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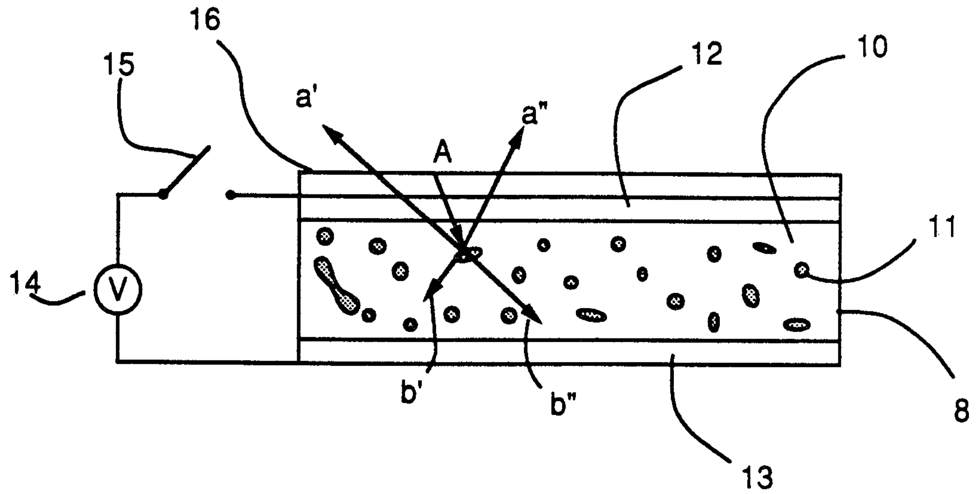

(57) Abstract

A self-lit display comprising: (a) display means having a viewing area switchable from one viewing state to another; (b) backplane reflector means positioned behind the display means; and (c) light source means which is positioned in front of the display means, is substantially coextensive with the viewing area, and directs light towards the viewing area.

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FRONT LIT LIQUID CRYSTAL DISPLAYS

Technical Field of the Invention

This invention relates to front lit liquid crystal displays.

Background of the Invention

Reflective liquid crystal displays, comprising a liquid crystal-based electrooptically active element placed in front of a reflector, are well known in the art. The electrooptically active element transitions between a first and a second optical state in response to an input such as an electrical signal. The amount of incident light which reaches the reflector depends on the optical state and accordingly so is the amount of light reflected by the reflector, thereby providing different viewing states to the observer. Reflective liquid crystal displays find many applications, one of the most popular of which is as a computer screen in portable or "laptop" computers, on account of their light weight and low power consumption.

A preferred type of liquid crystal display employs an encapsulated liquid crystal structure, in which liquid crystals are encapsulated or dispersed in a matrix (or containment medium) which can be a polymer. When a voltage corresponding to a sufficiently strong electric field is applied across the encapsulated liquid crystal material (the "field-on" condition), the alignment of the liquid crystals is re-oriented in accordance with the field, so that incident light is transmitted. Conversely, in the absence of such a voltage (the "field-off" condition) the alignment of the liquid crystals is random and/or influenced by the liquid crystal-matrix interface, so that the liquid crystal material scatters incident light. The applied voltage at which the liquid crystal material begins to change from its field-off condition to its field-on condition is called the threshold voltage.

Reflective liquid crystal displays generally do not include a light source, but instead rely on ambient lighting. Where such lighting is absent or of the wrong intensity or is incident at the wrong angle, the viewability of the display can be compromised, the viewability of such displays being notoriously sensitive to lighting conditions. It would be desirable to have a self-lit reflective display, but portability and weight considerations exclude many types of light sources. I have invented a self-lit reflective liquid crystal display which is light-weight, so that it is readily portable and usable under all types of ambient lighting conditions.

Summary of the Invention

This invention provides a self-lit display comprising: (a) display means having a viewing area switchable from one viewing state to another; (b) backplane reflector means positioned behind the display means; and (c) light source means which is positioned in front of the display means, is substantially coextensive with the viewing area, and directs light towards the viewing area. The light source means preferably is covered with an antireflective coating.

In a preferred embodiment, the display means comprises: (i) a front transparent electrode means; (ii) a rear transparent electrode means; (iii) an electro-optical display medium comprising an encapsulated liquid crystal structure, positioned between the front and rear transparent electrode means, the optical state of the encapsulated liquid crystal structure being responsive to the application of an electric field across the front and rear electrode means.

In another preferred embodiment, the display means comprises: (i) a front, transparent electrode means; (ii) a rear, reflective electrode means which also functions as the backplane reflector means; (iii) an electro-optical display medium comprising an encapsulated liquid crystal structure, positioned between the front and rear transparent electrode means, the optical state of the encapsulated liquid crystal structure being responsive to the application of an electric field across the front and rear electrode means.

Brief Description of the Drawing(s)

Fig. 1-2 illustrate the operation of a display of this invention in which the display means comprises encapsulated liquid crystal material.

Fig. 3, 3a, 4, and 4a show preferred light source means of the invention.

Fig. 5-6 show a display of the invention having additional preferred features.

Description of the Preferred Embodiments

A preferred display medium comprises an encapsulated liquid crystal structure, which is switchable between a first state in which incident light is scattered and a second state in which the amount of such scattering is reduced. Encapsulated liquid crystal structures and their preparation are disclosed in U.S. Pat. Nos. 4,435,047 (1984), 4,606,611 (1986); 4,616,903 (1986), and 4,707,080 (1987), all to Fergason; published European patent application EP 156,615 (1985), by Pearlman et al.; U.S. Pat. No. 4,671,618 (1987), to Wu et al.; U.S. Pat. Nos. 4,673,255 (1987) and 4,685,771 (1987), to West et al.; U.S. Pat. No. 4,688,900 (1987) to Doane et al.; and published European patent application EP 0,313,053 (1989), by Dainippon Ink and Chemicals; the disclosures of each which are incorporated herein by reference. In an encapsulated liquid crystal structure, discrete volumes of a liquid crystal composition are encapsulated, dispersed, embedded or otherwise contained in a containment medium or matrix. The volumes are not necessarily limited to spherical or substantially spherical ones. They may be irregularly shaped, and even interconnected. The amount of interconnection between volumes may be to an extent such that the liquid crystals appear to form a continuous phase, as described in the aforementioned EP 0,313,053. "Liquid crystal composition" denotes a composition having liquid crystalline properties, whether that composition consists of a single discrete liquid crystalline compound, a mixture of different liquid crystalline compounds, or a mixture of liquid crystalline and non-liquid crystalline compounds. Preferably, the liquid crystal composition is nematic or operationally nematic. More preferably, it also has a positive dielectric anisotropy.

Individual liquid crystal molecules typically have elongated shapes, with a tendency to align or orient themselves with their long molecular axes parallel to each other. This alignment causes a liquid crystal composition to be anisotropic, meaning that its measured physical, optical, and other properties are dependent on the direction of measurement (parallel or perpendicular to the direction of alignment). Further, the alignment direction can be influenced by an external stimulus, such as an electrical or magnetic field, causing the liquid crystal composition to exhibit a particular value of a physical characteristic in one direction when the stimulus is absent, but rapidly switching to a different value when the stimulus is applied. It is because of this anisotropy and its ready realignment that liquid crystal compositions are useful as materials for displays.

The containment medium for encapsulated liquid crystal structures is preferably a polymeric material. Suitable containment media include but are not limited to poly(vinyl alcohol) and its copolymers, gelatin, polyurethane, poly(ethylene oxide), poly(vinyl pyrrolidone), cellulosic polymers, natural gums, acrylic and methacrylic polymers and copolymers, epoxies, polyolefins, vinyl polymers, and the like. Poly(vinyl alcohol) is a preferred containment medium.

An encapsulated liquid crystal structure can be formed by deposition from an emulsion containing both the containment medium and the liquid crystal composition or by the evaporation of liquid from a solution containing both containment medium and the liquid crystal composition. It can also be formed by making an initially homogeneous mixture containing both containment medium and liquid crystal composition at an elevated temperature, then cooling to phase-separate out liquid crystal volumes contained in the containment medium. Further, it can be formed by an in-situ polymerization process, in which the containment medium is polymerized and simultaneously encapsulates a liquid crystal composition as it phase separates. The liquid crystal composition need not be entirely surrounded by the polymer, and may exist as part of a system with co-continuous phases.

Typically, an encapsulated liquid crystal structure is substantially non-transparent in the absence of a sufficient electric field (the "field-off" state) and substantially transparent in the presence of a sufficient electric field (or "field-on" state). The electric field induces a change in the alignment of the liquid crystal molecules in the liquid crystal composition, in turn causing the encapsulated liquid crystal structure to switch from a highly light-scattering (and/or absorbent) state to a highly non-scattering and substantially transparent state. Generally, it is preferred that the liquid crystal composition have a positive dielectric anisotropy and that the ordinary index of refraction of the liquid crystal composition be matched with the index of refraction of the containment medium, while the extraordinary index of refraction is substantially mismatched therewith. There is further scattering which may occur due to the different liquid crystal alignments in neighboring droplets. If this is the dominant mode of scattering, the requirement for refractive index matching may be relaxed. The physical principles by which such encapsulated liquid crystal structures operate are described in further detail in the aforementioned references, particularly the patents to Fergason. In those portions of the encapsulated liquid crystal structure to which a sufficient electric field is applied, the transition from a non-transparent state to a transparent state occurs, while adjacent areas to which no electric field has been applied remain non-transparent.

The principle of operation of a device of this invention wherein the display medium comprises encapsulated liquid crystal structure is illustrated in Figures 1 and 2 (like numerals referring to like elements). Encapsulated liquid crystal structure 8 comprises a containment medium 10 having distributed therein plural volumes of liquid crystal composition 11 and is positioned between top and bottom electrodes 12 and 13, made for example of indium tin oxide ("ITO") or a thin metal coating. A voltage source 14 is connected to electrodes 12 and 13, but with switch 15 in the open position (Figure 1), no voltage is applied across encapsulated liquid crystal material 12. A light source means 16 is positioned in front of the display's viewing area. Light ray A emitted by light source means 16 is scattered, both backward (rays a' and a") and forward (b' and b"). When switch 15 is closed (Figure 2), a voltage is applied across encapsulated liquid crystal material 8, causing molecules in liquid crystal composition 11 to align their long molecular axes with the field of the applied voltage. Owing to the match between the index of refraction of containment medium 10 and the ordinary index of refraction of liquid crystal composition 11, ray A is not scattered, but is transmitted through encapsulated liquid crystal structure 8.

The light source means should meet several requirements. It should emit or direct light emitted by it in a generally downward direction, toward the display means, and not towards the viewer. It should be substantially transparent, so that the viewer has a largely unimpeded view of the display means' viewing area. Preferably, it has a slim profile so that it is adapted for use in displays for use with compact or portable computers.

A preferred light source means comprises (i) substantially planar, transparent, light guide means having a plurality of angular facets on the face thereof away from the display means; (ii) light emitting means; and (iii) reflector means for redirecting light emitted by the light emitting means in the plane of the light guide means; the angular facets redirecting light from the light emitting means towards the display means. Such a light source means is shown in Fig. 3. Light source means 20, sometimes referred to in the art as a wedge shaped light pipe (although the wedge-shaped profile has been greatly exaggerated in the figure for clarity) comprises a light guide means 21, made for example of a transparent material such as glass or a clear synthetic resin such acrylate or polycarbonate. Light emitting means 24 (e.g., a fluorescent light) is positioned along one edge of light guide means 21. Light emitted by light emitting means 24 is redirected (if necessary — compare rays c and c') by reflecting means 25 generally along the plane of light guide means 21. The top surface of light guide means 21, the one facing the viewer and facing away from the display means, comprises a plurality of planar surfaces 22 and angular facets 23. Angular facets 23 redirect light from light emitting means 24 down towards the display means (not shown). They may do so by total internal reflection. Alternatively, they may be metallized and do so by simple reflection. The total relative areas of surfaces 22 and facets 23 is such that the former is much larger, for example 90:10 or larger (preferably 95:5 or larger), so that from the viewer's perspective light guide means appears to be a highly transparent body, with greater than 90% transparency, and the underlying viewing area of the display means is readily visible. In other words, the angular facets preferably cover less than 10% of the surface area of the light guide means. Light source means of this type are available from Display Engineering, Santa Rosa, California, under the tradename WEDGELIGHT™. Fig. 3a shows an alternative embodiment, in which the reflective means, instead of being distinct from the light emitting means, is integral therewith, in which light emitting means 24 is partially coated with a reflective material which forms reflective means 25'. (The remainder of the structure is the same as for Fig. 3 and is omitted for simplicity.)

Another preferred light source means comprises (i) electroluminescent light emitting means selectively directing light towards the display means and (ii) support means supporting the electroluminescent light emitting means. Such a light source means is shown in Fig. 4 and 4a. In Fig. 4, light source means 30 comprises series of electroluminescent stripes 31 supported by substrate 32. The construction of stripes 31 is such that light emitted by them is generally directed downward towards the display means (not shown), with little or no light being directed toward the viewer. The area of substrate 32 is much larger than the area occupied by stripes 31 (e.g., the latter being preferably less than 10%, more preferably less than 5%, of the total area), so that from the viewer's perspective light source means appears to be transparent. Fig. 4a shows a magnified cross-section of a stripe 31 (like numerals referring to like elements). Stripe 31 comprises an electroluminescent material 33 sandwiched between bottom and top electrodes 34 and 35, respectively. Top electrode 35 is opaque, blocking off any light emitted upwards by electroluminescent material 33. Bottom electrode 34 is transparent, permitting light to reach the display means.

Preferably the light source means can be switched on and off independently of the display means. This way, where the display is being used in an environment where the ambient lighting is adequate for good viewing, the light source means need not be switched on, reducing power consumption. This feature is an important consideration in battery-powered devices, to avoid draining the batteries unnecessarily.

Pleochroic dyes have been mixed with liquid crystals to form a solution therewith. The molecules of pleochroic dyes generally align with the molecules of liquid crystals, so that the application of the electric field affects not only the predominant alignment of the liquid crystals, but also of the pleochroic dye. As the extent of the absorption of incident light by the pleochroic dye depends on its orientation relative to the incident light, the application of an external stimulus to a liquid crystal-pleochroic dye combination provides an mechanism for the controlled attenuation of light by absorption. (Thus, as used herein, the term "liquid crystal composition" also means, in context, a liquid crystal composition containing pleochroic dye dissolved therein.) Pleochroic dyes may be used in encapsulated liquid crystal structures to form colored displays. A display capable of displaying colored images can be formed by depositing side by side red, blue, and green pixels made from encapsulated liquid crystal structures of the corresponding color.

A preferred LCD is of the active matrix type, in which each pixel (or picture element) is driven (switched from one visual state to another) by an active switching element such as a thin film transistor ("TFT"), varistor, diode, or MIM. The switching element helps eliminate cross-talk and maintain an initially applied voltage across the corresponding pixel, even when it is not being actively addressed, so that the pixel stays "on" while other pixels are addressed. The longer the pixels holds the initially applied voltage, the longer it can be maintained in the "on" state until it is next addressed, permitting the construction of displays having a larger number of pixels. If the matrix contains a sufficiently large number of switching elements of sufficiently small size, high resolution displays are possible. Active matrix displays are important for television, computer, and instrument screens. Active matrix displays employing liquid crystal structures are disclosed in of Becker et al., WO 91/17472 (1991) and Kamath et al., no. 07/806573, filed Dec. 12, 1991, the disclosures of which are incorporated herein by reference. To improve brightness, high aperture ratio (>75%) reflective pixel electrodes are used, together with color filters that are a compromise between highly saturated colors which yield a dark display and those that are bright but give colors which are too unsaturated.

Fig. 5 shows a display containing additional preferred features. Display 39 comprises display means 40 in turn comprising front and rear electrode means 42 and 43 sandwiching an encapsulated liquid crystal structure 44 between them. Front electrode means 42 may be made of ITO (preferably of the antireflective type). Rear electrode means 43 may also be made of ITO. Alternatively, rear electrode means 43 may be an active matrix array of individual electrode elements. A wedge-shaped light pipe 41 such a discussed hereinabove with reference to Fig. 1 is placed over display means 40 and is substantially coextensive with the latter's viewing area. To compensate for the wedge profile, a planarization layer 46 is used to protect the angular facets of light pipe 41 and to provide a smooth, even surface for the deposition of additional layers such as antireflective coating 47. Reflector means 45, positioned behind display means 40, may be of various types, depending on the angular distribution of light emitted by light pipe 41. Where the light has a narrow angular distribution then reflector means 45 is preferably a broad, low gain (diffuse) reflector. Where the light has a broad angular distribution, the reflector means 45 is preferably a narrow, high gain reflector (e.g., a mirror). Where the light has an intermediate angular distribution a gain reflector which preferentially reflects lights within a preferred range of viewing angles (typically within 35° of perpendicular) may be used. If the light distribution is greater than 20°, preferably greater than 35°, then a specular reflector such as a mirror may be used. This is a useful advantage, as mirror reflectors are easily placed within a display cell as a pixel rear electrode. Electroluminescent light sources intrinsically emit light with broad angular distribution.

Fig. 6 shows an alternative embodiment, for an active matrix color display, like numerals referring to like numerals in Fig. 5 and detailed discussion being limited to the differing elements. Positioned above the top electrode 42 is an array of color filters 47, for example in a repeating red-green-blue pattern. Instead of a single monolithic rear electrode 43, there is an array 43' of active matrix rear electrodes, positioned in a one-to-one correspondence to color filters 47. By switching a particular rear electrode 43', then a particularly colored pixel (e.g., red, blue, or green) can be switched on or off, to produce a color display effect. To maximize brightness, it is preferred to select a pixel electrode-reflector combination with as high an aperture ratio as possible, the aperture ratio being the per cent of the overall display area which is actually covered by pixel electrodes. In an alternative preferred embodiment, array 43' of rear electrodes are reflective, thereby functioning both as electrodes and as reflectors, in which instance separate reflector means 45 may be omitted.

Control of the angular distribution of light emanating from the display is important for comfortable viewing. Generally, it is desired that the light be distributed in a cone centered around 35° from vertical. The light distribution can be controlled by controlling (a) the aperture of the light emitting means (element 24 in Fig. 3), (b) the distance thereof from the reflective facets (element 23 in Fig. 3), (c) the curvature of the reflective facets (concave or convex or a combination of concave and convex curvatures), (d) the reflective distribution of the reflector, (e) the scattering characteristics of the encapsulated liquid crystal structure, or (f) combinations of the foregoing. More specifically, the light distribution becomes narrower as the distance between the reflective facets and the aperture increases. If flat facets are used, this leads to an apparent non-uniformity in the brightness of the display. This effect can be compensated for by using curved or slightly diffusing facets, both of which widen the distribution of light reflected from the facet. In particular, the facet has two radii of curvature, one in the vertical plane and one in the horizontal, both of which can be varied to achieve the best result. Another way to improve light uniformity is to use more than one light emitting means, for example to inject light from 2, 3, or 4 sides. The most uniform light source however is probably a circular light source with a stepped cone as the light guide, with the vertical radius of curvature of the facets increasing towards the center. Where the curvature of the facets is convex facing the liquid crystal element, a real image of the light emitting means is formed either above or below the display image plane. For a concave facet, a virtual image is formed above the facet plane. The choice between the two depends on the distance between facet plane and image plane, and whether the degree of collimation required is high or low.

While the foregoing preferred features have been illustrated or discussed in the context of a wedge-shaped light source means such as that of Fig. 3, those skilled in the art will understand that they are not limited to usage only in combination with such light source means, and may be combined with other light source means, mutatis mutandis.

Moiré fringe patterns may be observed if unwanted reflections interfere with the direct light path. These patterns can be minimized by (a) using antireflecting interfaces, e.g. at the liquid crystal structure-top electrode interface, (b) randomizing the a small extent the position, angle, and curvature of the reflective facets, (c) introducing a small degree of light diffusion, or (d) combinations of the foregoing. A small degree of light diffusion can be achieved by (i) interposing a diffuser between the light emitting means and the light guide material (e.g., element 21 in Fig. 3), (ii) making the light guide material slightly turbid, for example by including therein scattering particles, (iii) making the facet face diffusing, for example by roughening it, or (iv) inserting a diffusing layer between the facet plane and the image plane.

Claims

What is claimed is:

1. A self-lit display comprising (a) display means having a viewing area switchable from one viewing state to another; (b) backplane reflector means positioned behind the display means; and (c) light source means which is positioned in front of the display means, is substantially coextensive with the viewing area, and directs light towards the viewing area.

2. A display according to claim 1, wherein the light source means comprises (i) substantially planar, transparent, light guide means having a plurality of angular facets on the face thereof facing away from the display means; (ii) light emitting means; and (iii) reflector means for redirecting light emitted by the light emitting means in the plane of the light guide means; the angular facets redirecting light from the light emitting means towards the display means.

3. A display according to claim 1, wherein the light source means comprises (i) electroluminescent light emitting means selectively directing light towards the display means and (ii) support means supporting the electroluminescent light emitting means.

4. A display according to claim 1, wherein the display means comprises (i) a front transparent electrode means; (ii) a rear transparent electrode means; (iii) an electro-optical display medium comprising an encapsulated liquid crystal structure, positioned between the front and rear transparent electrode means, the optical state of the encapsulated liquid crystal structure being responsive to the application of an electric field across the front and rear electrode means.

5. A display according to claim 4, wherein the light source means comprises (i) substantially planar, transparent, light guide means having a plurality of angular facets on the face thereof facing away from the display means; (ii) light emitting means; and (iii) reflector means for redirecting light emitted by the light emitting means in

the plane of the light guide means; the angular facets redirecting light from the light emitting means towards the display means.

6. A display according to claim 4, wherein the light source means comprises (i) electroluminescent light emitting means selectively directing light towards the display means and (ii) support means supporting the electroluminescent light emitting means.

7. A display according to claim 1, wherein the display means comprises: (i) a front, transparent electrode means; (ii) a rear, reflective electrode means which also functions as the backplane reflector means; (iii) an electro-optical display medium comprising an encapsulated liquid crystal structure, positioned between the front and rear transparent electrode means, the optical state of the encapsulated liquid crystal structure being responsive to the application of an electric field across the front and rear electrode means.

8. A display according to claim 7, wherein the light source means comprises (i) substantially planar, transparent, light guide means having a plurality of angular facets on the face thereof facing away from the display means; (ii) light emitting means; and (iii) reflector means for redirecting light emitted by the light emitting means in the plane of the light guide means; the angular facets redirecting light from the light emitting means towards the display means.

9. A display according to claim 7, wherein the light source means comprises (i) electroluminescent light emitting means selectively directing light towards the display means and (ii) support means supporting the electroluminescent light emitting means.

10. A display according to claim 7, wherein the rear, reflective electrode means comprises an array of active matrix electrodes.

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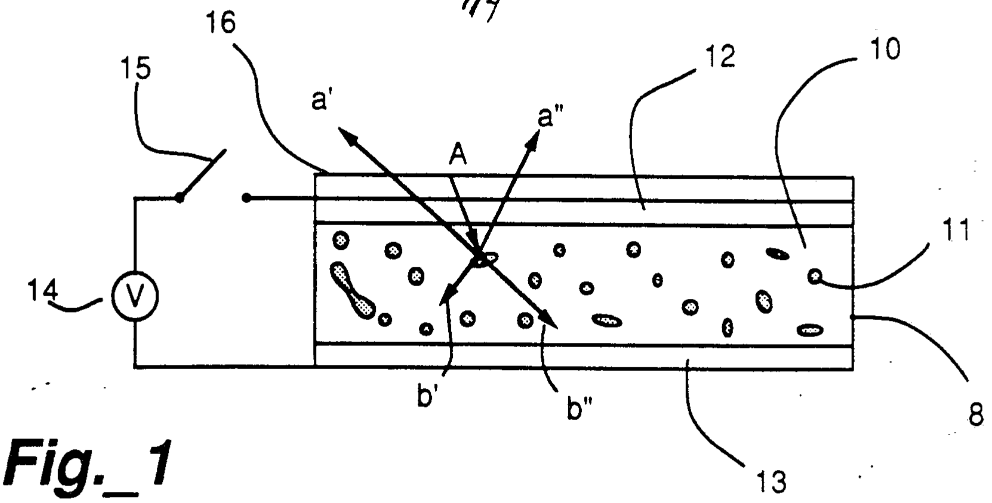

Fig._1

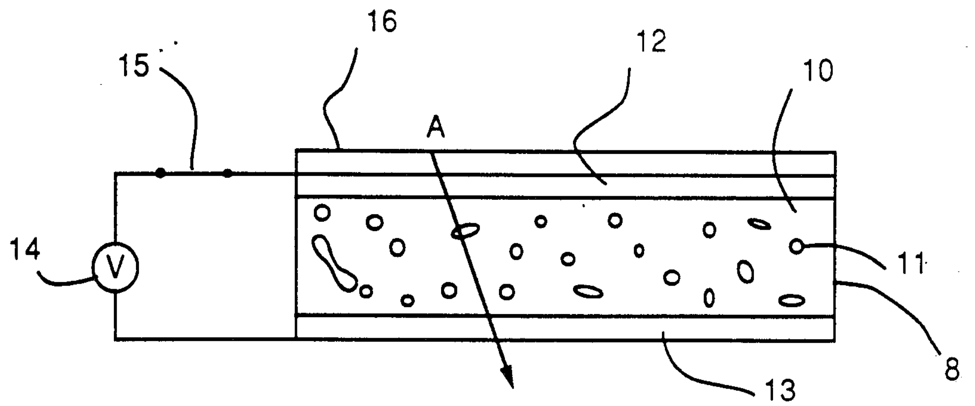

Fig._2

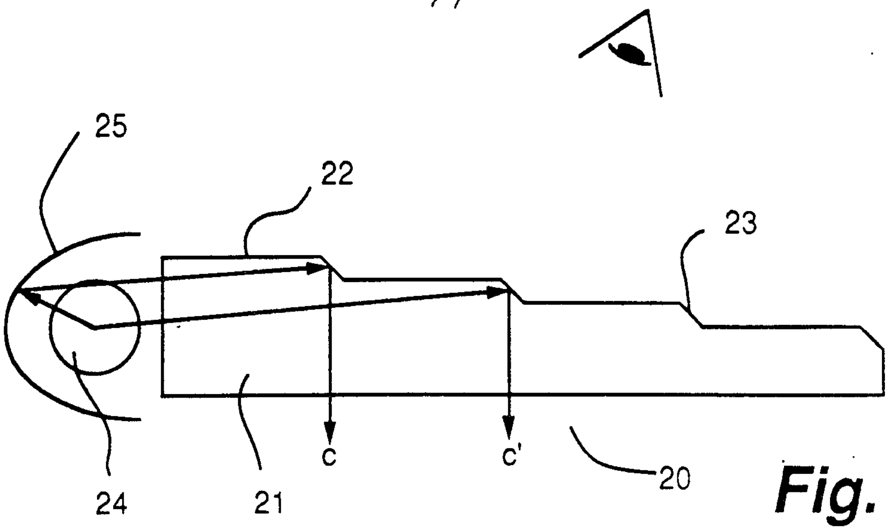

Fig._3

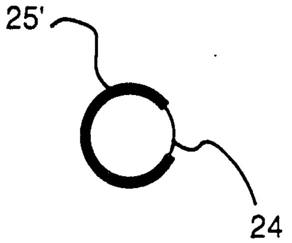

Fig._3a

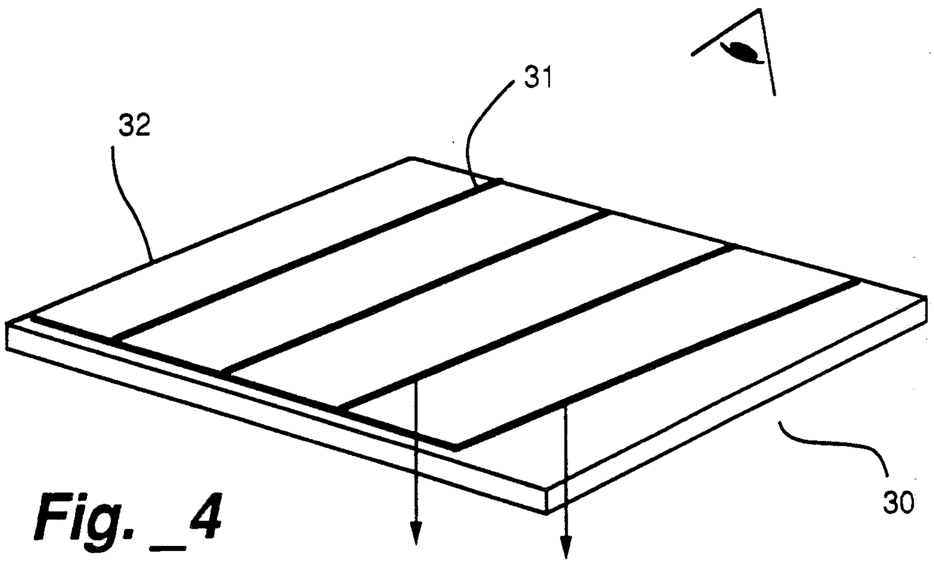

Fig._4

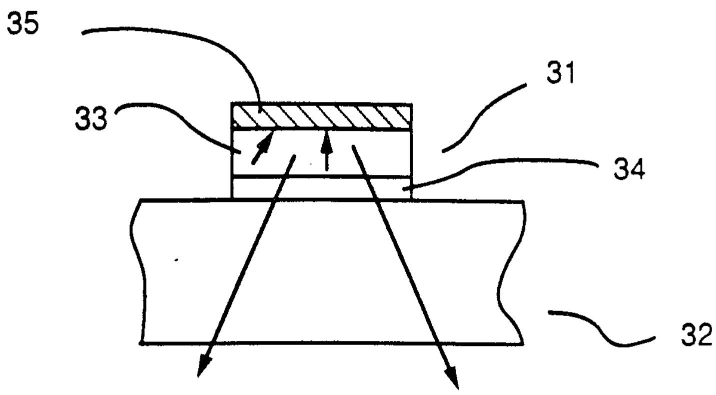

Fig._4a

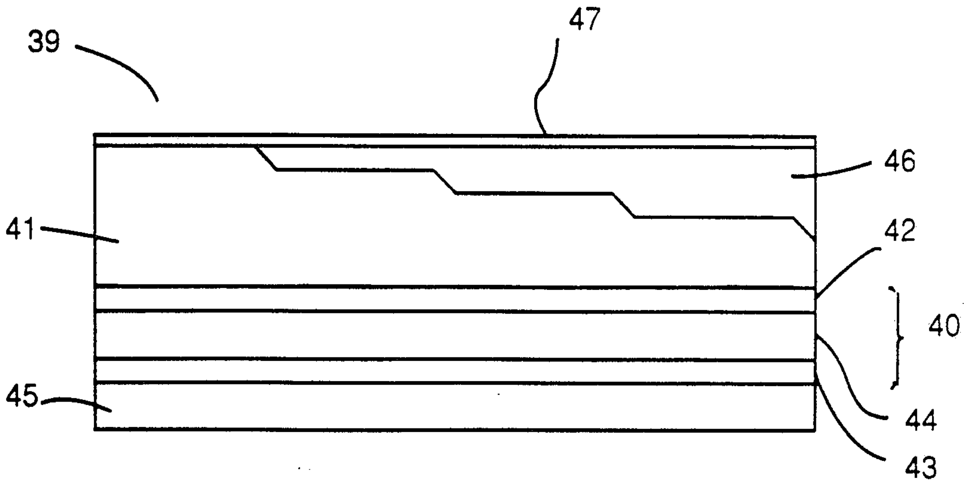

Fig._5

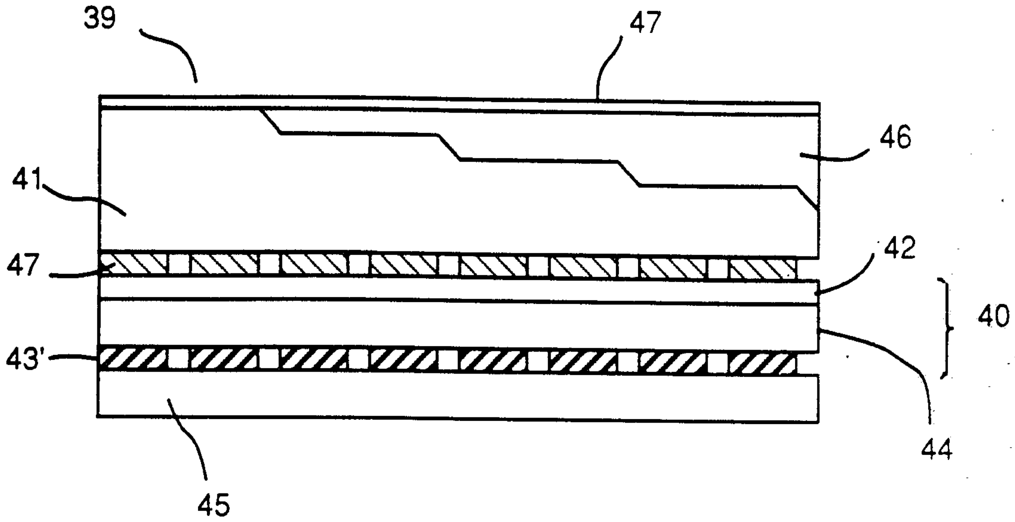

Fig._6

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 93/01190

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 G02F1/1335

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	G02F

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X	EP,A,0 056 843 (SIEMENS) 4 August 1982 see page 5, line 15 - page 6, line 27 ---	1-10
A	EP,A,0 399 506 (HUGHES AIRCRAFT) 28 November 1990 see page 3, line 36 - page 5, line 1; figures ---	1,2,4,5, 7,8
A	GB,A,2 162 300 (SHARP) 29 January 1986 see page 1, line 63 - page 3, line 22; figures 1-3 ---	1,2,5,8
A	EP,A,0 129 867 (NEC) 2 January 1985 * abstract * see page 5, line 5 - page 6, line 17; figures 1,2 -----	3,4,6,7, 9,10

° Special categories of cited documents : [10]

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IV. CERTIFICATION

1

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0056843	04-08-82	DE-A- 3102626	19-08-82
		JP-A- 57144581	07-09-82
EP-A-0399506	28-11-90	US-A- 5099343	24-03-92
		CA-A- 2016571	25-11-90
		JP-A- 3023423	31-01-91
GB-A-2162300	29-01-86	JP-C- 1662642	19-05-92
		JP-B- 3027908	17-04-91
		JP-A- 61034583	18-02-86
		DE-A,C 3526511	06-02-86
		US-A- 4914553	03-04-90
EP-A-0129867	02-01-85	JP-A- 60002980	09-01-85
		JP-A- 60002981	09-01-85

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