

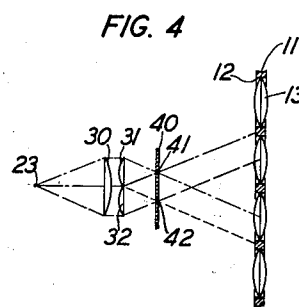
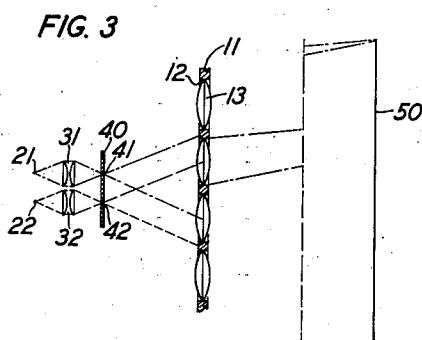
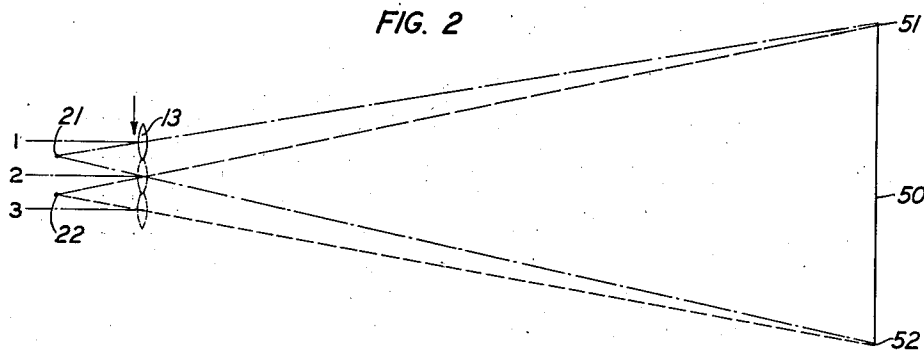
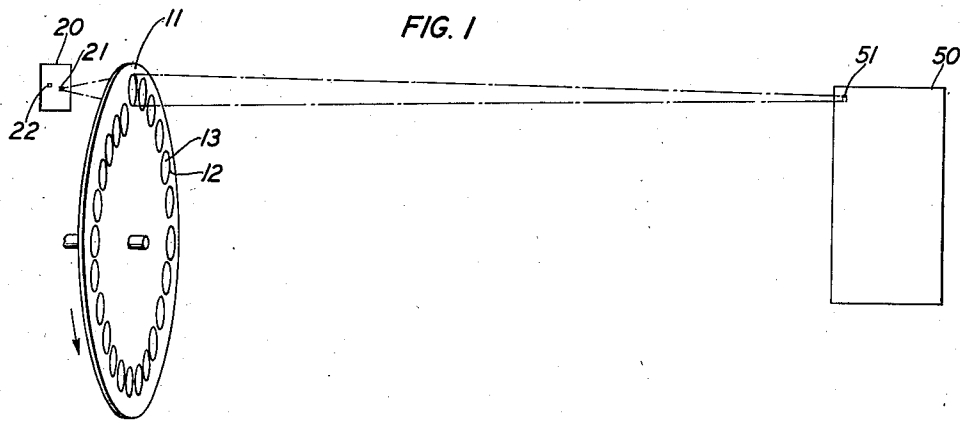
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ELECTROOPTICAL SCANNING APPARATUS

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ELECTROOPTICAL SCANNING APPARATUS

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1 Claim. (Cl. 178—7.6)

This invention relates to electro-optical scanning arrangements and more particularly to an arrangement whereby each aperture of a scanning member successively scans a plurality of lines across an image field, thereby proportionately reducing the number of apertures in the scanning member.

An important feature of this invention is the reduction of the number of apertures in the usual scanning members to one half or other aliquot part of the number of image scanning lines. In the usual single channel system, one aperture in the scanning member is required for each image scanning line. In accordance with this invention two or more different lines are successively scanned by each aperture in the scanning member during each scanning cycle and the number of scanning apertures required are equal only to the number of image scanning lines divided by the number of lines scanned per aperture. The apertures of the scanning member may be of the non-refracting type but are preferably equipped with light converging lenses which permit of a much higher efficiency in the use of the light sources. The use of lens equipped scanning members is old and the use of such scanning members in multiple channel electro-optical systems for the projection simultaneously of a plurality of points of light on the image field, one for each channel is also old. The employment, as in this invention, of each aperture for successively scanning a plurality of different lines across the field in non-overlapping periods is new.

In accordance with the specific form of the invention herein later described in detail and shown in the drawing, an apertured scanning disc, the apertures of which are preferably lens equipped, is associated with a plurality of effective light sources simultaneously energized by the incoming image current and so positioned with reference to the scanning disc that each lens in the disc as it passes the light sources projects a scanning beam from each in succession so as to scan different parallel elemental strips across the image field or screen. This arrangement not only has the advantage of reducing the number of apertures or lenses in the scanning disc for the same degree of resolution, and the size of the disc, but also the image distortion is lessened near the edges of the picture or field due to the smaller angles swept out in scanning each strip. Furthermore, by reducing the number of the lenses without correspondingly reducing the size of the disc, the size of

each lens may be increased and consequently a larger proportion of the light from the effective sources be collected in the scanning beam thereby increasing the efficiency of the utilization of the light.

A more detailed description of the embodiment of the invention illustrated in the accompanying drawing follows.

Fig. 1 of the drawing is a diagrammatic showing of an optical scanning arrangement for utilizing this invention with a lens carrying disc and two light sources;

Fig. 2 is a diagrammatic fragmentary showing of the arrangement of Fig. 1 viewed from above, one lens only being shown and the boundary of the effective optical path of the scanning beam from the two light sources being indicated;

Fig. 3 is a diagrammatic showing of a modified optical arrangement for obtaining two spaced effective point sources of light from two primary light sources; and

Fig. 4 is a diagrammatic showing of a further modification employing one primary source and two secondary light sources derived therefrom.

Referring to Figs. 1 and 2 of the drawing, the scanning apparatus comprises a scanning disc 11 having a series of spirally arranged apertures 12 each equipped with a converging lens 13. The effective light sources 21 and 22, respectively, are in the plane 20 to the rear of the scanning disc with respect to the field of view and parallel therewith. Their position and size may be definitely defined by using, for example, an apertured plate at 20 having either round or rectangular apertures at the positions 21 and 22 through which light is properly directed from the rear thereof, as shown for example in Figs. 3 and 4. However, when small light sources, such as crater lamps, are used they may be positioned at these points and directly define the size and position of the sources. The sources 21 and 22 are spaced slightly apart in a vertical direction and somewhat further apart in a horizontal direction. The conjugate foci of the lenses in the apertures 12 of the scanning disc are respectively in the planes of the effective light sources 21 and 22 and the screen 50. An elemental area 51 is illuminated by the apparatus in the position shown. As each lens aperture in the scanning disc becomes effective as the disc is rotated, a beam of light from source 21 through the lens first scans an elemental strip across the field and then a beam of light from source 22 through the same lens scans a second

elemental strip across the screen. During each revolution of the scanning disc, the apparatus scans the entire field with twice as many elemental strips being scanned as there are apertures in the scanning disc. As already stated, the number of scanings per aperture is proportional to the number of light sources and consequently if three light sources were employed, each aperture would scan three elemental strips across the screen, etc.

The exact operation of the lens equipped apertures in the scanning disc in scanning a plurality of elemental strips may be clearly understood by reference to Fig. 2. As will be apparent, the light sources 21 and 22 are relatively so located that the image of 22 falls below the image of 21 when a lens 13 moves from positions 1 to 3 in scanning two elemental strips across the screen 50. The following line is located radially so that the image from the light source 21 will be positioned on the screen below that of the previous image of the light source 22 produced by the preceding lens. This procedure is continued until the whole picture is scanned or formed. The light sources located at the two points 21 and 22 are so spaced that when a scanning lens 13 in the disc is in position 1, the image of the light 21 is projected on the screen 50 at its left edge position 51; as the lens in the disc moves from position 1 to position 2, the image of the light 21 on the screen moves from position 51 to position 52 at the right edge of the screen; when the lens in the disc reaches position 2, the image of the light 22 is projected on the screen at the left edge position 51 and as the lens moves from position 2 to position 3, the image on the screen moves from position 51 to position 52 at the right edge of the screen, but in a different parallel path to that traced in moving from position 1 to position 2. A scanning line displacement normal to the scanning motion, results from the lenses on the disc being in a spiral, each lens being displaced radially in the amount necessary to build up the picture by the light from the stationary sources in a series of juxtapositioned scanning lines.

The effective light sources can be obtained in a number of ways. As already stated, each source may be a small primary source, such as a crater lamp, properly positioned and directly viewed. In practice, it is somewhat difficult to obtain a very intense source of small area, but a larger source may be used with a condensing lens and an apertured plate. Such an arrangement employing a plurality of light sources is shown in Fig. 3 and one employing a single light source is shown in Fig. 4. In Fig. 3, the two light sources 21 and 22 are converged by means of the lenses 31 and 32, respectively, at two points 41 and 42. An opaque screen 40 has small apertures at points 41 and 42 in a plane conjugate to the screen 50 with respect to the lenses of the disc 11. In Fig. 4, the light from a single light source 23 is gathered by a relatively large lens 30 and directed by lenses 31 and 32 to points 41 and 42, respectively, the same as in Fig. 3. The lenses 31 and 32 in Fig. 4 may be replaced with a single lens of the same diameter as lens 30.

While this invention has been described in detail as an electro-optical receiver, the device is obviously reversible and the principles can be applied to an electro-optical transmitter. In the latter case, when flood illumination of the object

is employed, the light sensitive electric cells take the place of the light sources, and when spot scanning illumination of the object by an intense light source is employed, the light sensitive cells are properly positioned to receive reflected light from the elemental areas of the object as it is scanned.

It is further applicable to multiple channel operation and to the production of images in color. In one adaptation for color work, a colored light source is employed to represent each one of the three primary colors which are either so positioned that each elemental strip is scanned for each, or for a different, primary color. This may be effected by positioning light sources of the three primary colors in a line with such spacing that as a lens passes from one position to the next it will scan the screen first with one, then with the second and next with the third primary color. Each elemental strip of the field may be scanned for all three colors by each of the lenses or the three primary color light sources may be positioned with an off-set as described for monochrome operation and three different elemental strips scanned by each of the lenses for a primary color. In such arrangements, the separation of the different primary color signals is made at the transmitter, the transmitting scanning disc having sets of three properly spaced apertures for each color, these sets of apertures being circularly positioned where each line is scanned for all three colors, and spirally positioned where each line is scanned for only one primary color. The signal currents for the three primary colors may be generated successively or concurrently and so used, employing single or multiple channel transmission respectively. A further adaptation to color operation consists in placing three color light sources in two or more banks, each bank taking the place of one of the light sources in monochrome operation and being scanned by the same lens in succession. In this arrangement, there are the three spots of the three different primary colors simultaneously on the field. Further modifications may be made in adapting this invention to color or to monochrome multiple channel transmission.

While the illustrative arrangements herein described in detail employ a rotating lens equipped scanning device and form the image on a screen, it is to be understood that the invention is also applicable to other types of scanning apparatus.

What is claimed is:

Scanning apparatus comprising a rotating member having a plurality of lens equipped apertures, a stationary opaque screen having a plurality of small apertures therein, a stationary source of light of small cross-section, a stationary collimating lens located between said source and said screen with said source at the principal focus of said lens, a plurality of smaller lenses located side by side between said collimating lens and said screen with the principal focus of each small lens coincident with a respective aperture, and means to so position said rotating member with respect to said screen that each lens in succession forms an image of said screen on a scanning field, the apertures in said screen being offset in the direction of scanning so that one aperture only is imaged on said field at any one time and only slightly offset in a direction transverse to the direction of scanning.

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