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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
14 November 2013 (14.11.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/169206 A1

(51) International Patent Classification:
G03B 21/62 (2006.01) *G02F 1/15* (2006.01)
G02F 1/133 (2006.01)

(21) International Application Number:
PCT/SG2013/000152

(22) International Filing Date:
18 April 2013 (18.04.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
201203376-7 8 May 2012 (08.05.2012) SG

(71) Applicant: **PLAYWARE STUDIOS ASIA PTE LTD.** [SG/SG]; 167 Jalan Bukit Merah, #02-13 Connection One, Singapore 150167 (SG).

(72) Inventor: **JAIN, Siddharth**; Block 7 Elias Green, #02-02, Singapore 519962 (IN).

(74) Agent: **AMICA LAW LLC**; 30 Raffles Place, #18-03/04 Chevron House, Singapore 048622 (SG).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: PROJECTION SCREEN

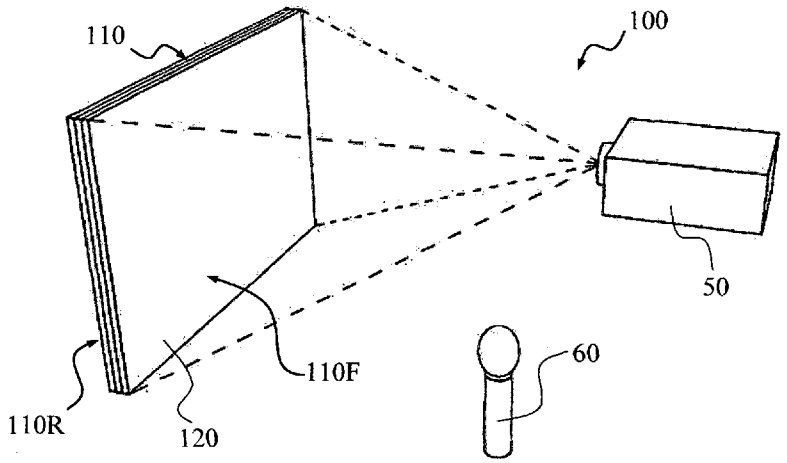

FIG. 3

(57) Abstract: A projection screen includes a first display layer at a front side for displaying an image projected thereon and a base layer and a privacy layer attached to the first display layer at a rear side. A first electrical field is coupled to the first display layer to vary an opacity level of the first display layer between a first state at which lights from the rear side are allowed to pass through the display layer to the front side, and a second state at which lights from the rear side are blocked from passing through the display layer to the front side. The privacy layer is to reflect more lights back to the rear side than the light passing through from the front side, hence to prevent the projected contents from being viewed from the rear side.

WO 2013/169206 A1

PROJECTION SCREEN

TECHNICAL FIELD

The present invention relates to a projection screen and in particular, to a projection screen for displaying visual contents to viewers at the same side of a projector.

DESCRIPTION OF THE RELATED ART

Currently there are two main types of projection screen that can display a projected surface image and/or visual contents, which are classified into front and rear projection screens.

In a front projection screen as shown in Fig. 1, the viewer 10 is on the same side of the screen 12 as the projector 14. This system of projection has several limitations. The projection screen is usually opaque to allow maximum light to be reflected off it and back to the viewer. In addition, this opacity also prevents other light sources 16 behind the screen from diluting the visibility of the projected image. When no projection is being cast on the screen, the viewer cannot see what is behind the screen without physically moving it, e.g. by rolling, collapsing, or folding the screen.

In a rear projection screen as shown in Fig. 2, the viewer 10 is on the opposite side of the screen 12 in relation to the projector 14. This kind of projection system also has several limitations. The projection screen is usually clear or translucent or made of a light diffusing surface. This creates one of the following experiences: firstly, the viewer can see the image projected if the screen is of the clear type but the image is diluted when there is a strong light source on either side of the screen. While no image is being projected, the viewer can see through the screen to the other side. Secondly, the viewer can see the image in most lighting conditions but is not able to see though the screen with any clarity if the screen is of the translucent type. Thirdly, the viewer can see the image projected on the screen from either side of the screen in most lighting conditions on either side but cannot see through the screen.

If there is a need to have the viewer and the projector on the same side of the screen, both the above-mentioned commonly and currently used types of projection screens will suffer from one or more of the following limitations:

- The surface will not allow the viewer to see clearly across the screen.
- The screen will not be able to display clear visible images in situations where there are strong light sources at either side of the screen.
- The screen will display a brighter image on the side opposite to the projector and the viewer, rather than displaying the image towards the viewer.
- The projected image will be visible on the opposite side of the screen.

Accordingly a new projection screen is desirable to overcome the above limitations.

SUMMARY OF THE INVENTION

A system and a method for creating a screen such that can alternate between an opaque projection surface, a partially transparent projection surface and a transparent glass meant to be installed in places where the projector and the intended viewer are on one side of the screen and the opposite side has a bright light source, e.g. sunlight etc.

Embodiments of the invention relate to a method and apparatus for creating a screen such that it can alternate between an opaque projection surface, a partially transparent projection surface for displaying visual contents projected thereon, and a transparent glass to allow viewers to see through the screen. A projection screen according to embodiments of the present invention can display an image which is front projected (projector and viewer are on the same side) even if there is a strong light source behind the screen. The projected image in both the opaque and the partially transparent modes are only visible from the projector's side of the screen. The projected image (in both the opaque and the partially transparent modes) is visible regardless of the lighting conditions on the non-viewer side of the screen.

According to one embodiment of the present invention, a projection screen has a front side facing a projector and an viewer, and a rear side opposite to the front site. The projection screen includes a display layer, a base layer and a privacy layer integrated together. The display layer is disposed at the front side of the screen, facing the viewer, for displaying visual contents projected from a projector. The base layer and the privacy layer are attached to the display layer at the rear side of the projection screen. An electrical field is coupled to the display layer to vary an opacity level of the display layer between a first state at which lights from the rear side are allowed to pass through the display layer to the front side, and a second state at which lights from the rear side are blocked from passing through the display layer to the front side. The privacy layer is to reflect more lights back to the rear side than the light passing through from the front side, hence to prevent the projected contents from being viewed from the rear side.

The privacy layer maybe sandwiched between the base layer and the display layer. Alternatively, the base layer maybe sandwiched between the privacy layer and the display layer.

Other aspects and advantages of the present invention will become apparent from the following detailed description, illustrating by way of example the inventive concept of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the present invention will be described in detail with reference to the accompanying drawings, in which:

Fig. 1 shows one type of conventional projection screen.

Fig. 2 shows another type of conventional projection screen.

Fig. 3 is a perspective view of a front-projection system using a projection screen according to one embodiment of the present invention.

Figs. 4A and 4B are schematic cross sectional views of a projection screen used in a system of Fig. 3 according to alternative embodiments of the present invention..

Figs. 5A, 5B and 5C are schematic cross sectional views of private layers of the projection screen of Fig. 3 according to alternative embodiments of the present invention.

Fig. 6 is a schematic view of a projection screen according to another embodiment of the present invention.

Fig. 7 is a perspective view of the projection screen of Fig. 6 when used in a projection system.

Fig. 8 is a schematic cross sectional view of a projection screen according to a further embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

As shown in Fig. 3, according to one embodiment, a projection screen 110 is used in a projection system 100 for displaying visual contents provided by projector 50 to viewer 60 at the same side of projection screen 110. Projection screen 110 has a front side 110F facing projector 50 and viewer 60, and a rear side 110R opposite to front side 110F. In one embodiment as shown in conjunction with Fig. 4A, projection screen 110A includes a display layer 120 positioned at front side 110F, and a privacy layer 130 and a base layer 140 disposed at rear side 110R. Display layer 120, privacy layer 130 and base layer 140 may be glued together using adhesives e.g. a UV (ultraviolet)-clear glue. Other forms for fastening of the layers to each other such as by the use of a vice or nuts and bolts can also be used to achieve the desired stacking effect. In the embodiment shown in Fig. 4A, privacy layer 130 is sandwiched between display layer 120 and base layer 140. In a projection screen 110B according to an alternative embodiment as show in Fig. 4B, base layer 140 is sandwiched between display layer 120 and privacy layer 130, i.e. an inner surface of privacy layer 130 is attached to base layer 120.

In either embodiment shown in Fig. 4A or Fig. 4B, base layer 140 maybe made of clear tempered glass, acrylic, polycarbonate or any other solid material that allows 90% or greater visibility through it and provides strength and rigidity necessary to support the rest layers of the projection screen.

Privacy layer 130 maybe of a film or glass or acrylic that allows one way vision, e.g. to reflect more lights back to the rear side than lights passing through from the front side, hence to prevent the projected contents from being viewed from the rear side. One way vision glass can be obtained by installing a high reflective window film. As shown with further details in Figs. 5A, 5B and 5C, reflective window tint is generally made from two transparent polyester sheets 132, 134, which has been through a process that deposits a partial transmission-partial reflection layer 133 of very small particles of metal, usually, aluminum, silver or bronze. This creates a very thin metalized layer in between the polyester sheets 132 and 134, as shown in Fig. 5A. Additionally, a clear adhesive and thin polyester backing liner 131 may be attached to polyester sheet 132 for necessary

support, as shown in Fig. 5B. Further. a scratch-resistant coating 135 may be formed on the other polyester sheet 134, i.e. at an external surface of privacy layer 130, as shown in Fig. 5C.

When this reflective window film is attached to base layer 140, it creates a one way mirror under the correct conditions, which allows lights from the rear side to pass through towards the front side, but to prevent visual contents from being viewed from the rear side. One form of the reflective window film is a reflective silver window film, the darkest usually referred to as “silver 20”. This silver film gives a silver mirrored appearance. Other colors can be combined such as grey, gold and bronze. For the purposes of embodiments of the present invention, the reflectiveness of privacy layer 130 may be between 30-70%. Additionally, privacy layer 130 may provide up to 99% reduction of UV light transmission.

Referring back to Figs. 4A and 4B, display layer 120 maybe made of polymer-dispersed liquid crystals (PDLC) layer. A PDLC layer includes liquid crystal droplets that are dispersed in a solid polymer matrix. The resulting material is a sort of "Swiss cheese" polymer structure, with liquid crystal droplets filling in the holes. These tiny droplets (in a size of about a few microns across for practical applications) are responsible for the unique behavior of the display layer 120. By changing the orientation of the liquid crystal molecules with an electric field 150 coupled to display layer 120, it is possible to vary the intensity of transmitted light passing through display layer 120. Electrical field 150 can therefore vary an opacity level of the display layer 120 between a first state, i.e. a charged state at which, lights from the rear side 110R are allowed to pass through the display layer 120 to the front side 110F, and a second state, i.e. a dormant state at which, lights from the rear side 110R are blocked from passing through the display layer to the front side 110F. Aside from using PDLC, similar effect can also be achieved by using suspended particle display (SPD) or Liquid crystal display (LCD) glass or films.

In a typical application, a thin PDLC film (about 25 microns thick) is deposited between clear plastic substrates. The plastic substrates are coated with a very thin layer of a conducting material known as indium tin oxide (ITO).

In the charged state, display layer 120 allows light to pass for clear visibility through the projection screen 110. In the dormant state, the particles disperse and diffuse the light, creating a surface with more than 90% opacity suitable for displaying visual contents from a projector.

According to another embodiment, as show in Figs. 6 and 7, a projection screen 210 includes a display layer, a privacy layer 230 and a base layer 240 structured in a manner similar to that illustrated in the previous embodiments. The difference lies in a situation where the display layer includes a plurality of segmented cells, e.g. 220A, 220B, 220C and 220D. Each cell is coupled to an independently controllable electrical field 250A, 250B, 250C and 250D, respectively. Cells 220A, 220B, 220C and 220D form into a grid such that the opacity of each cell in the grid can be controlled independently from each other.

Shown in Fig. 7 is an application example of projection screen 210 used in a projection system 200 having individual projectors 50A, 50B, 50C and 50D. Each projector maybe configured to provide its own visual signals to a corresponding cell 220A, 220B, 220C and 220D. In a situation where the region at one or more cells (e.g. cell 220A as shown in Fig. 7) is desired not to display the projected contents, but to allow viewers to see through the projection screen, projector 50A is switched off. In the meantime, the electrical field 250A coupled to cell 220A will be set to the charged state, to control and switch cell 220A to a transparent mode. The rest of cells, e.g. cell 220B, 220C and 220B may be at the dormant state, i.e. at opacity state to display visual contents from projectors 50B, 50C and 50D. As such, lights from external area i.e. the rear side of the projection screen, is blocked such that visual contents can be displayed in a clear manner on cells 220B, 220C and 220D.

According to a further embodiment, as shown in Fig. 8, a projection screen 310 includes a base layer 340, a privacy layer 330 attached to base layer 340, and first and second display layers 320A, 320B attached to privacy layer 330. Each of the display layers 320A, 320B is coupled to an electrical field 350A, 350B which are independently

controllable. The opacity level of each display layer 320A and 320B can therefore be controlled individually, hence varies levels of opacity of the projection screen 310 can be obtained by a combination of display layers 320A and 320B, e.g. at a full opacity state, a partial opacity state (translucent), or a transparent state.

As illustrated above, embodiments of the invention is suitable for use in a front-projection system to provide desired display effects. A projection screen displays visual contents which is front-projected even if there is a strong light source behind the screen. This feature enables an application of the present invention to form a projection screen on a window, i.e. in a meeting room, and provides viewers with the experience of viewing both the projected contents and the scenes outside the window under a controllable manner. The projected image in both the opaque and the partially transparent modes are only visible from the projector's side of the screen, hence privacy concern is addressed. Additionally, the projected image (in both the opaque and the partially transparent modes) is not visible regardless of the lighting conditions on the non-viewer side of the screen

Although embodiments of the present invention have been illustrated in conjunction with the accompanying drawings and described in the foregoing detailed description, it should be appreciated that the present invention is not limited to the embodiments disclosed. Therefore, the present invention should be understood to be capable of numerous rearrangements, modifications, alternatives and substitutions without departing from the spirit of the invention as set forth and recited by the following claims.

CLAIMS

1. A projection screen having a front side and a rear side, the projection screen comprising:

a first display layer at the front side for displaying an image projected thereon;

a base layer and a privacy layer attached to the first display layer at the rear side;

a first electrical field coupled to the first display layer to vary an opacity level of the first display layer between a first state at which lights from the rear side are allowed to pass through the display layer to the front side, and a second state at which lights from the rear side are blocked from passing through the display layer to the front side;

wherein the privacy layer is to reflect more lights back to the rear side than lights passing through from the front side, hence to prevent the projected contents from being viewed from the rear side.

2. The projection screen of claim 1, wherein the privacy layer is sandwiched between the base layer and the first display layer.

3. The projection screen of claim 2, wherein the privacy layer further comprises a pair of transparent sheets and a metal film sandwiched therebetween.

4. The projection screen of claim 3, wherein the privacy layer further comprises a transparent backing liner attached to one of the transparent sheets.

5. The projection screen of claim 1, wherein the base layer is sandwiched between the privacy layer and the first display layer.

6. The projection screen of claim 5, wherein the privacy layer has an inner surface attached to the base layer and an external surface coated with a scratch-resistant layer.

7. The projection screen of claim 6, wherein the privacy layer further comprises a pair of transparent sheets and a metal film sandwiched therebetween, wherein the scratch-resistant layer is attached to one of the transparent layers.

8. The projection screen of claim 7, wherein the privacy layer further comprises a transparent backing liner attached to the other one of the transparent sheets.

9. The projection screen of claim 1, further comprising a second display layer overlapped to the first display layer, and a second electrical field coupled to the second display layer to vary an opacity level of the second display layer.

10. The projection screen of claim 9, wherein the opacity level of the first and the second display layers are independently variable.

11. The projection screen of claim 1, wherein the first display layer includes a plurality of cells, and the first electrical fields includes a plurality of units each being coupled to one of the cells to vary an opacity level of the cell.

12. The projection screen of claim 11, wherein the opacity level of at least one of the cells is independently variable from that of the rest of the cells.

13. The projection screen of claim 12, wherein when said at least one of cells is at an opacity level to allow lights from the rear side to pass through the cell of first display layer, said rest of the cells are at an opacity level to block lights from the rear side from passing through the rest of cells of the display layer.

14. A projection system comprising at least one projection screen as recited in claim 1, and at least one projector for providing visual contents to said at least one projection screen.

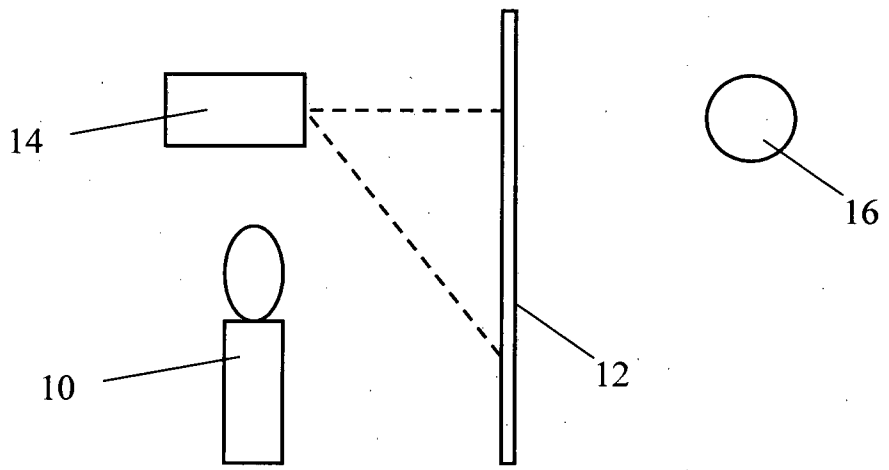

FIG. 1 (Prior Art)

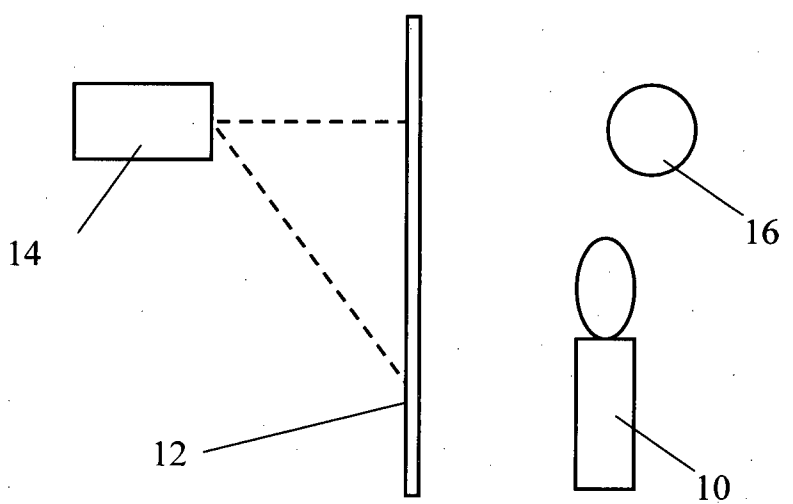

FIG. 2 (Prior Art)

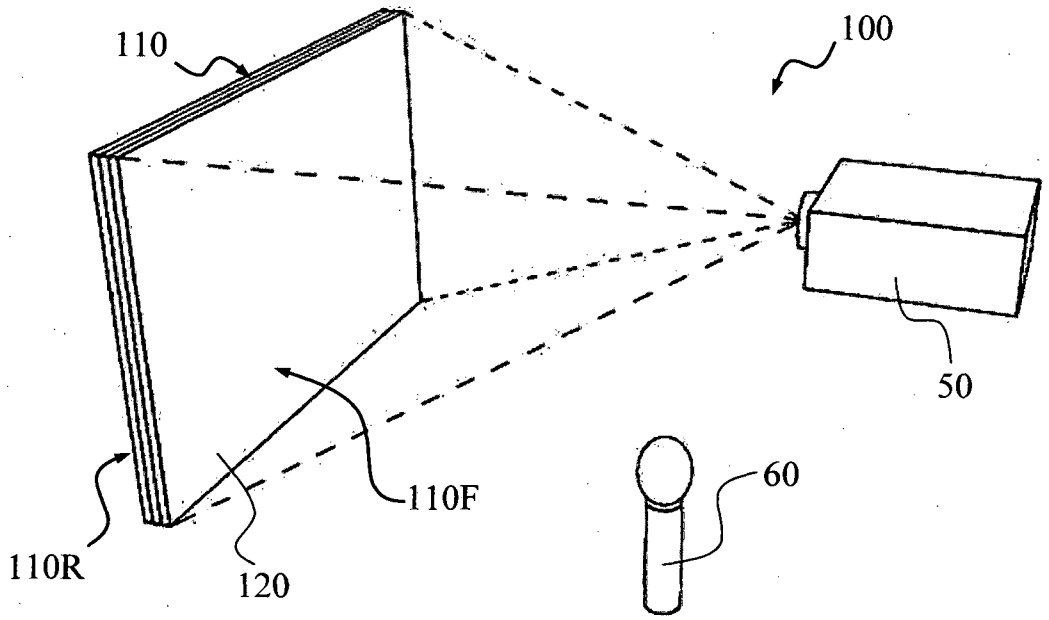

FIG. 3

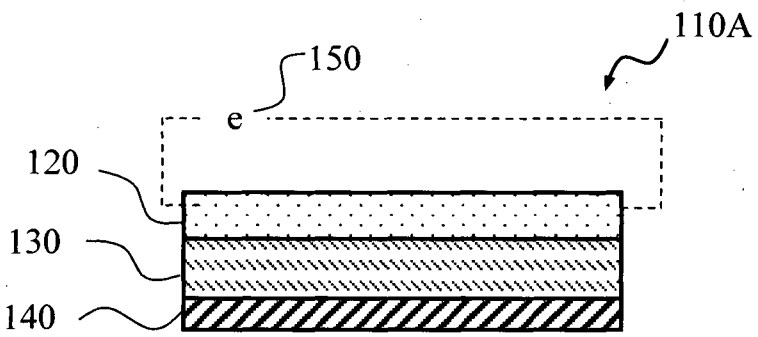

FIG. 4A

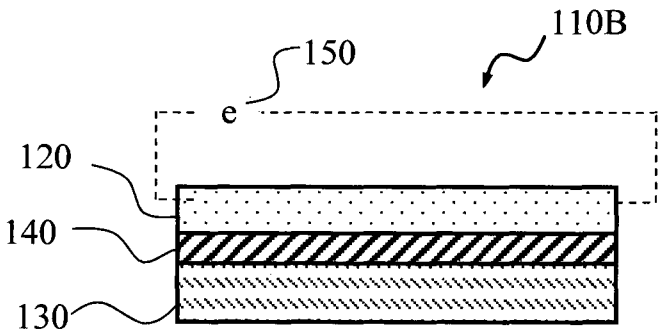

FIG. 4B

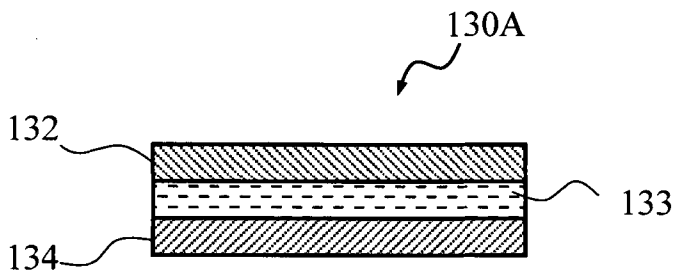

FIG. 5A

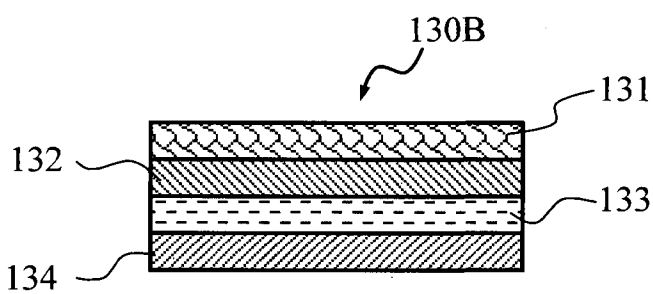

FIG. 5B

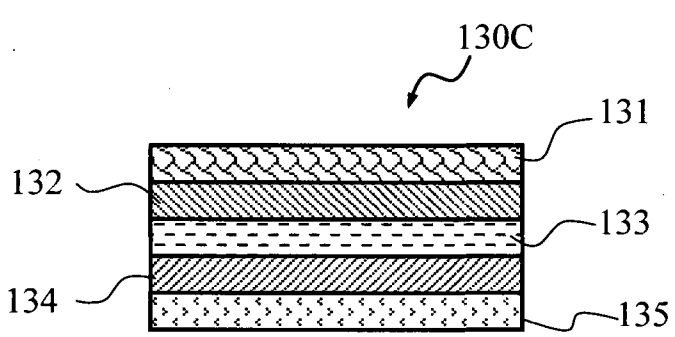

FIG. 5C

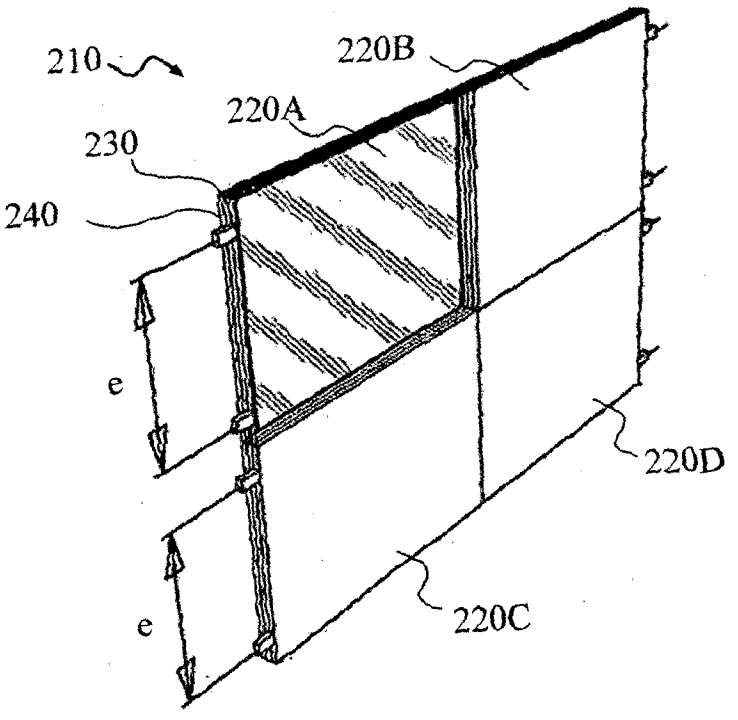
210
220B
220A
230
240
e
220D
e
220C

FIG. 6

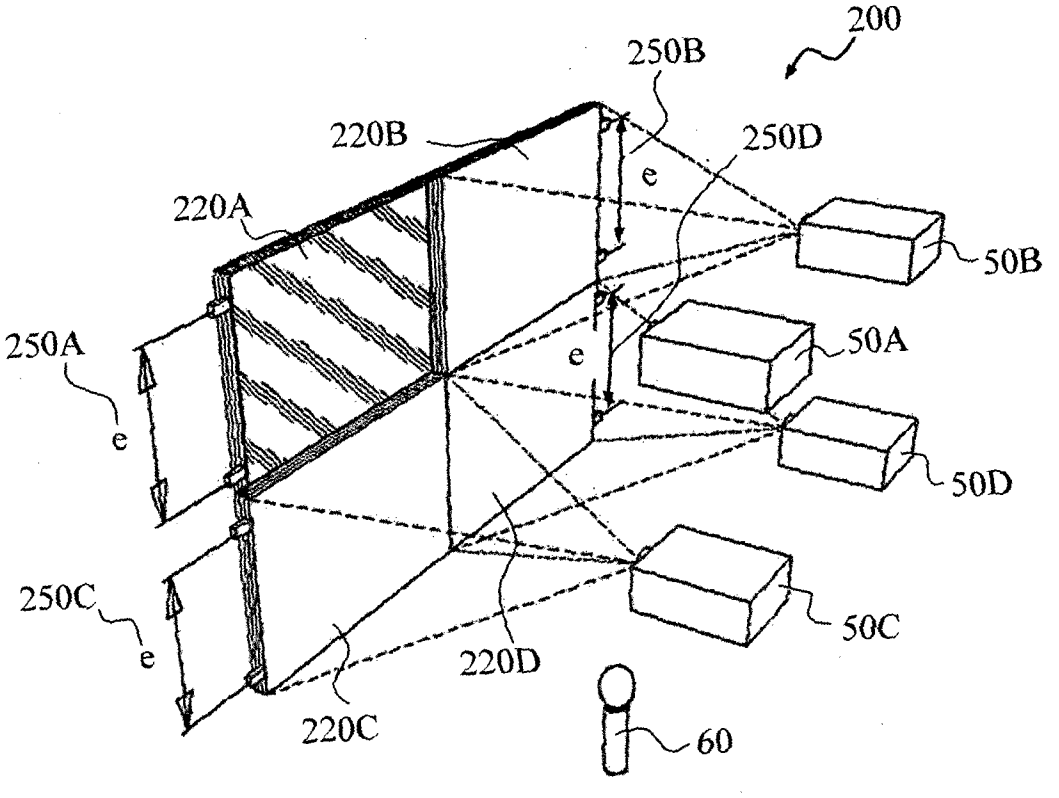
200
250B
220B
250D
220A
e
50B
250A
e
50A
e
50D
250C
e
50C
220D
220C
60

FIG. 7

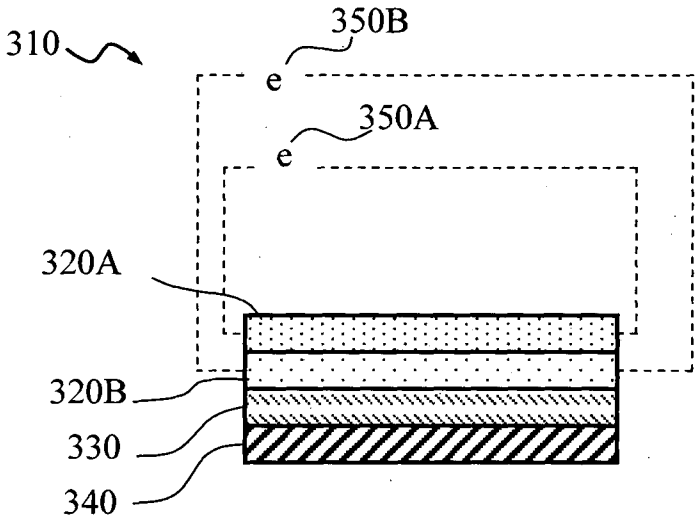

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SG2013/000152

A. CLASSIFICATION OF SUBJECT MATTER

G03B 21/62 (2006.01) G02F 1/133 (2006.01) G02F 1/15 (2006.01)

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)

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 practicable, search terms used)

Database: GOOGLE PATENTS, ESPACENET, EPODOC, WPI
Keywords: Projection screen, projection film, projection window, electrochromic, PDLC, polymer dispersed liquid crystal, opaque, suspended particle, privacy screen, filter, one way mirror, plasma cell and similar terms.

Database: AMBERSCOPE
Combi on US 7486342 B2 & US 5416617 A - all documents considered.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 July 2013	30 July 2013
Name and mailing address of the ISA/AU	**Authorised officer**
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au Facsimile No.: +61 2 6283 7999	ISAAC TAN AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262832814

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/SG2013/000152**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 5416617 A (LOISEAUX et al.) 16 May 1995 Columns 1 - 4, Figures 2a - 2b Abstract	1 - 8, 14 11 - 13
Y	US 7130118 B2 (SMYTHE et al.) 31 October 2006 Abstract, Columns 2 - 5	11 - 13
A	US 6538814 B2 (HUNTER et al.) 25 March 2003 Whole Document	1 - 14
A	US 7486342 B2 (MATHEY et al.) 03 February 2009 Whole Document	1 - 14
A	WO 2007/065694 A1 (ISOLAR ISOLIERGLASERZEUGUNG GMBH) 14 June 2007 Whole Document	1 - 14

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/SG2013/000152**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
US 5416617 A	16 May 1995	EP 0568690 B1	31 Jul 1996
		FR 2684198 A1	28 May 1993
		FR 2684198 B1	23 Sep 1994
		JP H06504635 A	26 May 1994
		US 5416617 A	16 May 1995
		WO 9310481 A1	27 May 1993
US 7130118 B2	31 Oct 2006	US 7130118 B2	31 Oct 2006
US 6538814 B2	25 Mar 2003	EP 1139158 A2	04 Oct 2001
		JP 2001296609 A	26 Oct 2001
		JP 4285920 B2	24 Jun 2009
		US 2001028501 A1	11 Oct 2001
		US 6538814 B2	25 Mar 2003
US 7486342 B2	03 Feb 2009	EP 1405131 A1	07 Apr 2004
		FR 2827397 A1	17 Jan 2003
		FR 2827397 B1	19 Sep 2003
		JP 2004534282 A	11 Nov 2004
		JP 5043285 B2	10 Oct 2012
		PL 364574 A1	13 Dec 2004
		US 2004169789 A1	02 Sep 2004
		US 7486342 B2	03 Feb 2009
		WO 03007060 A1	23 Jan 2003
WO 2007/065694 A1	14 Jun 2007	DE 102005059133 A1	14 Jun 2007
		EP 1963999 A1	03 Sep 2008
		EP 1963999 B1	17 Mar 2010
		WO 2007065694 A1	14 Jun 2007

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.