United States Patent

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[54] LIGHT BEAM INFORMATION PRESENTATION CONTROL MEANS

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[51] **Int. Cl.** **B41b 13/00**

[58] **Field of Search** 95/4.5; 178/6.7, 6.8, 7.4, 178/7.5, 7.7; 340/378; 346/108

[56] **References Cited**

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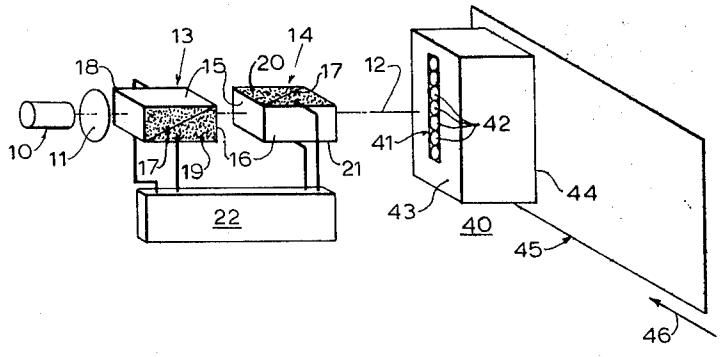
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Primary Examiner—John M. Horan

[57] **ABSTRACT**

Apparatus for controlling the formation and presentation of messages utilizing the high-speed light deflection characteristics of electro-optic light-refractive materials in combination with a longitudinally extended window of a light-limiting member supported in the path of a light beam. The light beam is deflected vertically and allowed to enter the window whereby a series of vertically oriented side-by-side lines of light may be exposed to the surface of a display medium. But, in the process of doing so, the light beam will be deflected horizontally and beyond the limits of the window so as to effect interruptions in lines of the series which correspond to the formation requirements of a message being presented.

6 Claims, 6 Drawing Figures



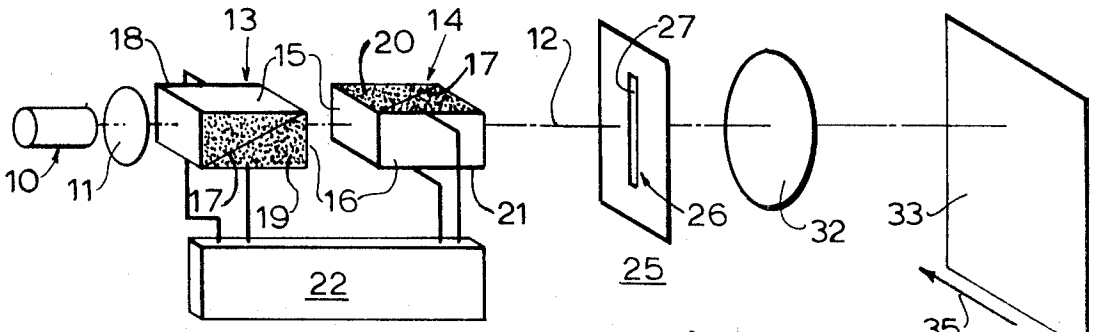


FIG. 1

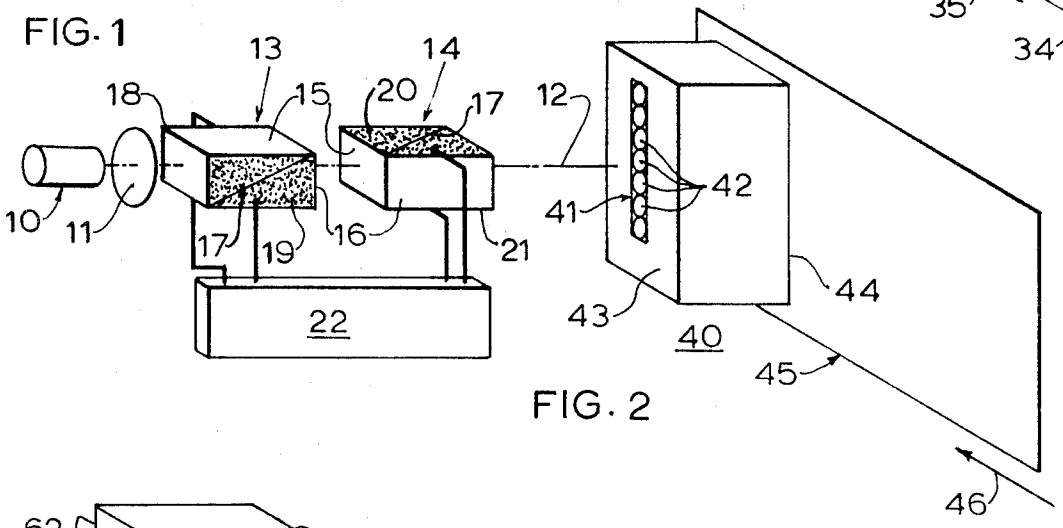


FIG. 2

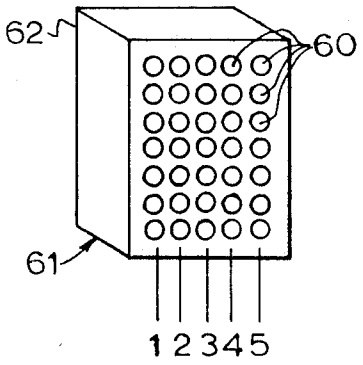


FIG. 5

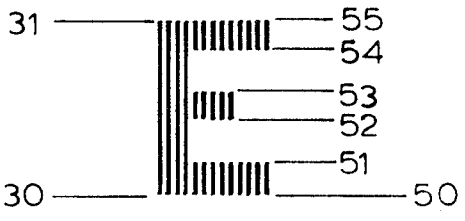


FIG. 3

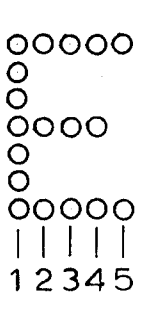


FIG. 6

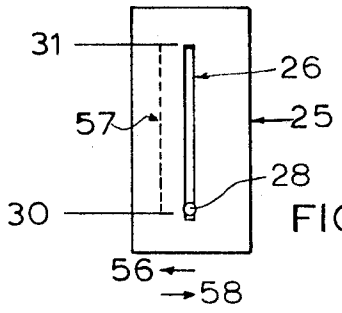


FIG. 4

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LIGHT BEAM INFORMATION PRESENTATION CONTROL MEANS

BACKGROUND OF THE INVENTION

The invention is related quite closely to recorders and displays of information-utilizing character and pictorial generators in combination with cathode-ray tubes, but instead of an electron beam a beam of light is being used either as the means of displaying information on a screen for viewing purposes or on a light-sensitive media for the purpose of storing information. However, in relation to the present invention, cathode-ray tubes and their associated equipment is complex, and recording media is usually in the form of sensitive film which is expensive. The light beam as used in the present invention may, of course, be obtained from a LASER and, therefore, capable of exciting the less sensitive and less expensive record media. Moreover, this invention is capable of providing printed information and displays of date which exceed the quality standards of the cathode-ray tube since the spot size and brightness of available light sources make this possible in the apparatus disclosed herein.

SUMMARY OF THE INVENTION

Included herein are several embodiments of apparatus for presenting information on a viewing screen or on a record medium for storage. In each case a spot-size beam of light is used, preferably from a LASER light source, and it is directed toward a screen or other media by means of a system of horizontal and vertical electro-optic light beam deflectors. Intermediate the target, toward which the beam of light is being directed, and these deflectors there is a light-stopping member containing an area through which light of the beam will be permitted to pass. The cross-sectional dimension of the beam is related to the size of the light-passing area of the light-stopping member to the extent that the area presents a longitudinal dimension substantially greater than the beam dimension; possibly 10 to 100 times greater.

The light-passing area will coincide with a common optical axis of the apparatus and along which the beam of light is projected, and the longitudinal dimension of the light-passing area is oriented in the direction in which the beam is capable of being displaced in relation to the optical axis by the vertical deflectors. Therefore, the area is scanned at a predetermined, and rapid, rate by the beam of light under the influence of voltages being applied to the electro-optic materials of the deflectors. When light reaches the target, which may be movable in a horizontal direction, a series of vertically oriented lines will be exposed to the surface of the target. In forming a meaningful image, however, these lines will be interrupted in various ways and to the extent necessary to form a message. These interruptions are initiated by the application of the influence of a voltage applied to the electro-optic material of the horizontal beam deflector while voltages are being applied to the vertical deflectors. During each interruption the beam is deflected horizontally and beyond the limits of the light-passing area. The duration of such interruptions will be in accordance with a given image formation requirement.

Within the light-passing area of the light-stopping member the invention will include the use of one of several beam utilization means, each designed to meet a different display or recording requirement of the invention. The light-passing area in one embodiment is in the form of a vertically oriented light-transparent window. The vertically scanned beam is thereby projected through the window and onto the surface of the image presentation target. In another embodiment a vertically oriented array of light-admitting end surfaces of optical fibers is positioned within the light-passing area and light is conducted through the fibers to a similar array of light-emitting end surfaces. A series of columns of light spots from these emitting ends may then be imaged on the surface of the target. In another embodiment a single vertically oriented array of the light-admitting ends of the fibers is divided into five, for example, vertically oriented arrays of light-emitting ends from which an individual series of five columns of light spots may be derived for forming message characters, either directly on the surface of a record medium or projected onto the viewing surface of a target medium.

Objects of the invention and its various embodiments include high-speed means of presenting informative light images on a display medium and more particularly on record media requiring relatively high levels of light output from the source of the information. Other objects include simplified means for generating the informative light images simply and at very high writing speeds.

The invention, however, both as to its originality and method of operation, and additional objects and advantages, will best be understood from the following description when read with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIGS. **1** and **2** each include a diagram of the unique means of generating light images with respectively different means of effecting the display and recordations of light image;

FIG. **3** will be referred to in describing the image-generating functions of the FIG. **1** embodiment;

FIG. **4** will be referred to in describing the function of the light-stopping member in the FIG. **1** embodiment;

FIG. **5** represents an array of light-emitting elements of a light-stopping member and of a type that may be used in FIG. **1**; and

FIG. **6** will be referred to in describing the image-generating function of the FIG. **2** embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the image-generating portions of the FIGS. **1** and **2** embodiments of the invention a light source **10**, and preferably a Laser light source **10**, in combination with a lens system **11** will project a beam of light along a common optical axis of the apparatus. Following the lens system **11** along this optical axis is an electro-optic light beam deflector **13** for effecting vertical deflections of the beam in relation to the axis **12**, and an electro-optic light beam deflector **14** for effecting horizontal deflections of the beam in relation to the axis **12**. In describing the invention it should be understood, of course, the positions of deflectors **13** and **14** are interchangeable in that the deflector **14** may be between the deflector **13** and the lens **11**. Each of these deflectors includes an electrically controllable light-refractive material and will be described, for example, as containing at least first and second, **15** and **16**, prismatic elements having surfaces adjacent one another and coincident with a line **17** which intersects, diagonally, the axis **12**. On opposite surfaces of the deflectors **13** electrodes **18** and **19** are provided, and on opposite surfaces of the deflectors **14** electrodes **20** and **21** are provided. Upon the application of the influence of an electrical potential between the electrodes of the respective deflectors the index of refraction of the material is altered sufficiently to effect a change in the direction of light leaving the deflectors. Electro-optic materials useful in meeting the light-deflecting functions of the invention may be chosen from a number of different materials including barium strontium niobate, barium sodium niobate, nitrobenzene, carbon disulphide and still other materials having similar characteristics for controlling the deflection of light beams. The influence of electrical potentials will be obtained from a controllable voltage source **22** which, of course, may be that of electronic data-processing equipments, however, the description of the invention herein will exemplify the use of mechanical means for effecting the desired control functions.

In the FIG. **1** embodiment there is a light-stopping member **25** supported in the path of light from the source **10**, which is provided with a light-passing area **26**, and being in the form of a light-transparent window **27** through which the light beam may pass. This area **26** has a longitudinal dimension, which will be referred to as being oriented vertically in the ap-

paratus, and which dimension is possibly 10 to 100 times the cross-sectional dimension of the light beam upon reaching this area. To illustrate, a beam cross section **28** is shown in FIG. **4** in relation to the area **26**, and upon the application of the influence of an electrical potential across the deflector **13** the effect will be equal to that of scanning the area **26** between the lower and upper limits **30** and **31** as indicated. In doing so, light beyond the member **25** will be projected, by a lens **32** for example, toward the surface **33** of a medium **34**. Depending upon the information presentation requirements of a given application the medium **34** may be moved in the direction of the arrow **35**, for example, while in a spaced-apart position from the member **25**, or, additional light deflectors between the medium **34** and the lens **32** can be used to deflect light beyond the member **25** in relation to a fixed position medium **34**, or, the medium **34** can be positioned adjacent the member **25** and moved in relation thereto.

In the FIG. **2** embodiment the light-stopping member **40** includes a light-passing area **41** in which there is an array of light-admitting end surfaces **42** of light guides, such as optical fibers, which extend from a first surface **43** of the member **40** to a second surface **44** thereof. Emitting end surfaces of the light guides at the surface **44** may be arranged in a straight line manner as the admitting surfaces **42** are shown to be, or, arranged in a manner considered best in meeting an image presentation application requirement. For contact printing therefrom, a record medium **45** can be supported adjacent the surface **44** and moved in the direction of the arrow **46**. However, light appearing at the surface **44** may be projected onto a display medium in a manner described in connection with the FIG. **1** embodiment.

In the process of presenting images on a display medium the light-passing area, either **26** of member **25** or **41** of member **40**, is scanned from one end of its longitudinal dimension to the other. Referring to FIG. **4**, the beam **28** will be deflected so as to scan the area **26** from the one end **30** to the other end **31**. Such scanning will be accomplished at some predetermined number of scans per second, and upon the application of sawtooth waveform voltages between the electrodes **18** and **19** of the vertical deflector **13**. If, for example, a record medium **34** is made to move in the direction of the arrow **35** a series of lines may be recorded on the surface **33**, and when on and off voltages are appropriately applied between the electrodes **20** and **21** of the horizontal deflector **14** a series of light beam scanning functions can be interrupted in a manner necessary to present meaningful images on the surface **33**. A recording of the letter "E" in FIG. **3** is exemplified as being comprised of a series of lines, some continuous and some interrupted. The first four lines extend from a lower limit **50** to an upper limit **55**, but the remaining lines thereof had been subjected to a program of interruptions. After a recording of the first four lines in the E is completed the fifth line is interrupted at a point **51** by the application of a voltage to the deflectors **14**, causing the beam **28** to be deflected horizontally in the direction of the arrow **56** and beyond the limits of the area **26**. The beam will follow a light-stopping path **57** until it has reached a point **52** as indicated in FIG. **3**, whereupon the voltage will be removed from the horizontal deflectors **14**, allowing the beam **28** to return in the direction of the arrow **58** to the area **26**. A recording of the fifth line continues from the point **52** until it reaches the point **53**, whereupon the beam is deflected in the direction of the arrow **56**, to follow the path **57** until it reaches a point **54**. The beam **28** is again allowed to return in the direction of the arrow **58** to the area **26** to complete the fifth line of the E. The process of applying on and off voltages to the horizontal deflectors will continue until the formation of the E is completed.

Another recording of a letter E, utilizing the light guide member **40**, is illustrated in FIG. **6**. The same technique of interrupting a vertically scanned light beam over the surfaces **42** of a series of seven light guides in the member **40** is used, but the E of FIG. **6** is composed of fewer vertical scans of the beam between the lower and upper limits of the light-passing area **41** of the member **40**. However, the process of applying voltages to the horizontal deflector **14** will be followed as described in connection with the FIG. **1** embodiment.

FIG. **5** represents a five-by-seven array of light guides **60** in a light-stopping member **61**, having a light-admitting surface **62**, wherein the light-admitting ends of the five-by-seven array of light guides are arranged in a straight single-column line, similar to the single-column line of ends **42** appearing at the surface **43** of the member **40**. The light-admitting surface **62**, however, will contain a single-column line of 35 light-admitting ends of the five-by-seven array of light guides **60**. In doing so, a single vertical scan over a light-passing area of the surface **62** will provide a record of the letter E as shown in FIG. **6**. To illustrate further, the light-admitting ends of the guides **60** are arranged and illuminated whereby column **1** in FIG. **5** is designed to emit light from the lowermost light guide **60**, first, and then the next lowermost guide, and so on until the seven guides in the column **1** have been illuminated. Then beginning with the lowermost guide in column **2**, column of guides **60** is illuminated. In this manner the illumination of columns **3**, **4** and **5** may continue. The horizontal interruption of the single scan of the 35 light-admitting ends of the guides **60** will be effected in the same manner as the scanning of five columns of seven ends separately.

In the embodiment described in connection with FIG. **1** the object is to project spot-size beams onto the surface **33** having cross-sectional dimensions of 0.001 in., or less, for high-density recording of information, but larger spot size beams for visual displays. And the lower and upper limits **30** and **31** of the light-passing area **26** are designed to effect well-registered, and therefore straight, lines of printed matter across the surface **33**. In the embodiments utilizing the light-conducting fibers **42** or **60**, such light guides as small as 0.001 in. are intended for high-density recording of information, while in direct contact with the medium **45**. The design of a light-stopping member as described in connection with FIG. **5** lends itself to the supporting of a plurality of members **61** side by side across the width of a record media, whereby, a line of images may be recorded while the media is held stationary.

The particular embodiments of the invention illustrated and described herein is illustrative only, and the invention includes such other modifications and equivalents as may readily appear to those skilled in the arts, and within the scope of the appended claims.

I claim:

1. Light beam information presentation apparatus comprising:

a. a light source and means for deriving a beam of light therefrom having a predetermined cross-sectional dimension;

b. a light-stopping member supported in the path of said beam presenting a light-passing area having a longitudinal dimension substantially greater than said cross-sectional dimension;

c. an electro-optic light beam deflector, intermediate said stopping member and said light source, including electrically controllable light-refractive material and electrodes with means for subjecting said material to the influence of an electrical potential for effecting deflections of said beam along said longitudinal dimension and, thereby, the entry of said beam to the light-passing area along said longitudinal dimension; and

d. another electro-optic light beam deflector, intermediate said stopping member and said light source, including electrically controllable light-refractive material and electrodes with means for subjecting said material to the influence of an electrical potential for deflecting said beam in a direction substantially perpendicular to said longitudinal dimension for selectively interrupting the entry of said beam to the light-passing area during said deflections of the beam along the longitudinal dimension thereof.

2. The invention as set forth in claim **1** additionally including:

e. said light-stopping member having a thickness dimension and said light-passing area comprising a light-transparent window extending through said thickness dimension.

3. The invention as set forth in claim 1 additionally including:

e. said light-stopping member having a thickness dimension and said light-passing area including an array of individual light-conducting fibers extending through said thickness dimension.

4. Light beam information presentation apparatus comprising:

a. a light source and means for deriving a beam of light therefrom;

b. a light-responsive medium;

c. light-stopping means intermediate said source and said medium, presenting a series of light-passing areas to said beam;

d. a light beam deflection system intermediate said source and said light-stopping means including electrically controllable light-refractive material and electrodes with means for connecting the influence of an electrical potential to said electrodes;

e. means for extending the influence of a combination to electrical potentials to the electrodes of said deflection system for effecting changes in the refractive index of said material and, accordingly, deflections of said beam in a first direction for exposing, successively, said light-passing areas to said beam in combination with deflections of said beam in a second direction for effecting a series of interruptions in said exposing of the light-passing areas to said beam;

f. a plurality of fibers of light-conducting material, each having first and second end surfaces;

g. each of said light-passing areas comprising a first end surface of one of said fibers and upon an exposing of the beam thereto light will be conducted to the second end surface of said one fiber; and

h. means for exposing said medium to light being conducted to the second end surfaces of said fibers and forming information thereon corresponding to said exposing of the light-passing areas to said beam in combination with said interruptions in the exposing of the light-passing areas to said beam.

5. The invention as set forth in claim 4 additionally including:

i. said second end surfaces of the plurality of fibers supported and arranged in a series of vertically oriented arrays of light-emitting ends from which said information will be exposed to said medium.

6. Light beam information presentation apparatus comprising:

a. a light source and means for deriving a beam of light therefrom;

b. light-stopping means supported in the path of said beam presenting a light-passing area having a longitudinal dimension;

c. a light beam deflection system intermediate said source and said light-stopping means including electrically controllable light-refractive material and electrodes with means for connecting the influence of an electrical potential to said electrodes; and

d. means for extending the influence of a combination of electrical potentials to the electrodes of said deflection system for effecting changes in the refractive index of said material and, accordingly, deflections of said beam along said longitudinal dimension of the light-passing area and, thereby, the entry of said beam of light to the light-passing area along said longitudinal dimension, in combination with deflections of said beam in a direction substantially perpendicular to said longitudinal dimension for selectively interrupting the entry of said beam to the light-passing area during said deflections of the beam along the longitudinal dimension thereof.

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