elemental areas of the entire field of view to effectively emit light in succession, and simultaneously causing the same operation to occur but in a different portion of the lamp at each instant, the two elemental portions which are simultaneously rendered effective being widely separated throughout the entire period and each element being simultaneously effective throughout its length when energized.

9. The method of controlling a stationary bank of light emitting elements to produce a television image which comprises causing elemental portions of the lamp bank corresponding to line series of elemental areas of the entire field of view to effectively emit light in succession and simultaneously causing the same operation to occur but in a different portion of the lamp bank at each instant, the two elemental portions which are simultaneously rendered effective being widely separated throughout the entire period and each element being simultaneously effective throughout its length when energized.

10. The method of controlling a stationary lamp to produce a television image which comprises causing elemental portions of the lamp corresponding to line series of elemental areas of the entire field of view to effectively emit light in succession, simultaneously causing the same operation to occur but in a different portion of the lamp at each instant, the two elemental portions which are simultaneously rendered effective being widely separated throughout the entire period, and repeating said process in time intervals substantially equal to the period of persistence of vision each element being simultaneously effective throughout its length when energized.

11. Image producing apparatus comprising a stationary lamp structure including a plurality of strip light sources constituting different groups, and means for simultaneously and completely energizing sources in said different groups respectively and the sources in each of said groups successively.

12. A glow lamp comprising a stationary structure lamp including a series of strip-shaped cathodes and a box-shaped anode enclosing the area defined by said strip-shaped cathodes, and means for applying energizing current to said anode and a plurality of adjacent cathodes to produce a strip light source and for sequentially applying energizing current to said anode and to said cathodes one after the other while maintaining simultaneous and complete energization of the same number of adjacent cathodes.

13. A glow lamp comprising a stationary lamp structure including a series of strip-shaped cathodes and a box-shaped anode enclosing the area defined by said strip-shaped cathodes, and means for applying energizing currents to said anode and simultaneously to a plurality of remotely spaced cathodes to produce a plurality of strip light sources and for sequentially applying the respective energizing currents to said anode and successive cathodes of said series.

14. An image producing means comprising a stationary lamp structure including a series of strip-shaped electrodes and an electrode common thereto, a plurality of image current channels, means for distributing image currents respectively received over said channels to said common electrode and simultaneously to a plurality of said strip electrodes and in succession to the strip electrodes of said series to produce a plurality of moving strip light sources, a member having a plurality of sets of optical apertures lying along different parallel spirals respectively, and means for actuating said member to cause said sets of optical apertures to respectively scan said moving strip light sources in a direction transverse to the direction of motion thereof.

FRANK GRAY.