

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
14 November 2002 (14.11.2002)

PCT

(10) International Publication Number
WO 02/091072 A1

(51) International Patent Classification⁷: **G02F 1/1335**,
H04N 13/00, G02B 27/22

Adam, W. [US/US]; 7 Barnes Drive, Wappingers Falls,
NY 12590 (US). SWIFT, David, C. [US/US]; 3 Janet
Lane, Cortlandt Manor, NY 10566 (US).

(21) International Application Number: PCT/US02/14554

(22) International Filing Date: 7 May 2002 (07.05.2002)

(74) Agent: BRILL, Gerow, D.; Reveo, Inc., 85 Executive
Boulevard, Elmsford, NY 10523 (US).

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/289,095 7 May 2001 (07.05.2001) US

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU,
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,
CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH,
GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC,
LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW,
MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG,
SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ,
VN, YU, ZA, ZM, ZW.

(71) Applicant (*for all designated States except US*): VREX,
INC. [US/US]; 85 Executive Blvd., Elmsford, NY 10523
(US).

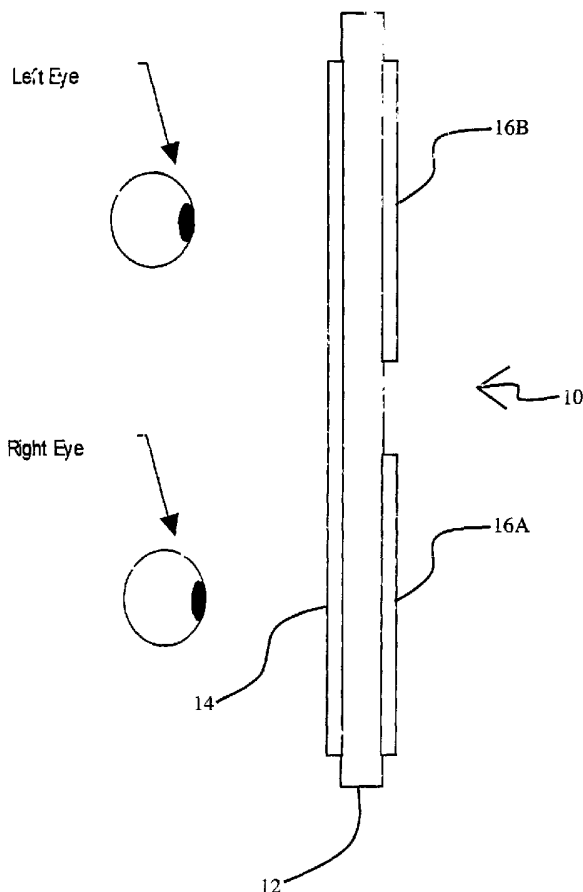
(72) Inventors; and

(84) Designated States (*regional*): ARIPO patent (GH, GM,
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),
Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),

(75) Inventors/Applicants (*for US only*): DIVELBISS,

[Continued on next page]

(54) Title: SINGLE CELL LIQUID CRYSTAL SHUTTER GLASSES



(57) Abstract: The invention is a stereoscopic shutter system having a single liquid crystal (LC) cell. The system may have flexible substrates or non-flexible substrates. The system requires only two electrical conductors to shutter both eyes. The system uses twisted nematic liquid crystal, ferro-electric liquid crystal, pi-cell technology, or other similar shuttering technologies. The system includes only one LC cell, a single large laminated linearly polarizing filter P1, and two smaller linear polarizing analyzers oriented in the P1 and P2 states. The shutters may be bent into a one-dimensional curved shape about the vertical or horizontal axis.



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European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— *with international search report*

SINGLE CELL LIQUID CRYSTAL SHUTTER GLASSES

BACKGROUND OF THE INVENTION

This invention relates to the field of stereoscopic viewing and in particular to the use of single cell liquid crystal shutter glasses.

Typical Liquid Crystal (LC) shutter glasses are composed of two separate liquid crystal shutters that open and closed in an alternating pattern that is synchronized to the command of an image display system. Further, current systems use LC cells that are constructed from glass substrates that are non-flexible and limit the range of designs achievable for the glasses. The present invention offers a new approach to the construction of LC shutter glasses by using a single flexible LC cell as the active element. The advantages of the present invention over prior art include a simpler drive scheme requiring only two wires, lower cost due to a single larger LC cell, a flexible substrate allowing simple curvature of the shutter for a broader range of design, and lighter weight due to the elimination of the glass substrates. Previous patents and applications by, Faris, Lazzaro, Divelbiss, Swift, Guralnick, Lipton, and Tettington have fixed field of view LC filters. The time-multiplexed technique for viewing electronic stereoscopic images is now a standard viewing modality for computer graphics and video. During the past decade, electro-stereoscopic displays have become a well-established means for viewing images.

All of these systems use liquid crystal ("LC") shuttering eyewear for viewing stereoscopic images are described in the following patents and patent applications: U.S. Patent No. 4,884,876 entitled "Achromatic Liquid Crystal Shutter For Stereoscopic And Other Applications;" U.S. Patent No. 4,967,268 entitled "Liquid Crystal Shutter System For Stereoscopic And Other Applications;" U.S. Patent No. 5,117,302 entitled "High Dynamic Range Electro-Optical Shutter For Stereoscopic And Other Applications;" U.S. Patent No. 5,181,133 entitled "Drive Method For Twisted Nematic Liquid Crystal Shutters For Stereoscopic And Other Applications;" U.S. Patent No. 5,463,428 entitled "Wireless Active Eyewear For Stereoscopic Applications;" ; High Dynamic Range Electro-optical Shutter For Stereoscopic And Other Applications; U.S. Patent No. 5,572,250 entitled "Universal Electronic Stereoscopic Display and WO 98/54614 entitled "Electrostereoscopic Eyewear." Additional patents describing LC shutter glasses include: U.S. Patent 5,821,989 entitled "Stereoscopic 3-D View System and Glasses Having Electro-optical

Shutters Controlled By Control Signals produced by Using Horizontal Pulse Detection Within the Vertical Synchronization Pulse Period of Computer Generated Video Signals”; U. S. Patent 6,295,065 entitled Method and Apparatus To Alternate Stereoscopic Images In a Video Display Device”; U.S. Patent 6,088,052 entitled “3D Stereoscopic Video Display System”; US patent 6,278,501 entitled Three Dimensional Liquid Shutter Glasses”; US Patent 6,359,664 entitled Electro-optical Display System For Visually Displaying Polarized Spatially Multiplexed Images of 3-D Objects for Use In Stereoscopically Viewing The Same With High Quality and High Resolution; and WO 01/25836 entitled 3D Shutter Glass and Line Blanker System. All of the above patents and patent applications are hereby incorporated by reference.

LC shuttering eyewear for the mass consumer market must be manufactured at the lowest possible cost of goods in order to compete in what is essentially a commodity marketplace. Therefore, there is a need for a shutter glass system that has lower cost, simplicity of design and a flexible substrate that allows for broader range of glasses designs.

SUMMARY OF THE INVENTION

The invention is a stereoscopic shutter system having a single liquid crystal (LC) cell. The system may have flexible substrates or non-flexible substrates. The system requires only two electrical conductors to shutter both eyes. The system uses twisted nematic liquid crystal, ferro-electric liquid crystal, pi-cell technology, or other similar shuttering technologies. The system includes only one LC cell, a single large laminated linearly polarizing filter P1, and two smaller linear polarizing analyzers oriented in the P1 and P2 states. The shutters may be bent into a one-dimensional curved shape about the vertical or horizontal axis.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a top view of a single cell LC stereoscopic shutter system;
Figure 2 illustrates a single cell LC shutter operational diagram for a cell in its OFF state;
Figure 3 illustrates a single cell LC shutter operational diagram for a cell in the ON state;
Figure 4 illustrates a typical shutter response for a twisted nematic liquid crystal based system; and
Figure 5 illustrates a typical optical shutter response for a ferro-electric liquid crystal based system.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 illustrates a top view of the compound liquid crystal shutter assembly 10. The LC cell itself may be constructed from any of the various methods known to the art including twisted nematic, Ferro-electric, and pi-cell, etc.. The LC cell is constructed using a flexible substrate 12 to allow bending of the cell in one dimension. One side of the shutter assembly 10 is laminated with a linear polarizing film 14 designated P1. The other side is laminated with two separate linearly polarizing films that correspond to each eye 16A and 16 B. One film 16 A is oriented such that its polarization axis is parallel to P1. The other film 16 B is oriented such that its polarization axis is perpendicular to P1 and known as P2. The order of the elements relative to the viewer's eyes is not critical.

Figure 2 illustrates an operational diagram of the compound LC shutter system 20 in which the LC cell 24 is in the off state. This is the case when no electric field is applied to the LC cell 24. In this case, light entering from the left passes through the P1 linear polarizing film 22. Linearly polarized light with a polarization angle of 45 degrees then passes through the LC cell 24 in the off state. Since the cell is OFF, the polarization angle of the light is rotated by 90 degrees to +45 degrees as shown by diagrams 26L and 26R. Next light that enters the P1 analyzer (output polarizing film) 28R is blocked since the polarization angle of the light is now perpendicular to the P1 state. Contrariwise, light entering the P2 analyzer 28L passes through since the polarization angle of the light is parallel to the P2 state. Note: We will refer the optical components associated with the left eye as the left element and the optical components associated with the right eye as the right element.

Figure 3 shows an operational diagram of the compound LC shutter 20 in which the cell itself is in the ON state. This is the case in which an electric field is applied to the LC cell. In this case, light entering from the left passes through the P1 linear polarizing film 22. Linearly polarized light with a polarization angle of -45 degrees then passes through the LC cell 24 in the off state. Since the cell is ON the polarization angle of the light is not rotated and remains in the P1 state. Next light that enters the P1 analyzer 28R (output polarizing film) is passed since the polarization angle of the light is parallel to the P1 state. Contrariwise, light entering the P2 28L analyzer is blocked since the polarization angle of the light is perpendicular to the P2 state.

Figures 2 and 3 illustrate one configuration of the system where the P2 filter is associated with the viewer's right eye. The system can also be setup so that the P2 filter is associated with the viewer's left eye.

Most LC shutter glass systems require separate control lines for each eye path since each eye path has a separate switching element. The present invention only requires the switching of a single LC cell. Therefore a simplified control system is utilized and that requires only a single pair of wires from the control system (not shown). The switching is controlled by electronics of the display system and is well known in the art. Several such systems are described in the disclosures discussed above.

One of the benefits of a single cell using a single drive system is that the user can easily determine if the glasses are not enabled because one of the elements will be dark (either the left element or the right element). In dual cell systems, when no power is applied, both cells are typically clear which can be easily confused with the active shuttering mode that also looks mostly clear.

It is also possible to achieve a mostly clear state for both elements (useful for viewing non 3D stereoscopic data) by shuttering the LC cell at a high frequency so that no flicker is perceived.

Figure 4 shows a typical optical response plot for the present invention implemented with a flexible twisted nematic LC cell. Figure 4a illustrates the exciting voltage to the shutter mechanism. In this case, the cell is OFF with the left eye observes light and the cell is ON when the right eye observes light. The OFF to ON transition shown in Figures 4b and 4c illustrates the slow response typical for TN cells.

Figure 5 shows a typical optical response plot for the present invention implemented with a flexible Ferro-electric LC cell. Figure 5a again illustrates the switching voltage. In this case, the cell is OFF with the left eye observes light and the cell is ON when the right eye observes light. The plot illustrates in Figures 5b and 5c show the typically faster response and more symmetric transitions of the Ferro-electric LC cell.

The present invention has been described with reference to the above illustrative embodiments. It is understood, however, modifications to the illustrative embodiments will readily occur to persons with ordinary skill in the art. All of such modifications and variations are deemed to be within the scope and spirit of present invention as defined by the accompanying claims.

Claims

1. A stereoscopic shutter system comprising:
 - only one LC cell;
 - a first single laminated linearly polarizing filter P1; and
 - an additional pair of linear polarizing filters oriented in the P1 and P2 states.
2. The system of claim 1 wherein
 - a first portion of said pair having its polarization axis parallel to P1 and located in line with a user's first eye;
 - a second portion of said pair having its polarization axis perpendicular to P1 (P2) and located in with a user's second eye.
3. The system of claim 1 further comprising:
 - means for controlling an Off and On state of said LC cell.
4. The system of Claim 3 wherein only two conductors are required to shutter both eyes.
5. The system of Claim 1 wherein said LC cell comprises one or more flexible substrates.
6. The system of Claim 1 in which said LC cell comprises one or more non-flexible substrates.
7. The system of Claim 1 wherein said LC cell comprises twisted nematic liquid crystal.
8. The system of Claim 1 wherein said LC cell comprises ferro-electric liquid crystal.
9. The system of Claim 1 wherein said LC cell comprises pi-cell technology.
10. The system of Claim 2 wherein said shutter is bent into a one-dimensional curved shape about the vertical or horizontal axis.
11. The system of any of claims 1-10 wherein if said system is not enabled one of the elements will be dark
12. The system of any of claims 1-10 wherein it is possible to achieve a mostly clear state for both elements by shuttering said LC cell at a high frequency so that no flicker is perceived.

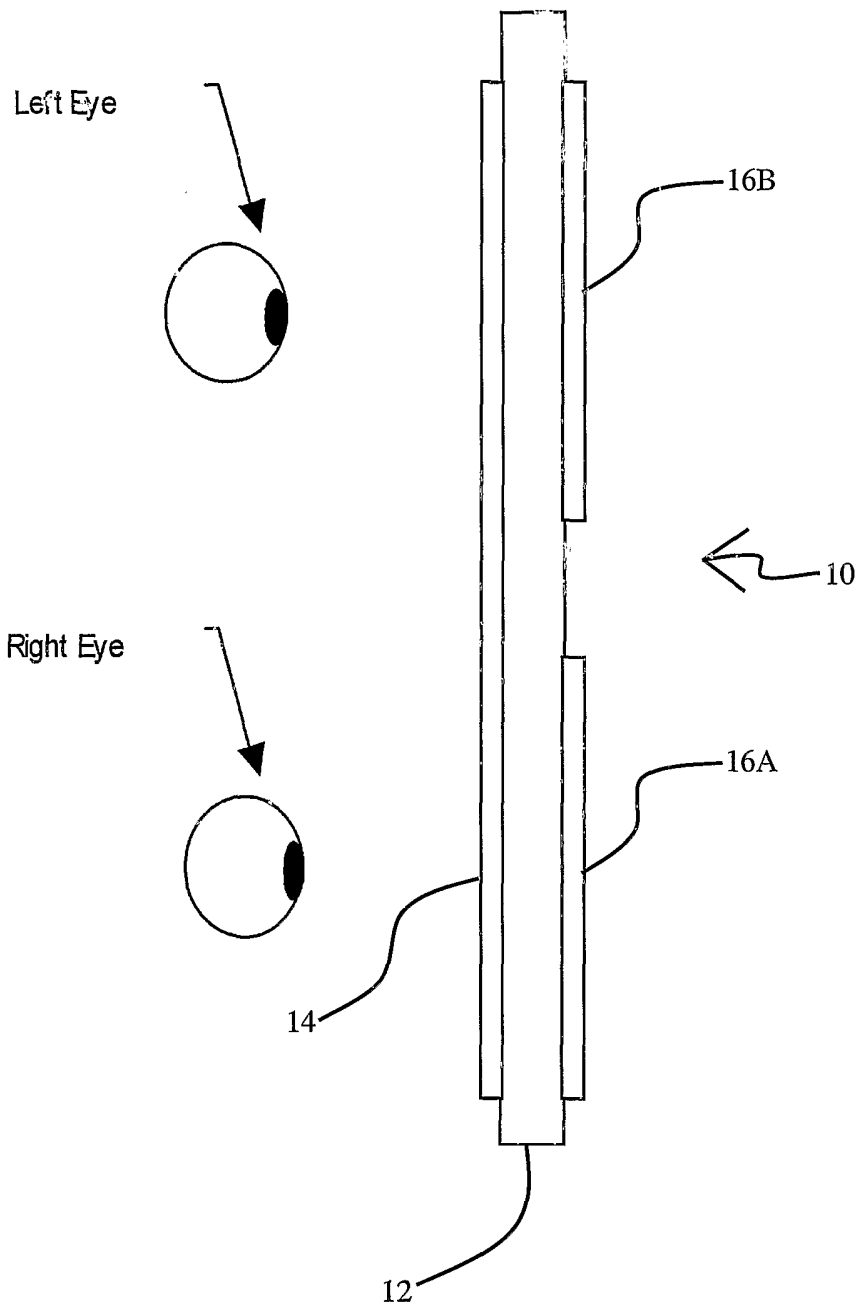
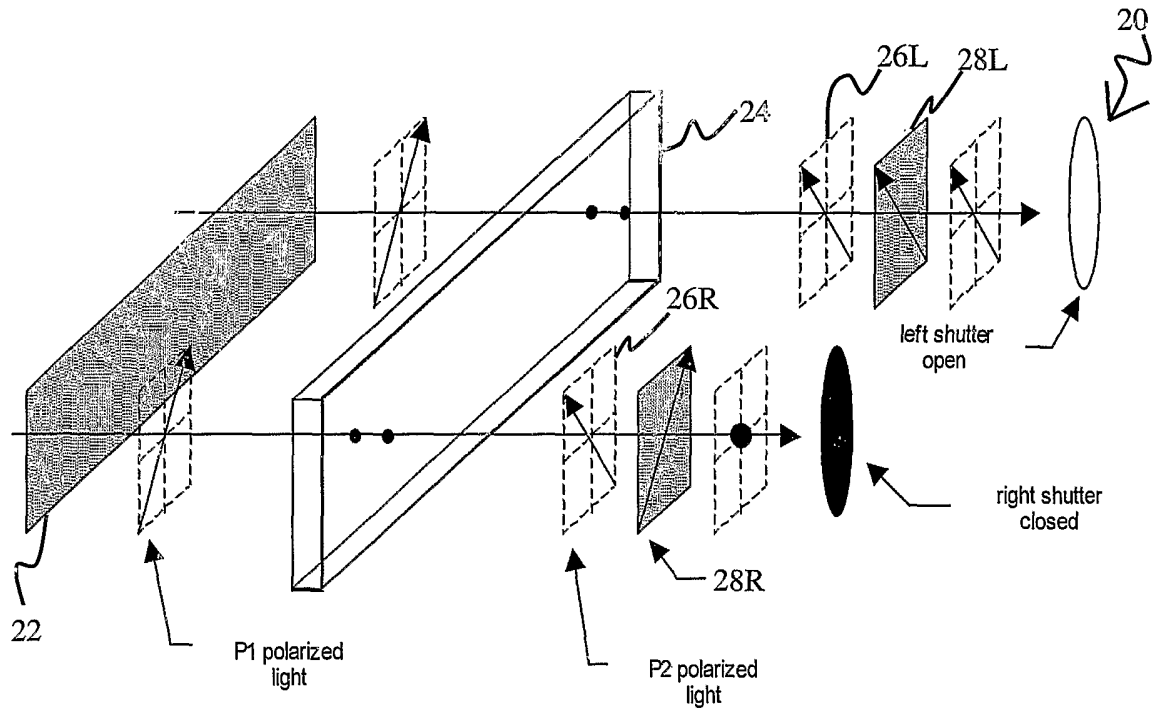
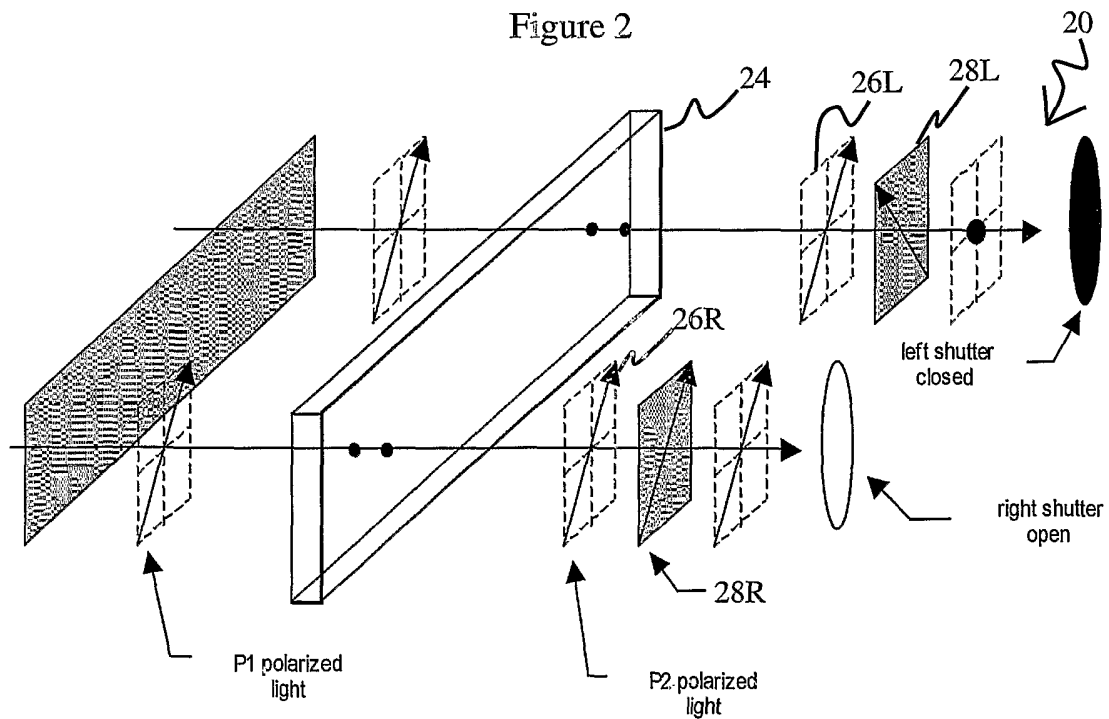


Figure 1



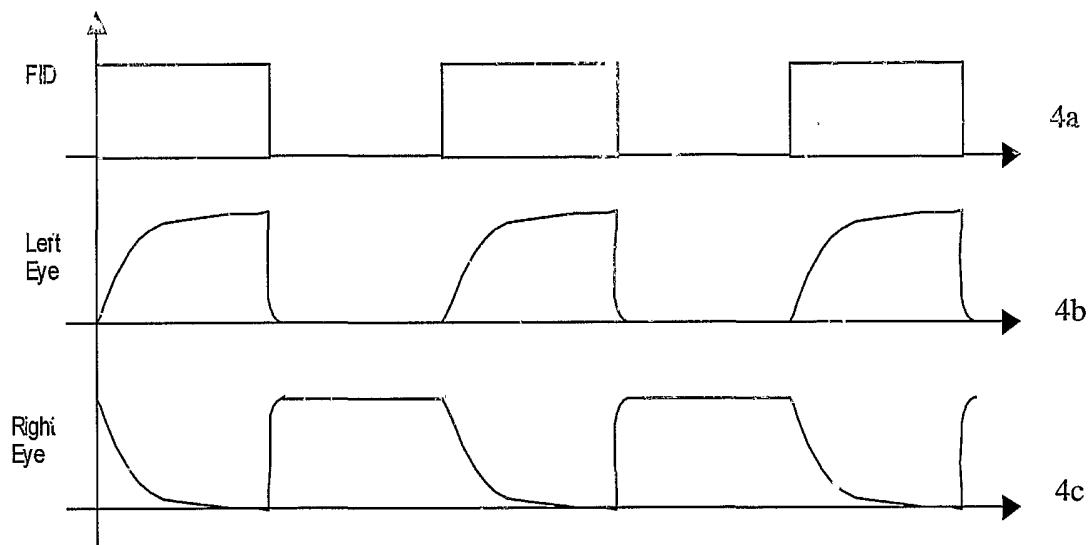
OFF State

Figure 2



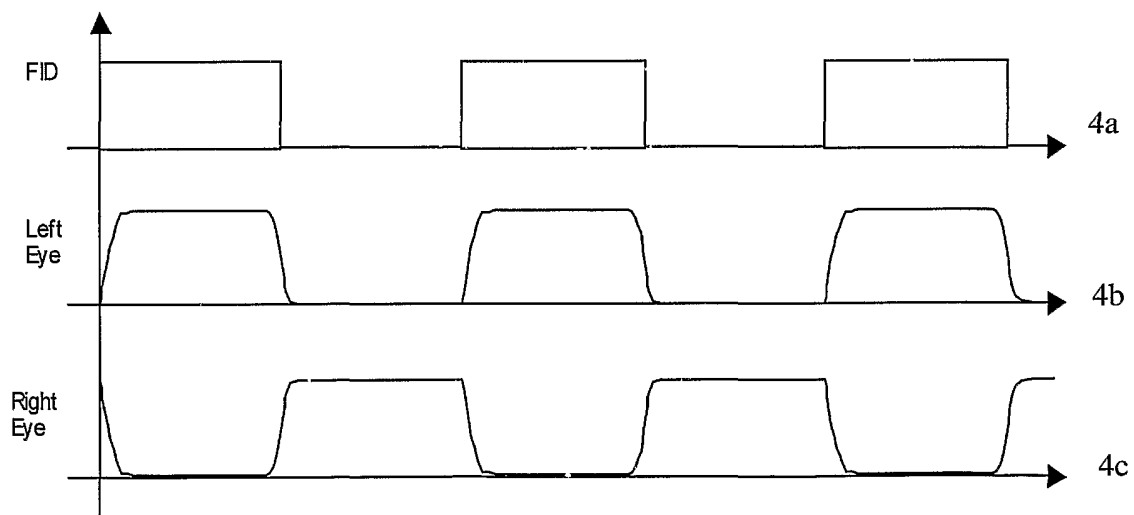
ON State

Figure 3



Twisted Nematic Liquid

Figure 4



Twisted Nematic Liquid

Figure 5

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 02/14554

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 G02F1/1335 H04N13/00 G02B27/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04N G02F G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 13, 5 February 2001 (2001-02-05) & JP 2000 284224 A (IDEMITSU KOSAN CO LTD), 13 October 2000 (2000-10-13)	1-4, 7-9
Y	abstract; figure 7	5, 6, 10
Y	EP 0 892 563 A (IDEMITSU KOSAN CO) 20 January 1999 (1999-01-20) page 9, line 42 - line 44	5, 6, 10

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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Date of the actual completion of the international search

13 August 2002

Date of mailing of the international search report

21/08/2002

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
 Fax: (+31-70) 340-3016

Authorized officer

De Paepe, W

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 02/14554

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2000284224 A	13-10-2000	NONE	
EP 0892563 A	20-01-1999	JP 11038361 A	12-02-1999
		JP 11234704 A	27-08-1999
		CA 2241583 A1	18-01-1999
		EP 0892563 A2	20-01-1999
		US 6252624 B1	26-06-2001