

Dec. 27, 1938.

F. GRAY

2,141,746

ELECTRO-OPTICAL IMAGE PRODUCING DEVICE

Filed Aug. 25, 1934

4 Sheets-Sheet 1

FIG. 1

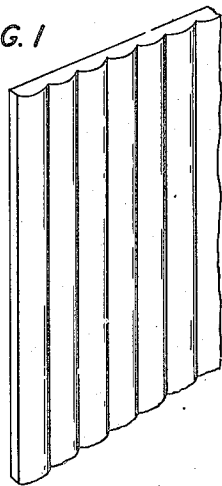


FIG. 2

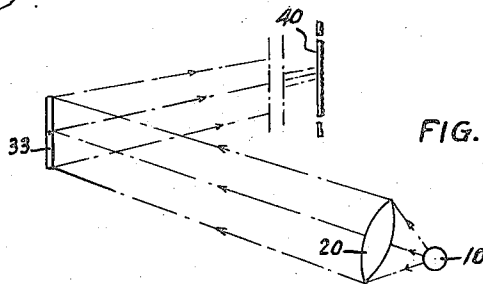
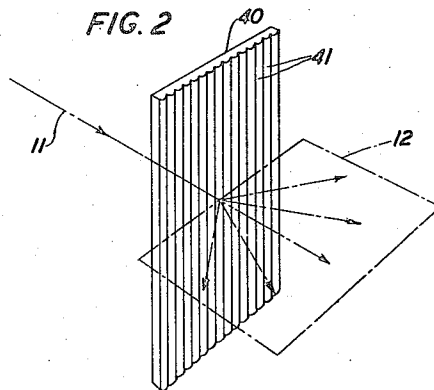


FIG. 2A.

FIG. 3

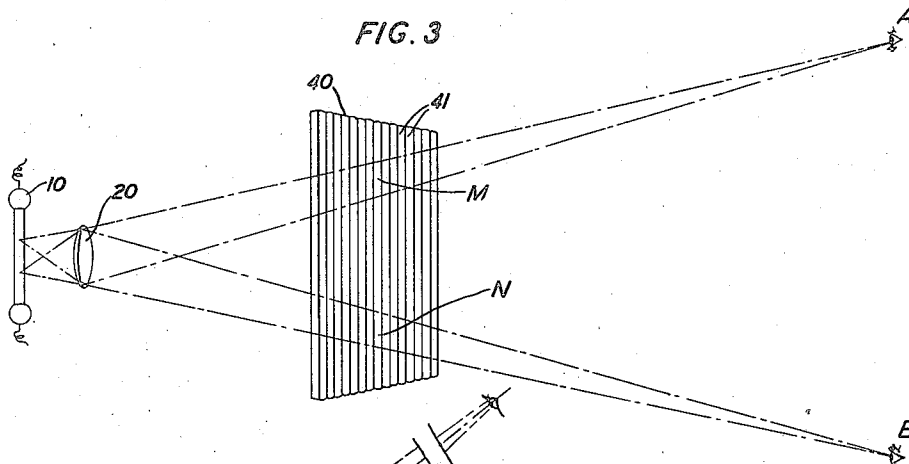
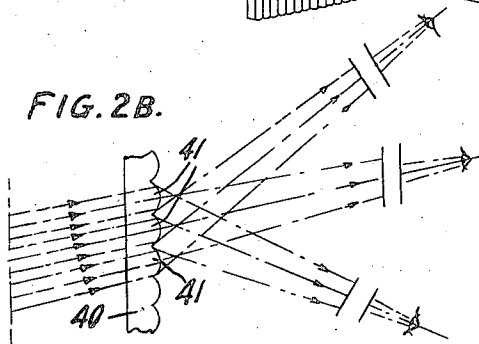


FIG. 2B.



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FIG. 4

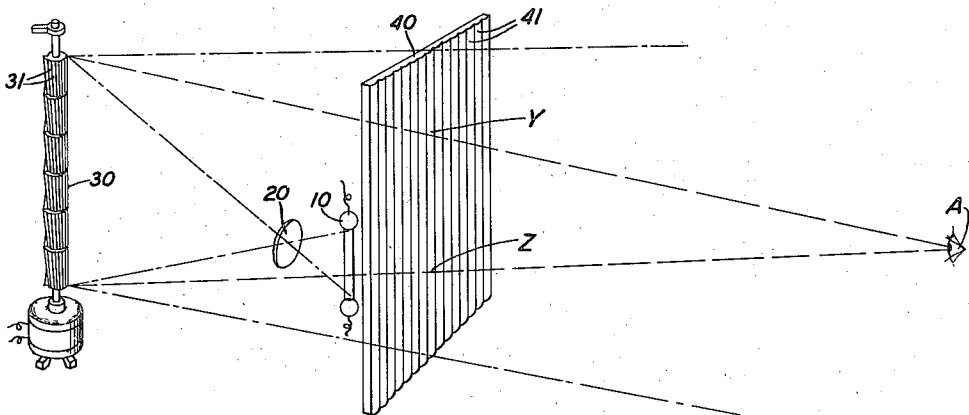


FIG. 4A

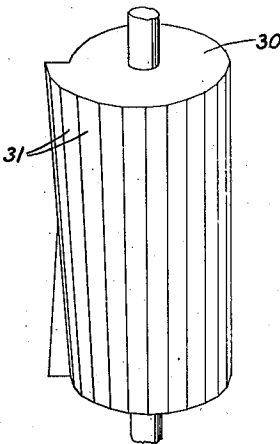
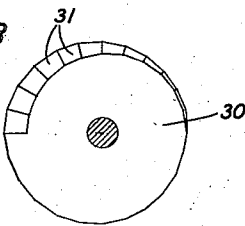


FIG. 4B



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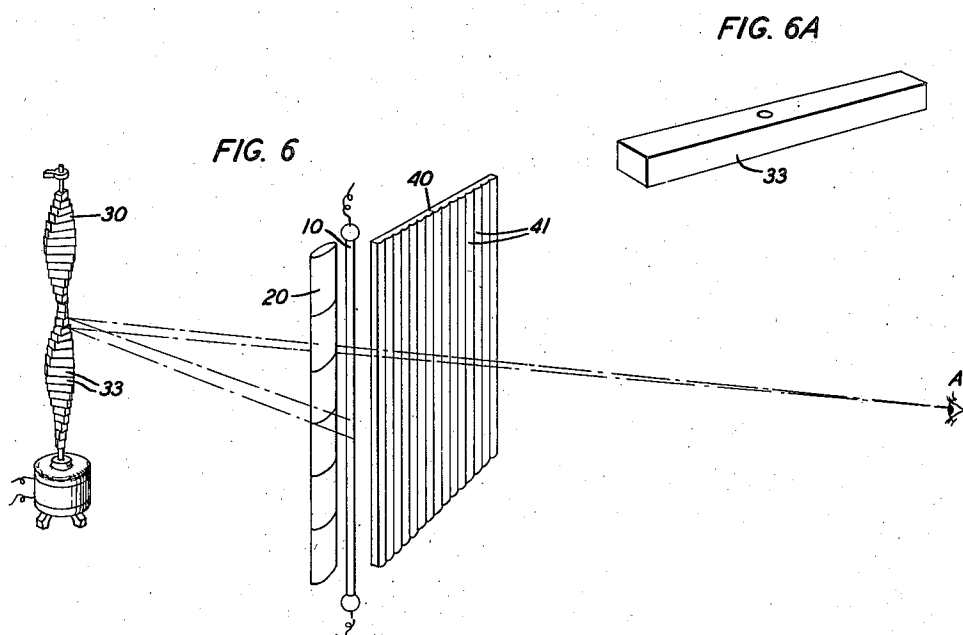
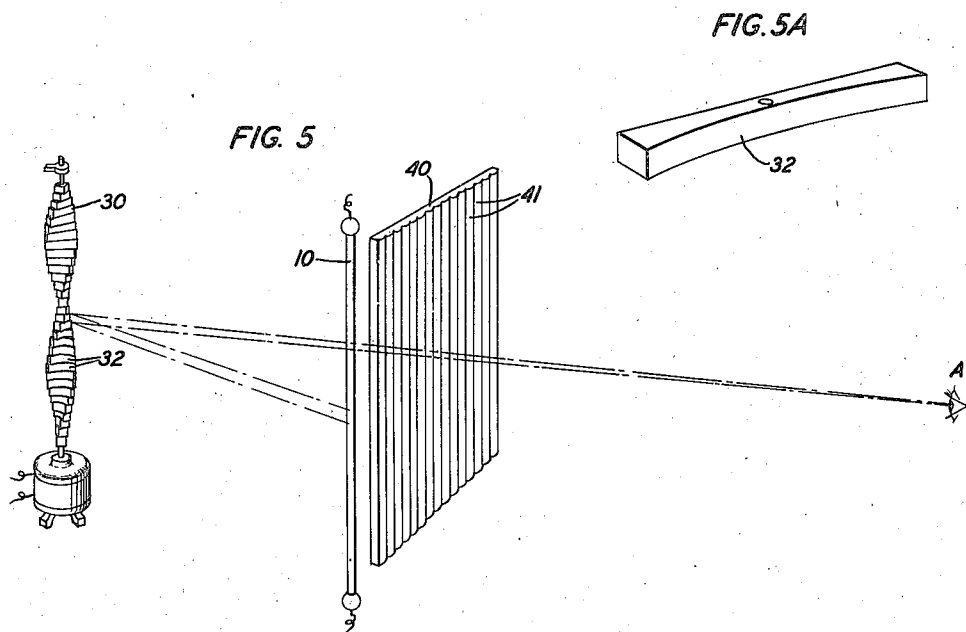
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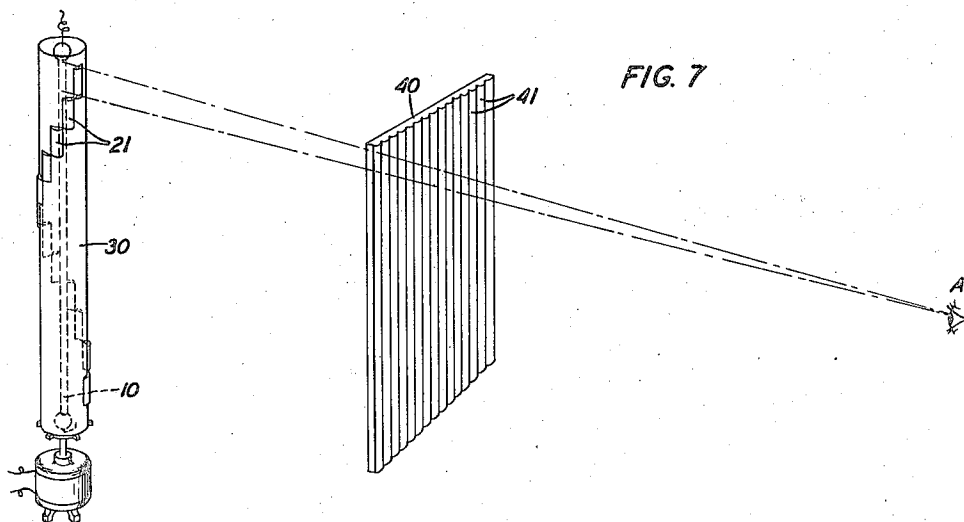


FIG. 8A

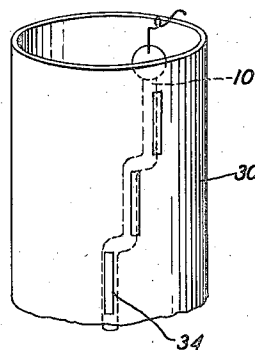
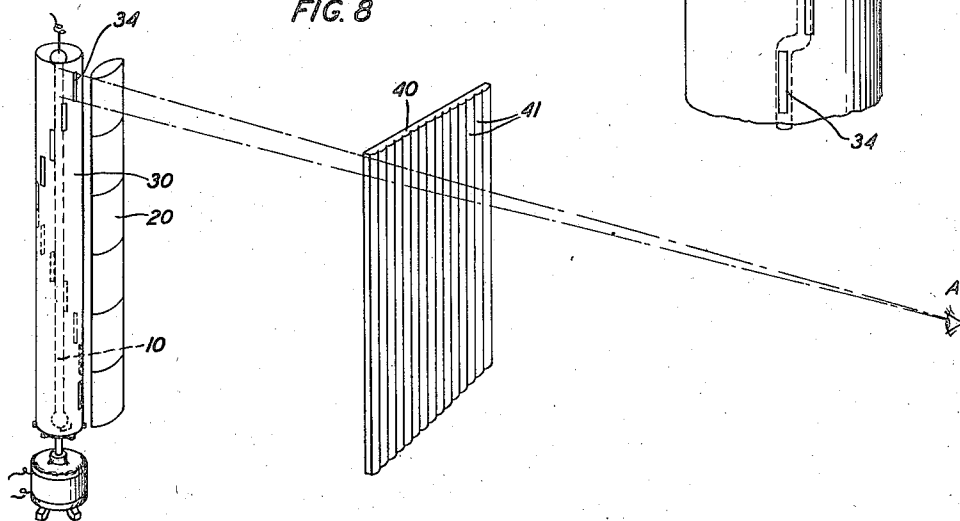


FIG. 8



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UNITED STATES PATENT OFFICE

2,141,746

ELECTRO-OPTICAL IMAGE PRODUCING
DEVICE

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Application August 25, 1934, Serial No. 741,369

3 Claims. (Cl. 178—7.3)

This invention relates to electro-optical image producing means and more particularly to a method and means of projecting an image on a screen that diffuses or spreads the scanning light beam in one plane only from each point of incidence.

An object of this invention is to increase the brightness of the projected spot of light over that obtainable with a screen that diffuses in all directions.

The method employed in this invention is intermediate to direct viewing of the light source and the usual method of projecting on a screen. In the ordinary arrangements two different methods have been employed to produce television images on a large screen. Images have been produced on a grid of lamps; and they have also been projected on a screen from a point source of light. The grid has ideal efficiency in the utilization of light because the observer views the source of light directly. The apparatus is, however, complicated and difficult to construct. On the other hand, projection from a point source permits the use of simpler apparatus, but utilizes the light with little efficiency as the light from a minute source is magnified to a large spot on the screen and a relatively small cone of light is diffused out over a wide solid angle, and the portion reaching the observer's eye is relatively very small.

This invention discloses an arrangement intermediate to the two extremes above mentioned and the desired result is achieved by projecting an image on a screen that diffuses light in one plane only from each point of incidence.

A more detailed description of the embodiments chosen for illustrating this invention follows:

Fig. 1 of the drawings is a perspective view of a screen suitable for use in this invention;

Fig. 2 is a schematic perspective view illustrating the underlying optical principles of this invention;

Fig. 2A is a diagrammatic plan view illustrating how a light source and an element of a mirror helix may be associated with the screen

Fig. 2B is an enlarged diagrammatic plan view including a longitudinal fragment of the screen indicating the path of light rays therethrough to three viewing positions;

Fig. 3 is a schematic perspective view of an image producing arrangement in accordance with the invention, the paths of the light beam

between the light source and the observers at a given instant being indicated;

Fig. 4 is a diagrammatic perspective view of a television projection arrangement in accordance with this invention employing a vertically positioned short strip light source, a vertically positioned rotating mirror drum having longitudinal plane mirrors conically and spirally positioned thereon, and a lens system therebetween, and a vertically ribbed screen;

Figs. 4A and 4B respectively show side and end views of a section of the mirror drum of Fig. 4;

Fig. 5 is a diagrammatic perspective view of a television projection arrangement in accordance with the invention employing a vertically positioned long strip light source, a long vertically positioned rotating mirror helix having concave reflector strips, and a vertically ribbed screen;

Fig. 5A is a perspective drawing of one of the concave reflector strips of the mirror helix of Fig. 5;

Fig. 6, a modification of Fig. 5, is a diagrammatic perspective view of a television projection arrangement employing a vertically positioned long strip light source with a long cylindrical lens in front thereof and parallel therewith, a long vertically positioned rotating mirror helix having plane reflector strips, and a vertically ribbed screen;

Fig. 6A is a perspective view of one of the plane reflector strips of the mirror helix of Fig. 6;

Fig. 7 is a diagrammatic perspective view of a television projection arrangement in accordance with the invention employing a vertically positioned long strip light source, a rotating cylinder concentric with the lamp and carrying a spiral of cylindrical lenses, and a vertically ribbed screen;

Fig. 8 is a diagrammatic perspective view of a television projector arrangement in accordance with the invention employing a vertically positioned long rotating cylinder pierced with a spiral of vertical slots behind each of which is a lamp or a part of a lamp, a vertically positioned stationary row of aligned cylindrical lenses in the path of the scanning beam, and a vertically ribbed screen; and

Fig. 8A is a perspective view of an enlarged section of the rotating cylinder of Fig. 8 showing how a long capillary lamp is bent to cover a plurality of slots.

In each of the different projection arrangements a scanning light beam is projected on a

screen which diffuses in substantially one plane only. All of the light in a narrow incident beam after being intercepted by the screen remains in one plane, the incident beam being fanned out, so to speak, in a plane by the diffusing action of the screen.

Fig. 1 is a perspective view of such a screen of the light transmitting type. It is ribbed in one direction and when traversed by a scanning beam is positioned with the ribs at right angles to the direction of movement of the beam. The screen may, however, be either of a transparent transmitting refracting type, or of a reflecting type. In the latter case the ribs direct the light backward towards the source in a plane meeting a perpendicular to the screen at the same angle as the incident beam. Either type of screen may be used with any of the methods herein described. However, for purposes of simplification, the transmitting type of screen only is shown in the various modifications illustrated in the drawings and described below.

Fig. 2 schematically shows the action of the screen employed for one position of the incident beam. The scanning beam 11 is directed in a plane 12 (a horizontal plane, as illustrated) through the vertically positioned screen 40 having vertical cylindrical ribs 41. The cylindrical ribs 41 of this screen cause the emerging beams to diverge in one plane only which for the beam in the position shown is at right angles to the axis of the ribs of the screen, that is, in the plane 12.

Fig. 2A is a diagrammatic plan view showing the course of the light rays from the source 10 through the lens 20 to one elemental reflecting surface 33 of a mirror helix and from there to the screen 40. The strip light source 10 and the screen 40 are in conjugate focal planes of lens 20.

Fig. 2B is an enlarged diagrammatic showing of the region near the focal point on screen 40 of Fig. 2A and also a showing of the paths of the light rays through three of the lenticular ribs of screen 40 to three eyes representing three possible viewing points in the same horizontal plane. The image of the strip light source has a horizontal dimension which is of course considerably larger than the horizontal dimension of the strip source. The beam from the mirror therefore may impinge simultaneously upon several of the ribs. It is here assumed that three ribs are simultaneously illuminated with this beam. Assuming that the three eyes are in the positions as shown in this figure, it is obvious that each of these eyes will receive certain rays from the source 10. That is, each of the eyes will simultaneously see an elemental area of the screen 40 as though light were emanating from this area as a primary light source. From this it is obvious that an eye placed anywhere within a large angle in the plane of the drawings, Figs. 2A and 2B, will similarly receive light from this same elemental area when it is illuminated by the scanning beam from the source 10 and one reflecting element of the helix.

Fig. 3 shows how observers in different horizontal planes, or tiers, may simultaneously view a light transmitting screen diffusing in a horizontal plane only, when the screen is illuminated from the rear with a narrow light beam extending from the top to the bottom of the screen. A mirror helix, for example, could be used to produce a succession of such beams sweeping across the screen in a horizontal direction. This figure being merely illustrative of the action of the

screen with respect to different vertical viewing positions, a simple stationary light source producing a stationary vertical strip beam is shown to avoid a complete showing of a mirror helix, or other suitable scanning arrangement, such as is disclosed in subsequent views. This figure is a schematic perspective view showing paths of light rays reaching two observing positions. A narrow vertical strip image of the strip light source 10 is projected by a lens 20 upon the screen 40 having vertical ribs 41 and the image extends from the top to the bottom of the screen. The light source and screen are in conjugate focal planes. An observer A sees light coming from a single region M on the screen; another observer B sees light coming from a different region N on the screen. Arrangements employing devices for moving such beams of light across the screen and for controlling their intensity to produce television images will be subsequently described.

Since the lenticular screen diffuses light in one plane only there is opportunity to make the projected spot brighter than with a screen diffusing in all directions. The method as already stated is intermediate to direct viewing and the usual method of projecting on a screen. The additional light comes from a relatively long strip source that may be used, compared with a point source used to project upon a viewing screen in the usual manner. The effectiveness of the method depends on the practical utilization of a considerable length of lamp which is equivalent to providing a separate point source of light for each tier of observers in the viewing audience, the total amount of light thus supplied to the audience is consequently many times greater than could be supplied from a single point source.

To produce television images the strip image projected on the screen must be swept across the screen in a direction at right angles to the ribs of the screen. Several arrangements for accomplishing the desired result are shown both for projection from apparatus positioned at a long distance from the screen and from apparatus positioned at a shorter distance from the screen; the former being shown in Figs. 4, 5 and 6, and the latter in Figs. 7 and 8, respectively.

Fig. 4 shows one arrangement for carrying out this invention. This figure shows a diagrammatic perspective view of a television projection arrangement employing a vertically positioned short strip light source, a vertically positioned rotating mirror drum having longitudinal plane mirrors conically and spirally positioned thereon, and a lens system therebetween, and a vertically ribbed screen such as shown in Fig. 1. An image of the relatively short light strip 10 is focussed by means of the lens 20 upon the vertically ribbed screen 40. The scanning motion of the beam is produced by the rotating mirror system 30 formed of long narrow mirrors 31 conically and spirally positioned around the periphery of a drum and in the path of the light beam directed by the lens 20. Each mirror is inclined at a different angle to the axis of rotation so that successive mirrors displace the apparent position of the lens 20 in a vertical direction and thus give the successive lines of the image. The vertical height of the image seen by an observer A is limited by the intercept YZ on the screen. This dimension of the image obviously depends upon the position of the observer, and the conditions are arranged so that the majority of the ob-

servers see an image of approximately the correct dimensions. For example, an image averaging three feet high is produced in seventy-two lines by a rotating mirror system about four feet long for viewing by a group of people positioned in an area approximately twenty-five to one hundred feet away from the screen, the image increasing in vertical dimension as the distance of the observer from the screen increases. For an image of this size the mirrors are about one-quarter inch wide and the rotating mirror system only six inches in diameter. With such a long mirror system each reflecting surface is preferably made up of separate parts. This may be done by assembling short units on the same shaft as indicated in the drawings. On account of the small diameter of these units they may be cut from a single piece of metal which is plated and polished.

Figs. 4A and 4B show side and end views, respectively, of the mirror system or a unit thereof. Each mirror surface is at a different angle with respect to the axis of rotation so as to produce displacement of the apparent position of the lens 20 as already stated.

Fig. 5 is another arrangement showing diagrammatically a perspective view of a television projection arrangement employing a vertically positioned long strip light source, a long vertically positioned rotating mirror helix having concave cylindrical reflector strips, and a vertically ribbed screen. Light from the long strip light source 10 is reflected from the long mirror helix 30 to the screen 40. The mirror surfaces 32 of the helix are concave in a horizontal direction and in this direction each reflector focusses an image of the lamp on the vertically ribbed screen 40. The successive mirrors sweep an image of the lamp repeatedly across the screen. In a vertical direction an observer A looks through the screen at the successive mirrors as they reflect light to the screen and thus sees the image produced in lines swept across the screen. Here again, the helix must be longer than the desired vertical length of the image. The lighting of the screen may be varied to some extent by using mirrors concave or convex in a vertical direction. The length of the lamp may be shortened by inclining the reflectors with respect to the axis of the helix; and multiple channel reception may be attained with two sets of reflectors inclined in the proper manner. An arrangement of inclined reflectors in a mirror helix for direct viewing without a screen is shown in my Patent No. 2,012,092, patented Oct. 15, 1935, Serial No. 538,959, filed May 21, 1931.

Fig. 5A shows a single strip of the mirror helix having a concave cylindrical reflecting surface 32.

Fig. 6 shows a modified use of the mirror helix that gives considerably more light than the arrangement shown in Fig. 5. This figure shows a diagrammatic perspective view of a television projection arrangement employing a vertically positioned long strip light source with a long cylindrical lens in front thereof and parallel therewith, a long vertically positioned rotating mirror helix having plane reflector strips, and a vertically ribbed screen. Light from the long strip source 10 is passed through the long cylindrical lens 20 in front of the lamp and a strip image of the lamp is formed on the vertically ribbed screen 40. The image is swept across the screen by reflection from the successive plane reflectors 33 of the mirror helix 30. In this case the reflectors may be much shorter than in the

arrangement shown in Fig. 5. Again, the lamp may be shortened and multiple channel reception attained by inclining the reflectors with respect to the axis. Depending on circumstances the illumination of the screen may be varied to some extent by also giving the lens 20 a curvature in a vertical direction. Since an observer A looks in a vertical direction at a reflector of the helix, the latter must be longer than the desired vertical length of the image.

As heretofore stated, the television projection arrangements described in Figs. 4, 5 and 6 are for long distance projection and those to be described in Figs. 7 and 8 are for shorter projection.

Fig. 7 is a diagrammatic perspective view of a television projection arrangement employing a vertically positioned long strip light source, a rotating cylinder concentric with the light source and carrying a spiral of cylindrical lenses, and a vertically ribbed screen. The long strip light source 10 is concentrically positioned within the rotating cylinder 30 carrying a spiral of cylindrical lenses 21. Each cylindrical lens in succession sweeps an image of the long strip light source 10 across the vertically ribbed screen 40. This short projection system causes far less variations in the vertical length of the image due to different positions of the observer A than do the other arrangements above described. By making the lens long and narrow as shown in the drawings, the diameter of the cylinder may be reduced to such practical dimensions as eight inches for a seventy-two line image. In this arrangement it is also practical to operate the light source on a high frequency current and commutate it in sections, though sectionalization of the light source and a commutator arrangement are not shown in the drawings.

Fig. 8 is another arrangement for short distance projection and shows a diagrammatic perspective view of a television projector arrangement employing a vertically positioned long rotating cylinder pierced with a spiral of vertical slots behind each of which is a lamp or part of a lamp, a vertically positioned stationary row of cylindrical lenses in the path of the scanning beams, and a vertically ribbed screen. In this arrangement the long rotating cylinder 30 is pierced with a spiral of vertical slots 34 behind each of which is a lamp or part of a lamp 10 controlled by a television signal. The stationary row of cylindrical lenses 20 projects the successive slots on the vertically ribbed screen 40, which is viewed by observer A. This arrangement also permits commutating the television signals to the successive lamps or to sections of a long lamp.

Fig. 8A is a perspective drawing of an enlarged section of the rotating cylinder 30 showing a long strip light source 10 bent to cover a plurality of slots 34 and attached to rotate with the cylinder.

In both the arrangements shown for shorter projection, Figs. 7 and 8, the lenses may be curved also in a vertical direction to give more light intensity.

The method described for long distance projection as illustrated by Fig. 4 presents an arrangement for efficient projection on a screen that diffuses in both planes, that is, on the usual type of screen. For this purpose the reflecting parts of the vertical elements of the rotating member 30 of Fig. 4 each constitute a spherical mirror that focusses an image of the lens 20 on the screen 40 arranged for diffusing in both

planes. The long mirror system permits the utilization of considerable length of the strip source 10 and thus makes possible an efficient projection system using the usual type of screen. 5
 As a simpler modification, the reflecting elements may constitute cylindrical mirrors curved in a vertical direction in which case a reflector focusses an image of lens 20 on the screen in a vertical direction; and the lens 20 forms an image 10
 of strip source 10 on the screen in a horizontal direction thus converging the scanning beam to a small area or spot of light on the screen.

What is claimed is:

1. An electro-optical image producing scanning 15
 device comprising an image screen diffusing light in one plane only, a rotatable cylindrical scanning member having a set of spirally arranged apertures therein and each aperture equipped with a cylindrical lens, a strip source of light positioned 20
 concentrically with respect to and within said cylindrical scanning member, means for positioning said screen, scanning member, and source of light in optical alignment and said source of 25
 ship with respect to said cylindrical lenses, and means for rotating said cylindrical scanning member to cause the light directed therefrom through each said cylindrical lens to sweep across said screen.

2. An electro-optical image producing scanning 30

device comprising an image screen diffusing light in one plane only, a rotatable cylindrical scanning member having spirally arranged scanning apertures, a long cylindrical lens system, a long strip source of light concentrically positioned with respect to the axis of said scanning member, means 5
 for positioning said screen, lens, scanning member, and source of light in optical alignment and said source of light and said screen in conjugate focal relationship with respect to said cylindrical 10
 lens, and means for rotating said scanning member to cause light directed therefrom through each said aperture to sweep across said screen.

3. An electro-optical image producing scanning 15
 device comprising an image screen diffusing light in one plane only, a rotatable cylindrical scanning member having spirally arranged scanning apertures, a long strip source of light formed or bent to cover said apertures and fixed within the said 20
 cylindrical element directly behind said apertures thereof, a long cylindrical lens system, means for positioning said screen, lens, scanning member, and source of light in optical alignment and 25
 said light and said screen in conjugate focal relationship with respect to said cylindrical lens, and means for rotating said scanning member to cause light directed therefrom through said apertures to sweep across said screen.

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