[19] 中华人民共和国国家知识产权局

[51] Int. Cl.
G02F 1/1335 (2006.01)

[12] 发明专利申请公开说明书

[21] 申请号 200480021231.5

[43] 公开日 2006 年 8 月 30 日

[11] 公开号 CN 1826553A

[22] 申请日 2004.7.21
[21] 申请号 200480021231.5
[30] 优先权
[32] 2003.7.23 [33] JP [31] 200607/2003
[86] 国际申请 PCT/JP2004/010327 2004.7.21
[87] 国际公布 WO2005/008322 日 2005.1.27
[85] 进入国家阶段日期 2006.1.23
[71] 申请人 夏普株式会社
地址 日本大阪府
[72] 发明人 津田和彦 植木俊 中村浩三
田口登喜生

[74] 专利代理机构 上海专利商标事务所有限公司
代理人 沈昭坤

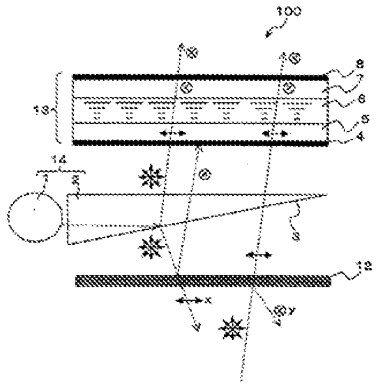
权利要求书 2 页 说明书 24 页 附图 14 页

[54] 发明名称

液晶显示装置

[57] 摘要

液晶显示装置配置从背面侧往表面侧反射 x 方向的线偏振光并使 y 方向的线偏振光透射的偏振光选择反射板(12)、使 x 方向的线偏振光透射的第 1 偏振板(4)、液晶显示面板(13)和使 y 方向的线偏振光透射的第 2 偏振板(8)。仅对液晶显示面板(13)背面侧配置偏振光选择反射板(13)。而且，可通过在偏振光选择反射板(12)反射从背面侧入射的光的 y 方向线偏振光，保护隐私。使透射的 x 方向线偏振光经第 1 偏振板(4)、液晶显示面板(13)和第 2 偏振板(8)逸出到表面侧。由此可实现即使在周围光强的环境下也能进行良好的画面显示的液晶显示装置。



Microsoft Exhibit 1002 - Page 789
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

1、一种液晶显示装置，其特征在于，具有

将液晶层设置在形成一对的第 1 偏振板与第 2 偏振板之间的液晶显示媒体；以及

与所述液晶显示媒体对置地设置在第 1 偏振板方的位置，并使从与所述液晶显示媒体侧的面相反侧的面入射的光中，使具有第 1 偏振状态的分量的光进行透射、而使具有与第 1 偏振状态不同的第 2 偏振状态的分量的光进行反射的偏振光选择反射部件。

2、一种液晶显示装置，其特征在于，具有

将液晶层设置在形成一对的第 1 偏振板与第 2 偏振板之间的液晶显示媒体；

与所述液晶显示媒体对置地设置在第 1 偏振板方的位置，并使从与所述液晶显示媒体侧的面相反侧的面入射的光反射的光中具有第 1 偏振状态的分量的光进行透射、而具有与第 1 偏振状态不同的第 2 偏振状态的分量的光进行反射的偏振光选择反射部件；以及

设置在所述偏振光选择反射部件与所述液晶显示媒体之间、并将来自光源的光照射到液晶显示媒体的光照射部件。

3、一种液晶显示装置，其特征在于，具有

将液晶层设置在形成一对的第 1 偏振板与第 2 偏振板之间的液晶显示媒体；

与所述液晶显示媒体对置地设置在第 1 偏振板方的位置，并使从与所述液晶显示媒体侧的面相反侧的面入射的光反射的光中具有第 1 偏振状态的分量的光进行透射、而具有与第 1 偏振状态不同的第 2 偏振状态的分量的光进行反射的偏振光选择反射部件；

设置在所述偏振光选择反射部件与所述液晶显示媒体之间、并将来自光源的光照射到液晶显示媒体的光照射部件；以及

设置在所述偏振光选择反射部件与所述光照射部件之间，并控制从偏振光选择反射部件往液晶显示媒体的光的偏振状态的偏振控制部件。

4、如权利要求 2 或 3 所述的液晶显示装置，其特征在于，

Microsoft Exhibit 1002 - Page 790
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

具有覆盖外表面的壳体，在该壳体的所述液晶显示媒体侧的面上形成显示窗，并且在所述偏振光选择反射部件侧的面上形成采光窗。

5、如权利要求 3 中所述的液晶显示装置，其特征在于，

所述偏振控制部件是根据液晶层的液晶分子取向状态来控制光的偏振状态的偏振控制液晶媒体。

6、如权利要求 1 至 3 中任一项所述的液晶显示装置，其特征在于，

所述偏振光选择反射部件使从与所述液晶显示媒体侧的面相反侧的面入射的光中的第 1 线偏振光进行透射，并将垂直于第 1 线偏振光的第 2 线偏振光进行反射。

7、如权利要求 1 至 3 中任一项所述的液晶显示装置，其特征在于，

所述偏振光选择反射部件使从与所述液晶显示媒体侧的面相反侧的面入射的光中的第 1 圆偏振光进行透射，并将旋转方向与第 1 圆偏振光相反的第 2 圆偏振光进行反射；

还具有使所述偏振光选择反射部件透射的第 1 圆偏振光变成线偏振光的相位差板。

8、如权利要求 5 中所述的液晶显示装置，其特征在于，

所述偏振控制液晶媒体的液晶层是双扭式向列型液晶层。

9、如权利要求 5 中所述的液晶显示装置，其特征在于，

所述偏振控制液晶媒体的液晶层是平行取向的向列型液晶层。

10、如权利要求 4 中所述的液晶显示装置，其特征在于，

所述壳体的采光窗中还具有使对所述液晶显示媒体的背面垂直方向倾斜的入射光折射到液晶显示媒体的正面方向的光折射部件。

Microsoft Exhibit 1002 - Page 791
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

液晶显示装置

技术领域

本发明涉及液晶显示装置。具体而言，本发明涉及在强周围光下可见性也良好的透射型液晶显示装置。

背景技术

近年来，即使在应运而生的显示媒体中，使用液晶的液晶显示装置(LCD：Liquid Crystal Display)，由于能以低耗电进行显示，也最快地付诸实用。作为该液晶显示装置的显示模式和驱动方法，提出单纯矩阵方式和有源矩阵方式两种。另一方面，随着信息多媒体化向前进展，要求显示器高析像度化、高对比度化、多色调(多彩色、标准彩色)化和大视场角化。对这样的要求，可认为单纯矩阵方式难适应。因此，提出各个像素设置开关元件(有源元件)从而使可驱动的扫描线电极数量增多的有源矩阵方式。

利用这种有源矩阵方式的技术，正在完成显示器的高析像度、高对比度化、多色调化以及大视场角化。有源矩阵方式的液晶显示装置，其组成为：通过开关元件电连接设置成矩阵状的像素电极和在该像素电极附近通过的扫描线。作为这种开关元件，有 2 端子非线性元件和 3 端子非线性元件，当前采用的开关元件的代表是 3 端子元件的薄膜晶体管(TFT：Thin Film Transistor)。

近年来，这种有源矩阵方式的液晶显示装置，在以便携电话等为代表的移动设备中快速普及。

已有的透射型液晶显示装置在液晶显示面板的背面配置背后照明单元进行透射显示。这种方法在室内等周围光较弱的环境下，能获得良好的画面显示。然而，在室外和窗口等直射阳光照射的周围光强的环境下，液晶显示面板的表面和内部布线上反射周围光。该反射光的光量从背后照明单元出射，并且大于液晶屏透射光的光量，因而周围光强的环境下，实际上不可能确认画面显示(不

Microsoft Exhibit 1002 - Page 792
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

可能取得良好的可见性)。

因此，作为在周围光强的环境下也能获得良好可见性的技术，开发了反射型和半透射型液晶显示装置。这种反射型和半透射型液晶显示装置，具有在液晶显示面板内部反射周围光，并进行画面显示用的反射部(反射板)。这种结构中能确保亮度，但色纯度降低。而且，提高与反射板对应的滤色片浓度时，亮度不足。这样用反射部的显示，实质上不可能实现美丽的图像显示。

针对这点，例如专利文献 1：日本国专利公开平 11－52374 号公报(1999 年 2 月 26 日公开)，下文当作已有技术例 1，或专利文献 2：日本国专利公开平 11－95199 号公报(1999 年 4 月 9 日公开，下文当作已有技术例 2)，揭示一种在设在透射型液晶显示装置背面的导光板上具有汇聚外部光(周围光)的部件的带聚光机构的液晶显示装置。这些专利文献揭示的液晶显示装置在导光板的端部形成透镜形状的聚光部(采光部)。

已有技术例 1 的液晶显示装置形成的结构为：以楔形的作为聚光部的第 1 照光部和楔形的作为光源部的第 2 照光部厚度相互补足的形式，与 LCD 屏重叠在一起。另一方面，已有技术例 2 的液晶显示装置在 LCD 的背后设置导光部，并且设置连接该导光部和光路的聚光部。导光部除往 LCD 的光出射面和来自聚光部的光导入口外，在周围形成镜面。这些已有技术例 1 和已有技术例 2 的任一液晶显示装置，都将所述聚光部汇聚的外部光引导到导光部(照射部)进行漫反射，并作为平面光源照射到 LCD。

作为利用周围光进行显示的液晶显示装置，有取消透射型液晶显示装置利用的导光板的配置在液晶屏相反侧(背面侧)的反射片，并使背面侧透明的液晶显示装置(下文当作已有技术例 3)。此结构中，由于周围光从液晶显示面板的背面入射，能确保充分的光取入口，可在强周围光的环境下进行良好的显示。

作为利用周围光进行显示的另一液晶显示装置，例如专利文献 3：日本国专利公开平 9－265069 号公报(1997 年 10 月 7 日公开，下文当作已有技术例 4)，揭示了在导光体背面设置半透射板的装置。专利文献 3 揭示的液晶显示装置是采用背后照明进行画面显示的透射型液晶显示装置。此透射型液晶显示装置构成在导光体的后方配置半透射板(半透射构件)和遮光用液晶元件(TN 型液晶元

Microsoft Exhibit 1002 - Page 793
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

件)。即，此液晶显示装置中，将遮光用液晶元件设在半透射板的与导光体方相反的一侧，可切换使外部光透射的透射状态和遮蔽外部光的遮光状态。通过将该遮光用液晶元件取为透射状态，能利用来自背面侧的外部光，又通过取为遮光状态，可防止从背面侧看到显示画面，保护隐私。还可借助半透射板，利用从导光体背面侧出射的光。

然而，上述已有液晶显示装置中，分别具有下面所示的课题。

首先，已有技术例 1 和已有技术例 2 的液晶显示装置中，在导光部(照光部)的端部形成透镜形状。因此，能由该透镜取入的周围光的光量与透镜部的面积成正比，为了取入较多的周围光，必须加大所述透镜部的面积。由此，必须加大形成透镜部的导光部的厚度。然而，实际的导光部只能加大几毫米的厚度，所以不可能利用光量充分的周围光。因此，上述液晶显示装置不能有效利用周围光进行良好的画面显示。

又，已有技术例 3 的液晶显示装置中，由于液晶显示面板的背面侧是透明的，从背面侧也能看到液晶显示面板的显示画面，在隐私方面产生问题。

另一方面，已有技术例 4 的液晶显示装置具有遮光用液晶元件，所以又能保守隐私又能利用周围光。然而，在周围光强的环境下将遮光用液晶元件切换到透射状态时，不能解决隐私的问题。即，已有技术例 4 的液晶显示装置不能兼顾保护隐私和提高周围光强的环境下的可见性。已有技术例 4 的液晶显示装置中，使所述遮光用液晶元件为遮光状态时，为了提高从导光体出射到背面侧的光的利用效率，还在导光体与遮光用液晶元件之间配置半透射板。然而，该半透射板的光透射率低，在将遮光用液晶元件切换到透射状态时，存在周围光的光利用效率降低的问题。

本发明是鉴于上述问题而完成的，其目的在于提供一种又能在周围光强的环境下作良好的画面显示，又能保护隐私的液晶显示装置。

发明内容

为了解决上述课题，本发明的液晶显示装置，具有

将液晶层设置在形成一对的第 1 偏振板与第 2 偏振板之间的液晶显示媒体；

Microsoft Exhibit 1002 - Page 794
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

以及与所述液晶显示媒体对置地设在第 1 偏振板方的位置，并使从与所述液晶显示媒体侧的面相反侧的面入射的光中，使具有第 1 偏振状态的分量的光进行透射，而使具有与第 1 偏振状态不同的第 2 偏振状态的分量的光进行反射的偏振光选择反射部件。

根据上述组成，例如液晶显示媒体的第 1 偏振板使具有第 1 偏振状态的分量的光进行透射，第 2 偏振板使具有第 2 偏振状态的分量的光进行透射。

对偏振光选择反射部件从与液晶显示媒体侧的面相反侧的面入射的光(周围光)中具有第 1 偏振状态的分量的光、穿透偏振光选择反射部件，而具有第 2 偏振状态的分量的光、在偏振光选择反射部件上反射。

穿透偏振光选择反射部件的具有第 1 偏振状态的分量的光，穿透液晶显示媒体的第 1 偏振板，入射到液晶层，经过该液晶层后，成为具有第 2 偏振状态的分量的光，穿透第 2 偏振板，到达观察者处。由此，能有效利用从与液晶显示媒体侧的面相反侧的面入射的光(周围光)。

又，如上所述，周围光中具有第 2 偏振状态的分量的光在偏振光选择反射部件受到反射，所以从液晶显示装置的背面侧不能看到显示画面。由此，能保护使用者的隐私。

为了解决上述课题，本发明的液晶显示装置，具有

将液晶层设置在形成一对的第 1 偏振板与第 2 偏振板之间的液晶显示媒体；与所述液晶显示媒体对置地设置在第 1 偏振板方的位置，并使从与所述液晶显示媒体侧的面相反侧的面入射的光反射的光中具有第 1 偏振状态的分量的光进行透射，而具有与第 1 偏振状态不同的第 2 偏振状态的分量的光进行反射的偏振光选择反射部件；以及设在所述偏振光选择反射部件与所述液晶显示媒体之间、并将来自光源的光照射到液晶显示媒体的光照射部件。

根据上述组成，例如液晶显示媒体的第 1 偏振板使具有第 1 偏振状态的分量的光进行透射，第 2 偏振板使具有第 2 偏振状态的分量的光进行透射。

因此，从光照射部件出射到液晶显示媒体侧的来自的光中具有第 1 偏振状态的分量的光穿透第 1 偏振板，入射到液晶层。这时，如果液晶层运作，使穿通第 1 偏振板的具有第 1 偏振状态的分量的光变成具有第 2 偏振状态的分量的

Microsoft Exhibit 1002 - Page 795
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

光，该光就到达观察者处。由此，能用从光照射部件出射到液晶显示媒体侧的来自光源的光进行良好的画面显示。

另一方面，从光照射部件出射到液晶显示媒体侧的来自光源的光中具有第 1 偏振状态的分量的光穿透偏振光选择反射部件。又，具有第 2 偏振状态的分量的光受偏振光选择反射部件反射，虽然照射到液晶显示媒体，但被第 1 偏振板吸收。因此，画面显示中不能利用从光照射部件出射到偏振光选择反射部件的来自光源的光。

又，对偏振光选择反射部件从与液晶显示媒体侧的面相反侧的面入射的光(周围光)中具有第 1 偏振状态的分量的光穿透偏振光选择反射部件，而具有第 2 偏振状态的分量的光在偏振光选择反射部件上进行反射。

穿透偏振光选择反射部件的具有第 1 偏振状态的分量的光，穿透液晶显示媒体的第 1 偏振板，入射到液晶层，经过该液晶层后变成具有第 2 偏振状态的分量的光，穿透第 2 偏振板，到达观察者处。由此，能有效利用从与液晶显示媒体侧的面相反侧的面入射的光(周围光)。

如上所述，周围光中具有第 2 偏振状态的分量的光在偏振光选择反射部件上反射，所以从液晶显示装置的背面侧不能看到显示画面。因此，能保护使用者的隐私。

其结果，可提供又能在周围光强的环境下作画面显示，又能在周围光弱的环境下获得明亮的画面显示的液晶显示装置。

本发明的液晶显示装置，具有

将液晶层设置在形成一对的第 1 偏振板与第 2 偏振板之间的液晶显示媒体；与所述液晶显示媒体对置地设在第 1 偏振板方的位置，并使从与所述液晶显示媒体侧的面相反侧的面入射的光反射的光中具有第 1 偏振状态的分量的光进行透射，而具有与第 1 偏振状态不同的第 2 偏振状态的分量的光进行反射的偏振光选择反射部件；设置在所述偏振光选择反射部件与所述液晶显示媒体之间，并将来自光源的光照射到液晶显示媒体的光照射部件；以及设置在所述偏振光选择反射部件与所述光照射部件之间，并控制从偏振光选择反射部件往液晶显示媒体的光的偏振状态的偏振控制部件。

Microsoft Exhibit 1002 - Page 796
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

根据上述组成，例如液晶显示媒体的第 1 偏振板使具有第 1 偏振状态的分量的光进行透射，第 2 偏振板使具有第 2 偏振状态的分量的光进行透射。

因此，从光照射部件出射到液晶显示媒体侧的来自光源的光中具有第 1 偏振状态的分量的光穿透第 1 偏振板，入射到液晶层。这时，如果液晶层运作，使穿通第 1 偏振板的具有第 1 偏振状态的分量的光变成具有第 2 偏振状态的分量的光，该光就到达观察者处。

另一方面，从光照射部件出射到液晶显示媒体侧的来自光源的光中具有第 2 偏振状态分量的光受偏振光选择反射部件反射后，朝向液晶显示媒体。这种情况下，偏振控制部件控制朝向液晶显示媒体的光的偏振状态。这时，偏振控制部件例如根据液晶层的液晶分子取向状态，使受偏振光选择反射部件反射的具有第 2 偏振状态的分量的光变成具有第 1 偏振状态的分量的光。由此，经过偏振控制部件的光穿透液晶显示媒体的第 1 偏振板，经第 2 偏振板达到观察者。因此，能有效利用光折射部件出射的光。由此，在周围光弱的环境下也能得到明亮的画面显示。

又，偏振光选择反射部件的从与液晶显示媒体侧的面相反侧的面入射的光(周围光)中具有第 1 偏振状态的分量的光穿透偏振光选择反射部件，具有第 2 偏振状态分量的光在偏振光选择反射部件上进行反射。

这时，偏振控制部件例如根据液晶层的液晶分子取向状态，使具有第 1 偏振状态的分量的光的偏振状态不变，则穿透偏振光选择反射部件的光以第 1 偏振状态穿透偏振控制部件，进而穿透液晶显示媒体的第 1 偏振板，经第 2 偏振板到达观察者处。

即，可实现即使在偏振光选择反射部件的从与液晶显示媒体侧的面相反侧的面入射的光强的环境下，也利用所述偏振控制液晶媒体的偏振控制进行良好的画面显示的液晶显示装置。

如上所述，周围光中具有第 2 偏振状态分量的光受偏振光选择反射部件反射，所以从液晶显示装置的背面侧不能看到显示画面。因此，能保护使用者的隐私。

其结果，又能在周围光强的环境下作良好地画面显示，又能在周围光弱的

Microsoft Exhibit 1002 - Page 797
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

环境下获得明亮的画面显示，同时还能在周围光弱的环境下得到画面明亮的显示。

可构成上述液晶显示装置具有覆盖外表面的壳体，在该壳体的所述液晶显示媒体侧的面上形成显示窗，并且在所述偏振光选择反射部件侧的面上形成采光窗。

根据上述组成，所述液晶显示媒体、所述光照射部件以及所述偏振光选择反射部件由壳体覆盖外表面。而且，该壳体的所述液晶显示媒体侧的面上形成显示窗，在所述偏振光选择反射部件侧的面上形成采光窗。

由此，该液晶显示装置能用于便携电话等，并可实现能有效利用来自采光窗的光同时又不能从背面侧看显示画面的液晶显示装置。

可构成上述液晶显示装置中，所述偏振控制部件是根据液晶层的液晶分子取向状态，控制光的偏振状态的偏振控制液晶媒体。

根据上述组成，通过将偏振控制液晶媒体用作所述偏振控制部件，能在画面显示中有效利用从所述光照射部件出射到偏振光选择反射部件的光。

可构成上述液晶显示装置中，所述偏振光选择反射部件使从与所述液晶显示媒体侧的面相反侧的面入射的光中的第 1 线偏振光进行透射，并将垂直于第 1 线偏振光的第 2 线偏振光进行反射。

例如，设第 1 偏振板使第 1 线偏振光进行透射，第 2 偏振板使第 2 线偏振光进行透射。根据上述组成，从与液晶显示媒体侧的面相反侧的面入射的光(周围光)中的第 1 线偏振光穿透偏振光选择反射部件。该线偏振光原样穿透第 1 偏振板后，在液晶层变成第 2 线偏振光，穿透第 2 偏振板，到达观察者处。由此，可实现能有效利用周围光的液晶显示装置。

而且，根据上述组成，从与液晶显示媒体侧的面相反侧的面入射的光(周围光)中的第 2 线偏振光受偏振光选择反射部件进行反射，由于该反射光，从背面侧不能看显示画面。

可构成上述液晶显示装置中，所述偏振光选择反射部件使从与所述液晶显示媒体侧的面相反侧的面入射的光中的第 1 圆偏振光进行透射，并将旋转方向与第 1 圆偏振光相反的第 2 圆偏振光进行反射，而且还具有使所述偏振光选择

Microsoft Exhibit 1002 - Page 798
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

反射部件进行透射的第 1 圆偏振光变成线偏振光的相位差板。

根据上述组成，从与液晶显示媒体侧的面相反侧的面入射的光中的第 1 圆偏振光穿透偏振光选择反射部件。由相位差板将该第 1 圆偏振光改变成线偏振光。该线偏振光穿通偏振控制液晶媒体。这时，如果偏振控制液晶媒体使该线偏振光的方向变成与第 1 偏振板的透射轴方向平行的方向，则该线偏振光不改变偏振状态，而穿透第 1 偏振板。然后，经液晶显示媒体和第 2 偏振板达到观察者。由此，可实现能有效利用周围光的液晶显示装置。

而且，根据上述组成，不导致产生以往那样在周围光强的环境下从背面侧能看显示画面的问题。即，根据上述组成，偏振光选择反射部件反射从与液晶显示媒体侧的面相反侧的面入射的光中的第 2 圆偏振光。由于该反射光，从第 1 侧不能看显示画面。

于是，根据上述组成可实现能有效利用周围光，而且从背面侧不能看显示画面的液晶显示装置。

可构成上述液晶显示装置中，所述偏振控制液晶媒体的液晶层是双扭式向列型液晶层。

根据上述组成，作为双扭式向列型液晶层的偏振控制液晶媒体，能根据该液晶层的液晶分子取向状态，改变线偏振光的方向。由此，可实现能有效利用周围光而且从背面侧不能看显示画面的液晶显示装置。

可构成上述液晶显示装置中，所述偏振控制液晶媒体的液晶层是平行取向的向列型液晶层。

根据上述组成，设定作为平行取向的向列型液晶层的偏振控制液晶媒体，使所述线偏振光的方向偏转 90 度，从而与上述向列型液晶层时相同，也可控制线偏振光的方向。

由以下所示的记述会充分理解本发明的另一些目的、特征和优点。在下面参照附图的说明中会明白本发明的利益。

附图说明

图 1 是说明本发明实施方式 1 的液晶显示装置的显示方法的运作图。

Microsoft Exhibit 1002 - Page 799
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

图 2(a)是示出本发明实施方式 1 的液晶显示装置的剖视图。

图 2(b)是示出用壳体保护并固定上述液晶显示装置时的组成的概略剖视图。

图 3 是图 2 的液晶显示装置中开关元件的放大剖视图。

图 4 是图 2 的液晶显示装置的俯视图。

图 5 是说明图 2 的液晶显示装置中各轴的设定的轴设计图。

图 6 是示出本发明实施方式 2 的液晶显示装置的剖视图。

图 7 是说明图 6 的液晶显示装置中各轴的设定的轴设计图。

图 8 是说明周围光不强的环境下的本发明实施方式 2 的液晶显示装置的显示方法的运作图。

图 9 是说明周围光强的环境下的本发明实施方式 2 的液晶显示装置的显示方法的运作图。

图 10 是示出本发明实施方式 3 的液晶显示装置的剖视图。

图 11 是说明图 10 的液晶显示装置中各轴的设定的轴设计图。

图 12 是说明周围光不强的环境下的本发明实施方式 3 的液晶显示装置的显示方法的运作图。

图 13 是说明周围光强的环境下的本发明实施方式 3 的液晶显示装置的显示方法的运作图。

图 14 是示出本发明实施方式 4 的液晶显示装置的剖视图。

具体实施方式

实施方式 1

根据图 1～图 5 说明一本发明实施方式如下。

图 2(a)示出本实施例的液晶显示装置 100 的组成的截面。如图 2(a)所示，液晶显示装置 100 由光源 1、导光板 2、液晶显示面板(液晶显示媒体)13 以及偏振光选择反射板(偏振光选择反射部件)12 组成。由光源 1 和导光板 2 构成背后照明(光照射部件)14，并设置液晶显示面板 13 和偏振光选择反射板 12，将该背后照明 14 夹在中间。本说明书中，将相对于背后照明 14 设置液晶显示面板 13 的一方取为表面侧(第 2 侧)，将其反面的设置偏振光选择反射板 12 的一方取为

Microsoft Exhibit 1002 - Page 800
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

背面侧(第 1 侧)。将导光板 2 至液晶显示面板 13 的方向取为上方向，其相反的方向取为下方向。各种构件中，将表面侧的面简称为表面，背面侧的面称为背面。

所述导光板 2 具有散射加工面。由导光板 2 的散射加工面 3 使光源 1 发出的光进行散射，分成从该导光板 2 往正面方照射的光和往背面侧照射的光。背后照明 14 只要具有光源 1 和导光板 2，不专门限于图中所示的。

配置在液晶显示装置 100 的背面侧的偏振光选择反射板 12，在入射到本身的线偏振光的偏振方向与反射轴平行时，反射该光，而在偏振方向与透射轴平行时，使该光透射。由此，无偏振的光从背后照明 14 入射到偏振光选择反射板 12 时，使规定偏振方向的光(一线偏振光)反射，并且与其不同的偏振方向的光(另一线偏振光)透射。即，偏振光选择反射板 12 具有利用设定透射轴和反射轴有选择地使不同偏振方向的光透射或反射的功能。本实施方式中，使用通过层叠高分子膜制成的已知偏振光选择反射板，但只要是透射一线偏振光并反射另一线偏振光的偏振光选择反射板即可。

图 2(b)示出在便携电话等中采用所述液晶显示装置 100 时的组成的概略剖视图。在壳体 613 的表面侧设置空开液晶显示面板 13 的画面显示区的显示窗 615，在背面侧设置大小与显示窗 615 大致相同的采光窗 616。

所述液晶显示面板 13，具有第 1 偏振板 4、第 1 透明衬底 5、开关元件 605、液晶层 6、透明电极 607、滤色片 608、第 2 透明衬底 7 以及第 2 偏振板 8。构成将液晶层 6 夹在作为一对透明衬底的第 1 透明衬底 5 与第 2 透明衬底 7 之间，在背面侧设置第 1 透明衬底 5，表面侧设置第 2 透明衬底 7。将第 1 偏振板 4 设在第 1 透明衬底 5 的背面，第 2 偏振板 8 设在第 2 透明衬底 7 的表面。在第 1 透明衬底 5 设置开关元件 605，在第 2 透明衬底 7 设置滤色片 608 和透明电极 607。

液晶层 6 例如由 TN(Twist Nematic ：双扭式向列型)液晶组成。本实施方式中，液晶层 6 进行对入射到其本身且穿通的线偏振光未施加电压时使偏振方向旋转 90 度的控制，并进行施加电压时不使偏振方向旋转的控制。液晶层 6 不限于 TN 液晶，只要是能控制通过的光的偏振状态的液晶即可。

Microsoft Exhibit 1002 - Page 801
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

第 1 偏振板 4 和第 2 偏振板 8 具有设定规定朝向的透射轴，仅使透射轴方向的线偏振分量的光进行透射。来自背后照明 14 的无偏振的光入射到第 1 偏振板 4 时，第 1 偏振板 4 仅透射与其透射轴平行的线偏振光。穿透所述液晶层 6 的线偏振光入射到第 2 偏振板 8 时，第 2 偏振板 8 仅透射与其透射轴平行的线偏振光。

作为第 1 偏振板 4 和第 2 偏振板 8 的材料，最好通过高分子树脂膜中混入碘、双色性染料并加以延展，使其取向，但不限于此，只要是能使规定的线偏振光透射的材料即可。

滤色片 608 在第 2 透明衬底 7 的背面分别设置 RGB 三种色。

将透明电极 607 设置在第 2 透明衬底 7 上且为滤色片 608 的液晶层 6 方的面上。作为透明电极材料，ITO(氧化铟和氧化锡组成的合金)为佳，但不限于此，也可用其它具有透明性的导电金属膜。本实施例中记载使用金属组成的透明电极材料的例子，但可以是金属以外的树脂、半导体等具有透明性的导电材料。

将开关元件 605TFT 等有源元件，设置在第 1 透明衬底 5 的表面，进行切换，以驱动各像素。

这里用图 3 和图 4 说明使用例如 TFT 元件时的开关元件 605 的组成。

如图 3 所示，由栅极(栅极线)701、栅极绝缘膜 702、i 型非晶硅层 703、n + 型非晶硅层 704、源极(源极线)705、像素电极 706，组成开关元件 605。

如图 4 所示，在第 1 透明衬底 5 上，将栅极(栅极线)701 和源极(源极线)705 设置成网格状。在相邻的栅极(栅极线)701 之间与该栅极(栅极线)701 平行地配置辅助电容布线 802。

如图 3 所示，开关元件 605 在第 1 透明衬底 5 上具有栅极 701，并且在该栅极上具有栅极绝缘层 702。

在栅极 701 上以所述栅极绝缘层 702 为中介，形成 i 型非晶硅层 703。进而，在该层上以 n+型非晶硅层 704 为中介形成源极 705 和像素电极 706。源极 705 和像素电极 706 位于 i 型非晶硅层 703 上。源极 705 的另一端部位于栅极绝缘层 702 上。像素电极 706 的另一端部位于栅极绝缘层 702 上。

这里，用图 5 说明液晶显示装置 100 中控制偏振的构件的轴的组成(这里轴

Microsoft Exhibit 1002 - Page 802
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

的组成是指透射轴、反射轴和液晶层取向方向的组成)。作为所述构件，可列举偏振光选择反射板 12、第 1 偏振板 4、液晶层 6 以及第 2 偏振板 8。图 5 的空心箭头号表示偏振板的透射轴，参考号 6a 和 6b 分别表示液晶层 6 的表面侧液晶分子层和背面侧液晶分子层，实心箭头号表示液晶分子的取向方向。

如图 5 所示，液晶显示面板 13 的结构为：由第 1 偏振板 4 和第 2 偏振板 8 将液晶层 6 夹在中间。液晶层 6 具有往厚度方向扭 90 度的 TN 取向。

将第 1 偏振板 4 和第 2 偏振板 8 的透射轴设定成相互正交。将偏振光选择反射板 12 的透射轴设定成与第 1 偏振板 4 同方向。反射轴则设定成与该透射轴正交。

通过利用这种结构，从偏振光选择反射板 12 的背面入射的周围光可几乎无损耗地通过第 1 偏振板 4，因而即使在强周围光的环境下也能获得充分的可见性。

例如，直射阳光下(60000 勒)，普通透射型液晶显示装置的背后照明光亮度相对于液晶显示面板表面反射不充分，因而对比度降低到 10 以下。与此相反，本实施方式的液晶显示装置 100 通过利用来自背面的光能确保对比度为 20 以上，可确认能显示非常美丽的图像。又由于在液晶显示装置 100 的最深背面侧配置偏振光选择反射板 12，不能从背面确认显示，可确认能充分保护隐私。

接着，用图 1 说明所述液晶层 6 为 TN 层时的显示方法。图 1 是示出本实施方式的液晶显示装置 100 的概略组成和画面显示原理的剖视图。这里，说明将第 1 偏振板 4、第 2 偏振板 8 和偏振光选择反射板 12 的轴组成如下文所述那样设定成对纸面平行的方向(下文当作 x 方向(图 5 所示的 x 方向))或垂直的方向(下文当作 y 方向(图 5 所述的 y))的情况。

图 1 中，将第 1 偏振板 4 的透射轴设定成 x 方向(第 1 偏振状态)，第 2 偏振板 8 的透射轴设定成 y 方向(第 2 偏振方向)。将偏振光选择反射板 12 的反射轴设定成 y 方向，透射轴设定成 x 方向。

液晶显示装置 100 能利用背后照明 14 发出的光和照射到背面的周围光来显示画面。

首先，利用图 1 说明照射到液晶显示装置 100 的背面的周围光(无偏振的光)

Microsoft Exhibit 1002 - Page 803
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

的运作。图 1、图 8、图 9、图 12 和图 13 中，双向箭头号、两方向箭头号和带圈的×号分别表示光的偏振状态。即，双向箭头号表示 x 方向，两方向箭头号表示无偏振状态，带圈的×号表示 y 方向。如图 1 所示，照射到液晶显示装置 100 的背面的周围光中，偏振光选择反射板 12 反射 y 方向的线偏振光，并透射 x 方向的线偏振光。穿透偏振光选择反射板 12 的 x 方向的线偏振光(第 1 线偏振光)到达液晶显示面板 13。然后，不改变偏振方向地穿透第 1 偏振板 4 后，由液晶层 6 将偏振方向旋转 90 度，变成 y 方向线偏振光(第 2 线偏振光)。进而，该光不改变偏振方向地穿透第 2 偏振板 8，到达观察者处。

这样，照射到液晶显示装置 100 的背面的周围光(无偏振的光)中，y 方向的线偏振光在偏振光选择反射板 12 上反射。因此，观察者从液晶显示装置 100 的背面侧观察时，就象看到镜子那样。所以，观察者从液晶显示装置 100 的背面侧不能确认显示画面，可保护隐私。

偏振光选择反射板 12 透射周围光中的 x 方向线偏振光。于是，该光用于液晶显示装置 100 的画面显示。由此，能在画面显示中有效利用照射到液晶显示装置 100 的背面的周围光。即，能实现在周围光强的环境下也可作良好画面显示的液晶显示装置。

接着，说明背后照明 14 发出的光的运作。如上文所述，该光受导光板 2 上形成的散射加工面 3 散射，分成上方向的光和下方向的光。上方向的光到达液晶显示面板 13，下方向的光到达偏振光选择反射板 12。

所述上方向的光(无偏振的光)通过第 1 偏振板 4 后，变成 x 方向线偏振光。进而，在液晶层 6 使偏振方向旋转 90 度，形成 y 方向线偏振光。该光不改变偏振方向地通过第 2 偏振板 8 后，到达观察者处。

另一方面，所述下方向的光(无偏振的光)中，由偏振光选择反射板 12 反射 y 方向偏振分量，使其到达液晶显示面板 13。x 方向线偏振光则穿透偏振光选择反射板 12，往背面侧出射。所述到达液晶显示面板 13 的 y 方向线偏振分量的反射光由于其偏振方向与第 1 偏振板 4 的透射轴方向不同，被第 1 偏振板 4 吸收。因此，该下方向的光不用于画面显示。

这里，将偏振光选择反射板 12 的反射轴和透射轴设定成反射 y 方向线偏振

Microsoft Exhibit 1002 - Page 804
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

光且透射 x 方向线偏振光，但不限于此，也可将偏振光选择反射板 12 的透射轴取为往 y 方向扭转 0 度至 90 度中的任意角度的配置。由此，能控制从背后照明 14 反射到偏振光选择反射板 12 的光和入射到液晶显示装置 100 的背面的周围光的利用程度。

这里，说明了使用反射规定的线偏振光并使与其垂直的线偏振光透射的偏振光选择反射板 12 的情况，但不限于此，使用反射规定的圆偏振光并使与其相反地旋转的圆偏振光透射的圆偏振光选择反射板，也能得到同样的效果。这时，通过在圆偏振光选择反射板与导光板之间配置相位差板，选择任意相位差，能获得与上述改变偏振光选择反射板 12 的透射轴方向同样的效果。

实施方式 2

根据图 6～图 9 说明本发明另一实施方式如下。为了说明方便，对具有与上述实施方式 1 说明的构件相同的功能的构件标注相同的标号，并省略其说明。能对本实施方式组合并应用上述实施方式 1 所述的各种特征。

图 6 是示出本实施方式的液晶显示装置 101 的概略组成的剖视图。

上述实施方式 1 的液晶显示装置构成背后照明 14 中，在液晶显示面板 13 的相反侧设置偏振光选择反射板 12。与此相反，本实施方式的液晶显示装置 101 通过在背后照明 14 的背面侧除设置偏振光选择反射板 212 外，还设置偏振控制液晶板 15，能更有效地利用背后照明 14 发的光。

液晶显示装置 101 具有光源 1 和导光板 2 组成的背后照明 14、液晶显示面板(液晶显示媒体)13、偏振控制液晶板(偏振控制液晶媒体)15 以及偏振光选择反射板(偏振光选择反射部件)212。相对于背后照明 14，将液晶显示面板 13 设在表面侧，将偏振光选择反射板 212 设在背面侧。在背后照明 14 与偏振光选择反射板 212 之间，配置偏振控制液晶板 15。

该组成中，偏振控制液晶板 15 能根据有没有施加驱动电压控制通过其本身的光的偏振方向。由此，能在画面显示中有效利用从背后照明 14 往下方向照射的光。

所述偏振控制液晶板 15 具有第 1 透明衬底 9、第 1 透明电极 1002、偏振控

Microsoft Exhibit 1002 - Page 805
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

制用液晶层 10、第 2 透明电极 1004、第 2 透明衬底 11 以及驱动电路 1006。构成将偏振控制用液晶层 10 夹在第 1 透明衬底 9 与第 2 透明衬底 11 之间，并且在表面侧设置第 1 透明衬底 9，在背面侧设置第 2 透明衬底 11。

第 1 透明衬底 9 和第 2 透明衬底 11 分别通过第 1 透明电极 1002 和第 2 透明电极 1004，接触偏振控制用液晶层 10。这里，将第 1 透明电极 1002 和第 2 透明电极 1004 配置在一个面，使其 至少包含液晶显示面板 13 的画面显示区，并且由驱动电路 1006 同时驱动整个偏振控制用液晶层 10。

偏振控制用液晶层 10 由例如 TN 液晶组成。本实施方式中，偏振控制用液晶层 10 对入射到其本身且通过的线偏振光进行未施加电压时使偏振方向旋转 90 度的控制，并进行施加电压时使偏振方向不旋转的控制。液晶层 10 不限于 TN 液晶，只要是能控制通过的光的偏振状态的液晶即可。

作为这种液晶，可例如举出平行取向液晶。此情况下，通过将其相位差设定成 λ/2，与 TN 液晶时相同，也能将线偏振光扭转 90 度。而且，通过施加电压，使液晶分子对衬底垂直取向时，相位差消失，通过的光的偏振轴无变化。这样，使用平行取向液晶，也能进行与 TN 液晶完全相同的运作。

接着，图 7 示出液晶显示装置 101 轴控制偏振方向的构件的轴组成。图 7 中，作为控制偏振方向的构件，举出液晶显示面板 13、偏振控制用液晶层 10 以及偏振光选择反射板 212。液晶显示面板 13 的轴组成与实施方式 1 的相同。因此，这里说明偏振控制用液晶层 10 和偏振光选择反射板 212 的轴组成。

这里，10a 和 10b 分别表示偏振控制用液晶层 10 的表面侧液晶分子层和背面侧液晶分子层。如图 7 所示，偏振控制用液晶层 10 具有往厚度方向扭转 90 度的 TN 取向。

将偏振光选择反射板 212 的透射轴设定成与第 1 偏振板 4 的透射轴正交。而且，将反射轴设定成与该透射轴正交。这里，将住友 3M 公司制造的 D-BEF 膜用作液晶显示装置 101 的偏振光选择反射板 212。然而，作为偏振光选择反射板 212，不限于此，也可使用将 Al 薄膜按小于或等于 1/λ波长形成缝隙状的线栅偏振板等。偏振光选择反射板 212 的轴组成也不限于此，可将透射轴设定成对第 1 偏振板 4 的透射轴平行。

Microsoft Exhibit 1002 - Page 806
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

上述那样设定轴组成时，不对偏振控制用角 10 施加电压的状态下，穿透偏振光选择反射板 212 的周围光的线偏振光被偏振控制用液晶层 10 扭转 90 度，变成与第 1 偏振板 4 的透射轴相同。于是，能几乎无损耗地通过第 1 偏振板 4，所以即使强周围光下，也能获得充分的可见性。

例如，直射阳光下(60000 勒)，普通透射型液晶显示装置的背后照明光亮度相对于液晶显示面板表面反射不充分，因而对比度降低到 10 以下。与此相反，液晶显示装置 101 通过利用来自背面的光，能确保对比度为 20 以上。因此，可提供在周围光强的环境下，也能显示非常美丽的图像的液晶显示装置。

但是，此情况下不能有效使用后面阐述的从背后照明 14 往下方向产生的光，所以在室内等周围光较弱的环境中，比普通透射型液晶显示装置暗。

因此，对偏振控制用液晶层 10 施加足够大的电压时，偏振控制用液晶层 10 的液晶分子以对衬底垂直的方式取向。由此，通过偏振控制用液晶层 10 的光的偏振状态不变。

这种状态下，在偏振光选择反射板 212 反射的来自导光板 2 的光不改变偏振状态地穿透偏振控制用液晶层 10，到达第 1 偏振板 4，因而可最有效地利用来自导光板 2 的光。可确认这时的画面显示为与普通透射型液晶显示装置完全相同的亮度。

这里，记载对偏振控制液晶板 15 施加足够大的电压的情况和不施加电压的情况，但也可通过施加其中间的电压，连续切换利用周围光的状态和利用导光板背面出射光的状态。

又，由于将偏振光选择反射板 212 配置在液晶显示装置 101 的最深背面侧，从背面不能确认显示，可充分保护隐私。

接着，用图 8 和图 9 详细说明上述液晶层 6 和偏振控制用液晶层 10 是 TN 层时的显示方法。这里，偏振光选择反射板 212 将轴组成设定成反射 x 方向的线偏振光，y 方向的偏振光则透射。

首先，说明在室内等周围光比较不强的环境中最有效利用光源 1 发出的光的情况。

如上文所述，从光源 1 出射的光受导光板 2 上形成的散射加工面 3 散射，

Microsoft Exhibit 1002 - Page 807
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

分成上方向出射光(无偏振的光)和下方向出射光(无偏振的光)。上方向出射光到达液晶显示面板 13，在通过第 1 偏振板 4 时，有选择地仅透射 x 方向偏振光，并且在液晶层 6 扭转 90 度，变成 Y 方向偏振光，穿透第 2 偏振板 6 后，到达观察者处。

另一方面，下方向出射光穿通偏振控制液晶板 15，到达偏振光选择反射板 212。然后，偏振光选择反射板 212 仅反射 x 方向线偏振光。对偏振控制液晶板 15 施加电压，使偏振控制用液晶层 10 为垂直取向状态时，被反射的 x 方向线偏振光不改变偏振方向地穿透偏振控制液晶板 15，到达液晶显示面板 13。于是，该光无损耗地穿透第 1 偏振板 4，经液晶层 6 和第 2 偏振板 8 到达观察者处。这样，通过对偏振控制液晶板 15 施加电压，能在画面显示中有效利用下方向出射光。

接着，用图 9 说明在周围光强的环境中有效利用来自背面的周围光的方法。这种环境下，通过不对偏振控制液晶板 15 施加电压，能在画面显示中有效利用来自背面的周围光。

从光源 1 出射的光入射到导光板 2，在导光板 2 上形成的散射加工面 3 进行散射，往上下方向出射。上方向出射光到达图像显示用的第 1 液晶显示面板 13，并通过第 1 偏振板 4 时，有选择地仅透射 x 方向线偏振光，在液晶层 6 将其扭转 90 度，变成 y 方向线偏振光，穿透第 2 偏振板 8 后，到达观察者处。

下方向出射光穿通偏振控制液晶板 15，到达偏振光选择反射板 212。不对偏振控制液晶板 15 施加电压时，偏振控制用液晶层 10 为 TN 液晶。因而，偏振光选择反射板 212 上反射的 x 方向线偏振光通过偏振控制用液晶层 10，则扭转 90 度，变成 y 方向线偏振光，被第 1 偏振板 4 吸收。因此，该下方向出射光不用于画面显示。

另一方面，从偏振光选择反射板 212 的背面侧入射的周围光通过偏振光选择反射板 212 时，变成 y 方向线偏振光。进而，通过偏振控制液晶板 15，则扭转 90 度，变成 x 方向线偏振光。然后，该光无损耗地穿透液晶显示面板 13 的第 1 偏振板 4，经液晶层 6 和第 2 偏振板到达观察者处。这样，通过形成不对偏振控制液晶板 15 施加电压的状态，能实现周围光强的环境下画面显示也良

Microsoft Exhibit 1002 - Page 808
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

好的液晶显示装置 101。

根据以上所述，通过设置利用加不加电压控制光偏振方向的偏振控制液晶板 15，可实现即使周围光比较不强的环境下也能在画面显示中有效利用来自光源 1 的光的液晶显示装置。

又，将偏振光选择反射板 212 的轴组成设定成 x 方向线偏振光反射，且 y 方向偏振光透射，但不限于此，也可设定成 y 方向线偏振光反射，且 x 方向偏振光透射。

此情况下，通过周围光强的环境下施加偏振控制用液晶层 10 的驱动电压，周围光比较不强的环境下不施加该驱动电压，可实现能有效利用来自所述光源 1 的光的液晶显示装置。

实施方式 3

根据图 10～图 13 说明本发明又一实施方式如下。为了说明方便，对具有与上述实施方式 1 和实施方式 2 说明的构件相同的功能的构件标注相同的标号，并省略其说明。也能对本实施方式组合并使用上述实施方式 1 和实施方式 2 所述的各种特征。

实施方式 1 或实施方式 2 中，将透射或反射线偏振光的构件用作偏振光选择反射板，但可以说使用其它偏振光选择反射板也相同。本实施方式说明将透射或反射圆偏振光的构件用作偏振光选择反射板的情况。

图 10 示出液晶显示装置 102 的截面组成。液晶显示装置 102 具有液晶显示面板 13、光源 1、导光板 2、偏振控制液晶板 315、相位差板 16 以及偏振光选择反射板 312。由光源 1 和导光板 14 形成背后照明 14。相对于背后照明 14，在最深背面侧设置偏振光选择反射板 12。从偏振光选择反射板 312 往背后照明 14，依次设置相位差板 16 和偏振控制液晶板 315。

所述偏振光选择反射板 315 具有第 1 透明衬底 39、第 1 透明电极 3002、偏振控制用液晶层 310、第 2 透明电极 3004、第 2 透明衬底 311 以及驱动电路 3006。构成将偏振控制用液晶层 310 夹在第 1 透明衬底 39 与第 2 透明衬底 311 之间，并且在表面侧设置第 1 透明衬底 39，在背面侧设置第 2 透明衬底 311。

Microsoft Exhibit 1002 - Page 809
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

第 1 透明衬底 39 和第 2 透明衬底 311 分别通过第 1 透明电极 3002 和第 2 透明电极 3004，接触偏振控制用液晶层 310。这里，将第 1 透明电极 3002 和第 2 透明电极 3004 配置在一个面，使其至少包含液晶显示面板 13 的画面显示区，并且由驱动电路 3006 同时驱动整个偏振控制用液晶层 310。

所述偏振控制用液晶层 310 是迟滞约 $\lambda / 2(\Delta n \bullet d = 220$ nm，其中Δn 是液晶的双折射，d 是液晶单元厚度)的平行取向的向列型液晶层。

所述相位差板 16 使从背面侧入射的圆偏振光成为线偏振光。

偏振光选择反射板 312 使入射的右旋圆偏振光反射，并使左旋圆偏振光透射。液晶显示装置 103 中，将日东电工制造的 PCF 膜用作偏振光选择反射板 103，但不限于此，也可用使胆甾醇型液晶分散成高分子的胆甾醇型液晶聚合物等。还可以是使左旋圆偏振光反射，并使右旋圆偏振光透射的偏振光选择反射板。

接着，图 11 示出液晶显示装置 102 中控制偏振方向的构件的轴组成。作为控制偏振方向的构件，举出液晶显示面板 13、偏振控制用液晶层 310 和偏振光选择反射板 312。液晶显示面板 13 的轴组成与实施方式 1 的相同。因此，这里说明偏振控制用液晶层 310 和偏振光选择反射板 312 的轴组成。

这里，310a 和 310b 分别表示偏振控制用液晶层 310 的表面侧液晶分子层和背面侧液晶分子层。如图 11 所示，偏振控制用液晶层 310 具有不往厚度方向扭转的平行取向，将其 取向方向设定成对第 1 偏振板 4 的透射轴右扭 45 度的方向。

将相位差板 16 的滞后轴设定成取与偏振控制液晶层 310 的取向方向扭转 90 度的方向并且其迟滞为 $\lambda / 4$。

配置偏振光选择反射板 312 的透射旋转方向为左旋的这种反射板。

使用上述结构，则不对偏振控制用液晶层 310 施加电压的状态下，从偏振光选择反射板 312 背面侧入射的左旋线偏振光因相位差板 16 而变成垂直于第 1 偏振板 4 的透射轴的方向的线偏振光，进而因偏振控制用液晶层 310 而成为平行于第 1 偏振板 4 的透射轴的方向的线偏振光。因此，能几乎无损耗地通过第 1 偏振板 4，所以即使强周围光下也能获得充分的可见性。

Microsoft Exhibit 1002 - Page 810
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

例如，直射阳光下(60000 勒)，普通透射型液晶显示装置的背后照明光亮度相对于液晶显示面板表面反射不充分，因而对比度降低到 10 以下。与此相反，液晶显示装置 103 通过利用来自背面的光，能确保对比度为 20 以上，可确认能显示非常美丽的图像的液晶显示装置。但是，此情况下不能有效使用导光板 2 往下方向产生的光，所以在室内等周围光较弱的环境中，比普通透射型液晶显示装置暗。

因此，对偏振控制用液晶层 310 施加足够大的电压时，偏振控制用液晶层 310 的液晶分子上升，通过其本身的光的偏振状态不变。此状态下，从导光板 2 往下方向出射的光中，右旋圆偏振光在偏振光选择反射板 312 上反射后，通过相位差板 16，从而成为与第 1 偏振板 4 的透射轴平行的线偏振光。这里，偏振控制用液晶层 310 被施加充分的电压，作垂直取向，因而偏振状态不变，能最有效利用来自导光板的光。此状态下，可确认是与普通透射型液晶显示装置完全相同的亮度。

这里，记载对偏振控制用液晶层 310 施加足够大的电压的情况和不施加电压的情况，但也可通过施加其中间的电压，连续切换利用周围光的状态和利用从导光板 2 往下方向出射光的状态。

又，由于将偏振光选择反射板 312 配置在液晶显示装置 301 的最深背面侧，从背面不能确认显示，可充分保护隐私。

接着，用图 12 和图 13 详细说明液晶显示装置 103 的显示方法。这里，将偏振光选择反射板 312 设定成使右旋圆偏振光反射，并使左旋圆偏振光透射。

首先，用图 12 说明室内等周围光不强的环境中最有效利用来自背后照明 14 的光的情况。

如上文所述，从背后照明 14 往上方向出射的光通过偏振板 4 时，有选择地仅透射 x 方向线偏振光，在液晶层 6 将其扭转 90 度，变成 y 方向线偏振光后，穿通偏振板 5，到达观察者处。

另一方面，往下方向出射的光，经偏振控制用液晶层 310、相位差板 16，到达偏振光反射板 12。下方向出射光到达偏振光选择反射板 312 时，尚为杂乱偏振光未变。然而，偏振光选择反射板 312 使右旋圆偏振光反射、左旋圆偏振

Microsoft Exhibit 1002 - Page 811
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

光透射。被反射的右旋圆偏振光通过相位差板 16 时，偏振状态变化，如果将相位差板 16 设定为 λ/4 的状况，就变成对滞后轴右偏 45 度方向的线偏振光。这里，为了简便，定为变成 x 方向的线偏振光。

进而，偏振控制用液晶层 310 上施加电压而形成垂直取向状态时，该 x 方向线偏振光不改变偏振状态地到达液晶显示面板 13。于是，该光无损耗地穿透第 1 偏振板 4，经液晶层 6 和第 2 偏振板 8，到达观察者处。

接着，用图 13 说明周围光强的环境中有效利用来自液晶显示装置 103 的背面侧的入射光的方法。

与图 12 相同，光源 1 发出的光中，因导光板 2 的散射加工面 3 而往上方向出射的光也经液晶显示面板 13，到达观察者处。

另一方面，往下方向出射的光穿通偏振控制液晶层 310 和相位差板 16，到达偏振光选择反射板 312。偏振选择反射板 312 上反射的右旋圆偏振光因相位差板 16 而变成 x 方向线偏振光。

进而，偏振控制用液晶层 310 上不施加电压，形成平行取向状态。这里，偏振控制用液晶层 310 在平行取向状态下，与相位差板 16 的滞后轴垂直的方向上具有滞后轴，并将其相位差设定为 λ/2。利用此组成，x 方向线偏振光穿通偏振控制用液晶层 310，从而扭转 90 度，变成 y 方向线偏振光。因此，上述 x 方向线偏振光一到达第 1 偏振板 4 就被吸收，所以不能有效利用。

然而，从背面入射的周围光穿透偏振光选择反射板 312 时，变成左旋圆偏振光，进而通过相位差板 16、偏振控制用液晶层 310，则变成 x 方向线偏振光，到达液晶显示面板 13，可无损耗地利用。

这样在液晶显示面板 13 配置第 1 偏振板 4，并且这时由于仅利用 x 方向线偏振光，配置在背面侧的偏振光反射板 12 即使仅透射左旋圆偏振光也不发生损耗，可全然有效利用光。

这时，图 12 中，配置 TN 液晶，代替偏振控制用液晶层 310 的平行取向液晶，也能与平行取向液晶相同地将偏振轴扭转 90 度。而且，通过在偏振控制用液晶层 310 上施加电压，使液晶分子垂直取向，则通过的光的偏振方向不变。这样使用 TN 液晶，也可进行与平行取向液晶完全相同的运作。

Microsoft Exhibit 1002 - Page 812
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

实施方式 4

根据图 14 说明本发明又一实施方式如下。为了说明方便，对具有与上述实施方式说明的构件相同的功能的构件标注相同的标号，并省略其说明。也能对本实施方式组合并使用上述实施方式所述的各种特征。

图 14 是示出本实施方式的液晶显示装置 104 的组成的剖视图。如该图所示，液晶显示装置 104 从正面方往背面侧，具有液晶显示面板(液晶显示媒体)13、背后照明 14、图中未示出的所述偏振光选择反射板(偏振光选择反射部件)12 和棱镜阵(光折射组件)17。将棱镜阵 17 设在液晶显示装置 104 的最深背面侧的位置。

液晶显示装置 104 由图 2(b)所示的壳体 613 覆盖外表面。该壳体 613 背面侧的采光窗 616 形成可从液晶显示面板 13 的整个背面采光的尺寸。可将所述棱镜阵 17 例如嵌入壳体 613 的采光窗 616。

液晶显示装置 104 除设置棱镜阵 17 及其作用外，还具有与实施方式 1 中所示的液晶显示装置 100 相同的组成和作用。

这里，将液晶显示装置 104 用于室外那样周围明亮的环境时，从液晶显示装置 104 背面的采光窗 616 采光，则液晶显示装置 104 的亮度提高，可见性改善。然而，通常以倾斜成显示面朝上的状态使用液晶显示面板 13。因此，该情况下，采光方位变成背面下方(对液晶显示装置 104 的背面垂直的入射方向变成倾斜向上)，得不到大采光效果。因此，如上所述，液晶显示装置 104 设置上述棱镜阵 17，以从光量较多的液晶显示装置 104 的背面上方采光。即，棱镜阵 17 具有将从斜上方对液晶显示装置 104 的背面入射的光折射到液晶显示装置 104 的正面方向的功能。

所述棱镜阵 17 由例如光折射膜组成，是具有并行设置多个棱镜 17a 的结构的透明基材。各棱镜 17a 具有对液晶显示面板 13 倾斜的倾斜面 17a1，该面边界前后折射率不同。

本实施方式中，棱镜阵 17 用折射率为 1.57 的透明基材形成，各棱镜 17a 具有对空气界面倾斜 22 度的倾斜面 17a1。此棱镜阵 17 的作为棱镜 17a 形成面的

Microsoft Exhibit 1002 - Page 813
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

凹凸面朝向液晶显示面板 13 方，而且以朝向液晶显示装置 104 的上方的状态配置倾斜面 17a1。

上述组成中，从液晶显示装置 104 的背面斜上方入射到液晶显示装置 104 的背面的光不是直线行进，而是由棱镜阵 17 折射到观察者观看液晶显示装置 104 的方向(液晶显示装置 104 的正面方向)。

表 1 示出在各种环境中测量照度的结果。测量环境为室外(直射阳光下)、室外(阴天)、室内、室内(走廊)、室内(窗口)，在各环境中分别将测量仪朝向上方、横方、下方进行测量。结果，各处的照度在任一场所均为：将测量仪朝向上方测量时与朝向下方测量时相比，具有后者的 3～6 倍的照度。根据此结果，能容易理解与从下方采光相比，从上方采光时获得采光效果大。

[表 1]

各处的照度测量结果(照度：勒)

测量环境	上方	横方	下方
室外(直射阳光下)	90000	20000	10000～15000
室外(阴天)	14000	10000	5000
室内	200～500	100～200	50～100
室内走廊	10～300	10～50	10～50
室内出口	1000～1500	700～1000	300～400

配置棱镜阵 17 的组成(液晶显示装置 104)和非那样的组成(从液晶显示装置 104 去除棱镜阵 17 的组成)中，测量显示装置的正面亮度时，尤其在室外和窗口处显著呈现采光效果不同，配置棱镜阵 17 时得到亮度高、可见性高的显示。

本实施方式中，将倾斜角 22 度、折射率 1.57 的棱镜阵运作光折射部件。然而，只要是具有将来自显示装置背面光量大的方位的光折射到观察者方位的作用的构件，就实质上没有问题，可用于本发明。可适当选择基材的质量和形状。例如，可用 3M 公司制造的称为 BEF 的形状与图 14 所示构件不同的棱镜阵和透射全息漫射件等。

Microsoft Exhibit 1002 - Page 814
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

实施发明用的最佳方式(具体实施方式)的说明书部分中完成的具体实施方式或实施例毕竟是说明本发明技术内容的，不应仅限于这种具体实例狭义地解释，可在本发明的精神和接着记述的权利要求书的范围内作各种变换并付诸实施。

工业上的实用性

本发明适合用于周围光强的环境下也要求画面显示良好的、例如有源矩阵式的透射型液晶显示装置。

Microsoft Exhibit 1002 - Page 815
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

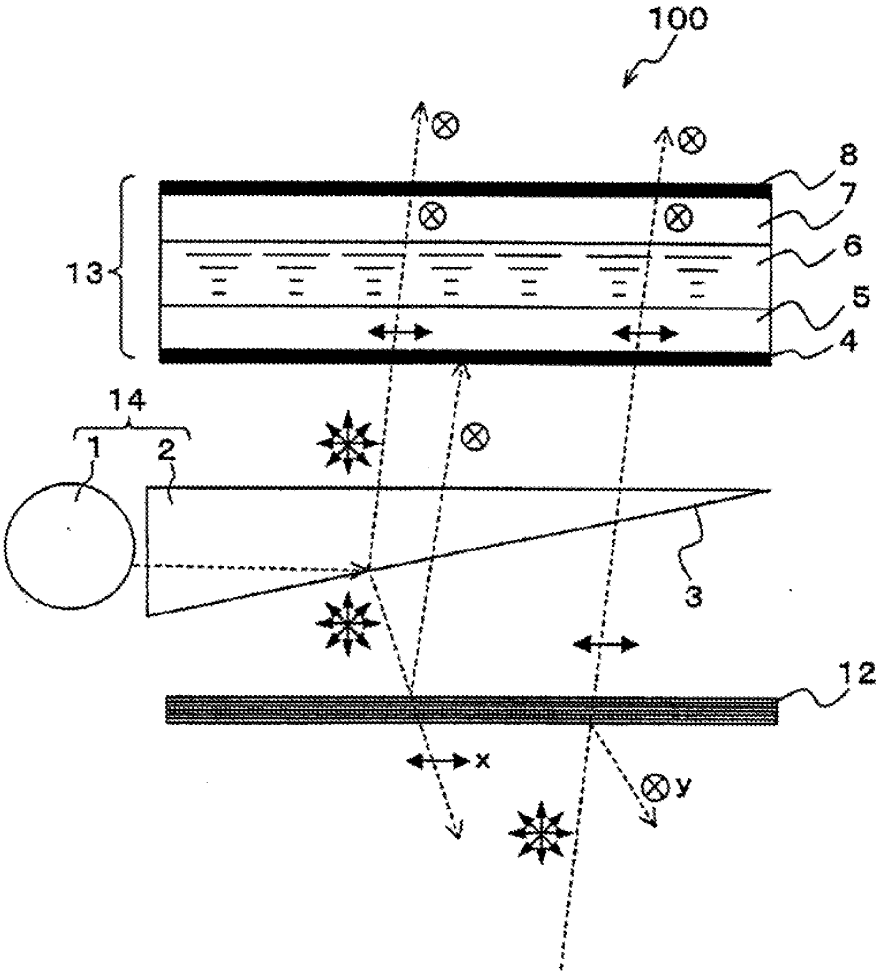


图 1

Microsoft Exhibit 1002 - Page 816
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

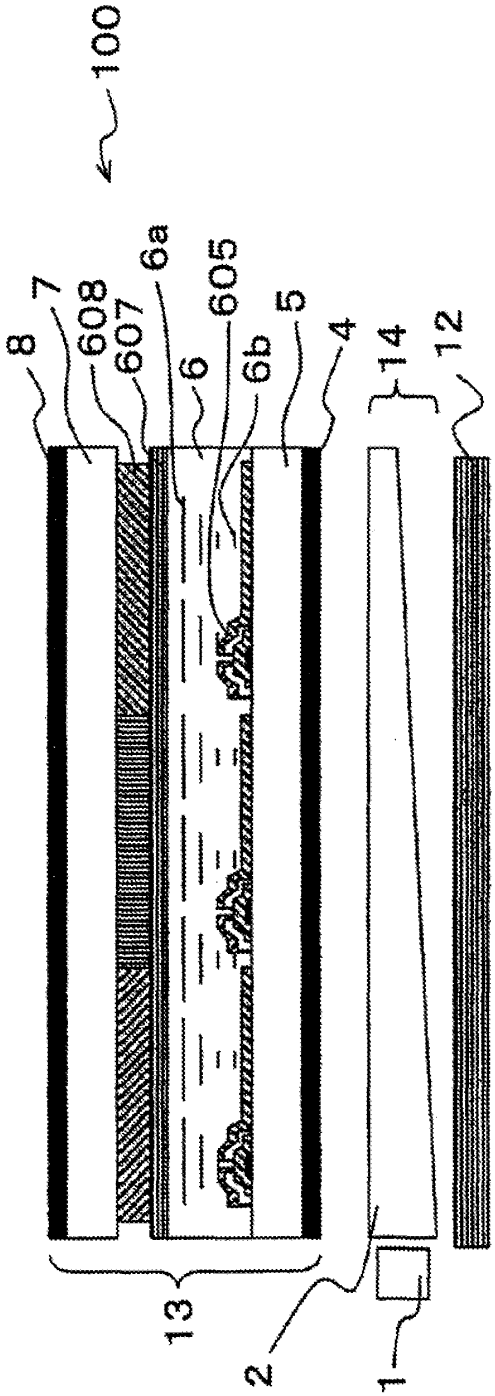


图 2(a)

Microsoft Exhibit 1002 - Page 817
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

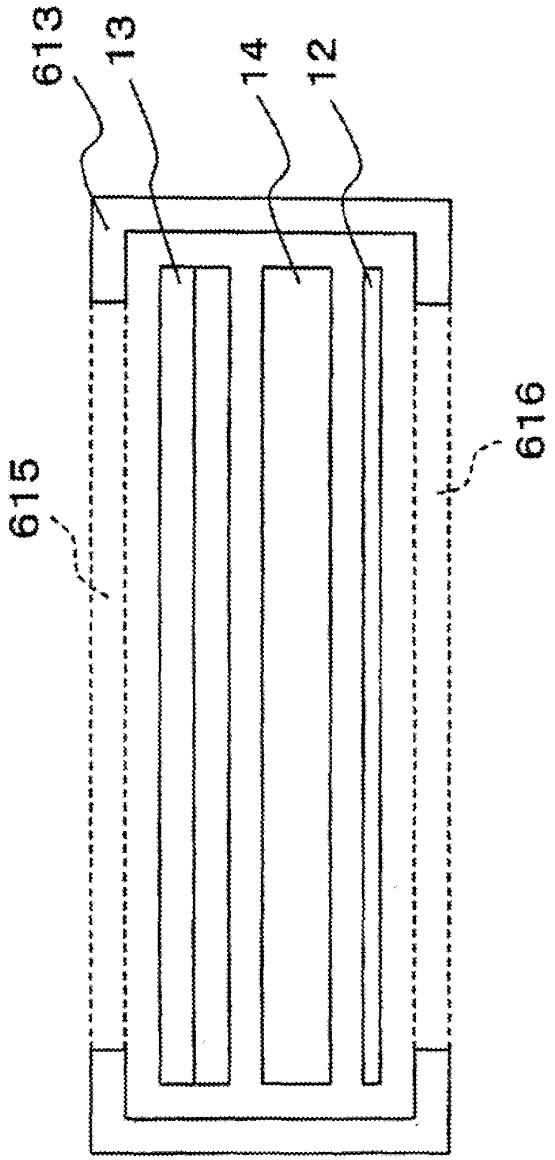


图 2(b)

Microsoft Exhibit 1002 - Page 818
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

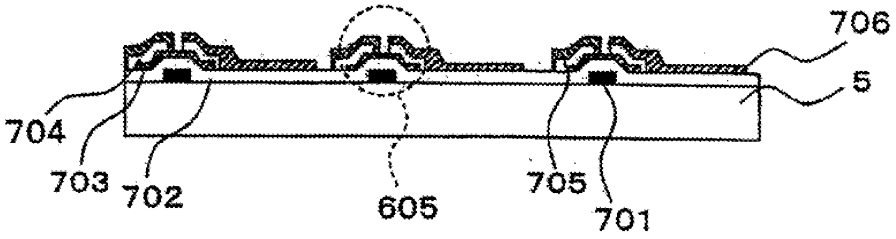


图 3

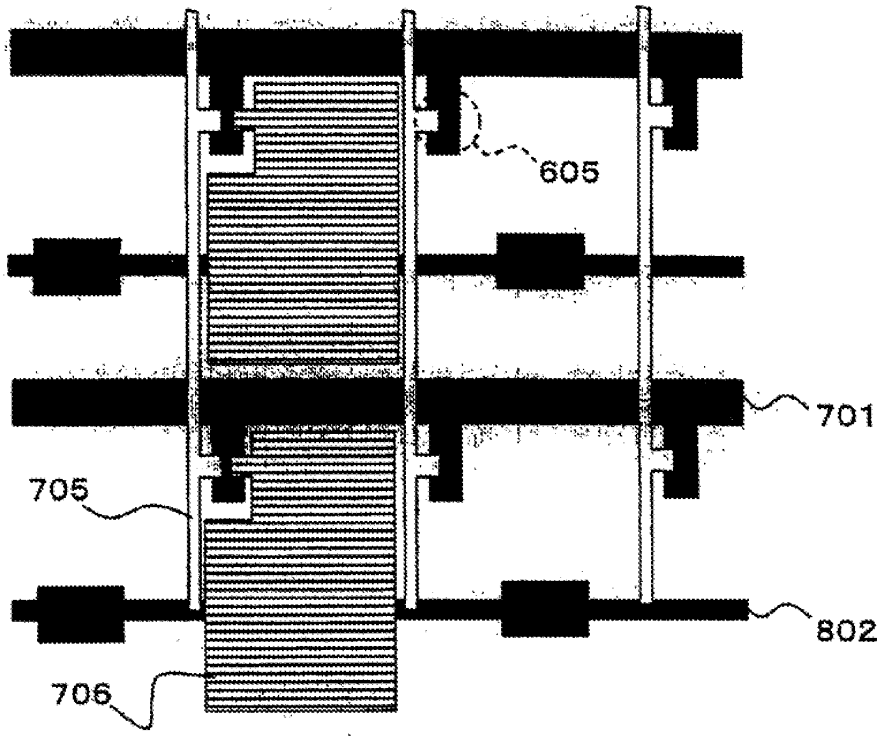


图 4

Microsoft Exhibit 1002 - Page 819
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

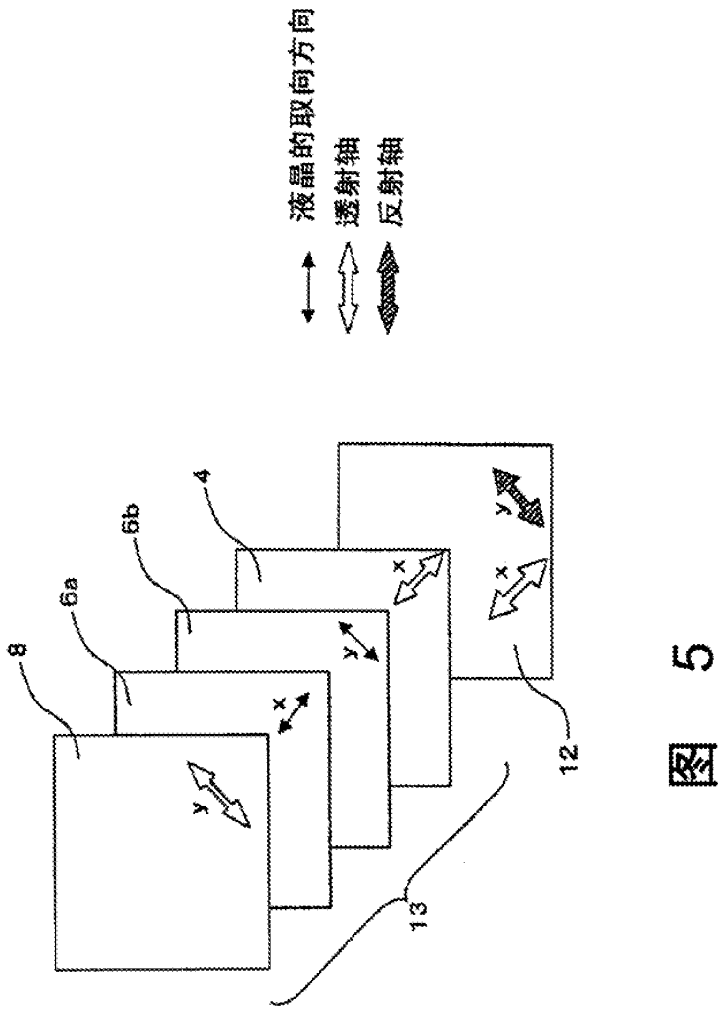


图 5

Microsoft Exhibit 1002 - Page 820
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

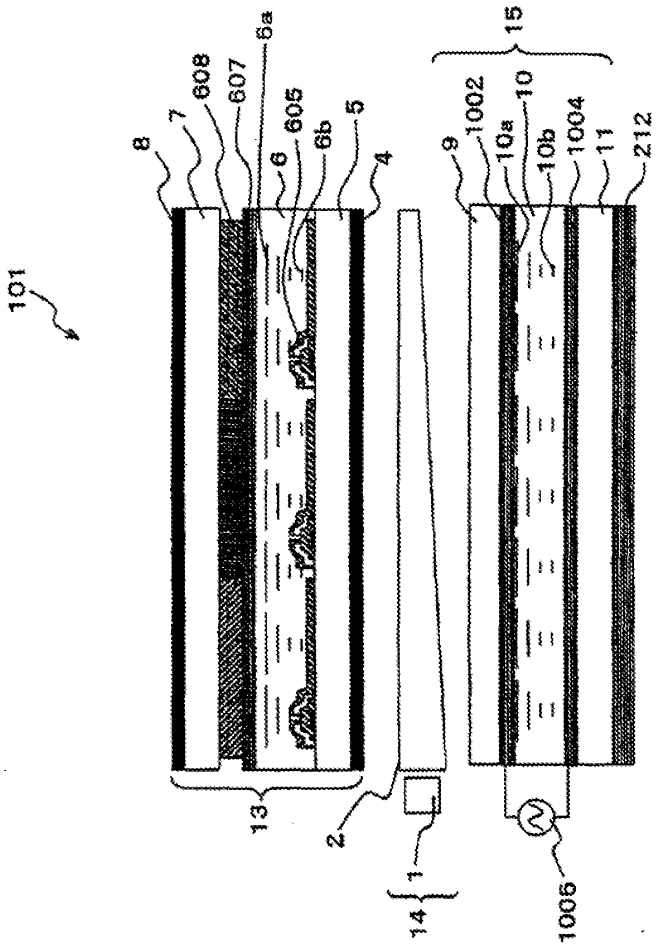


图 6

Microsoft Exhibit 1002 - Page 821
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

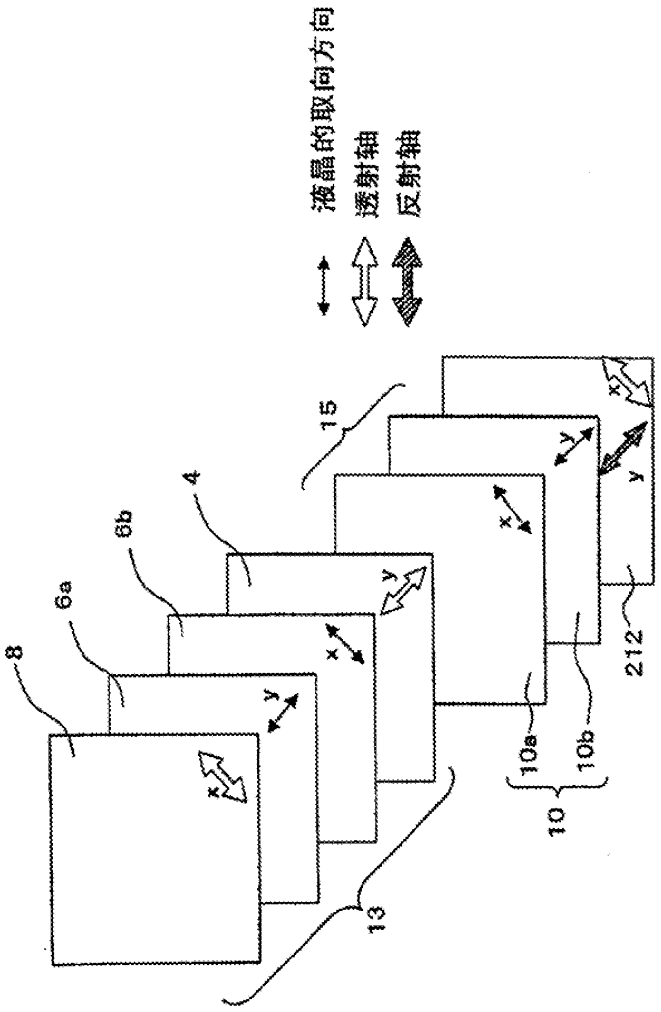


图 7

Microsoft Exhibit 1002 - Page 822
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

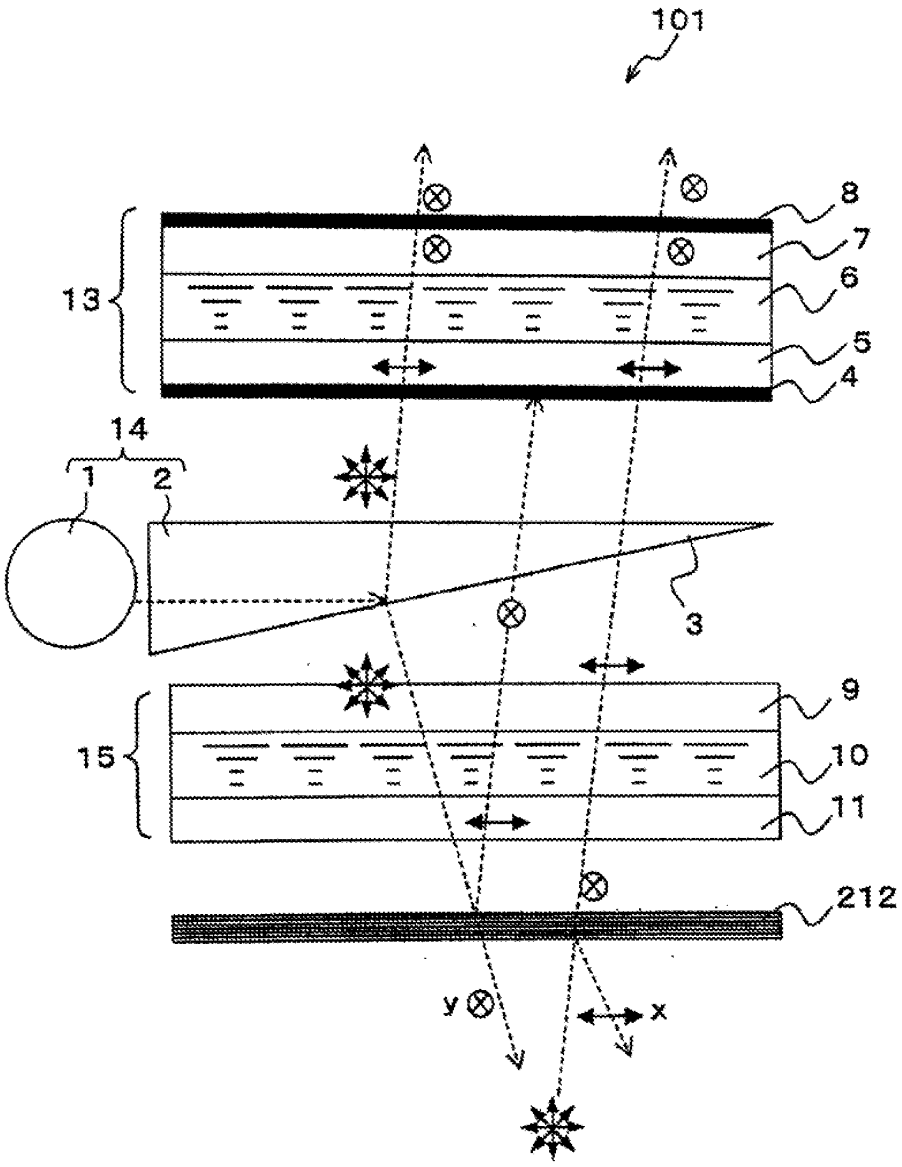


图 8

Microsoft Exhibit 1002 - Page 823
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

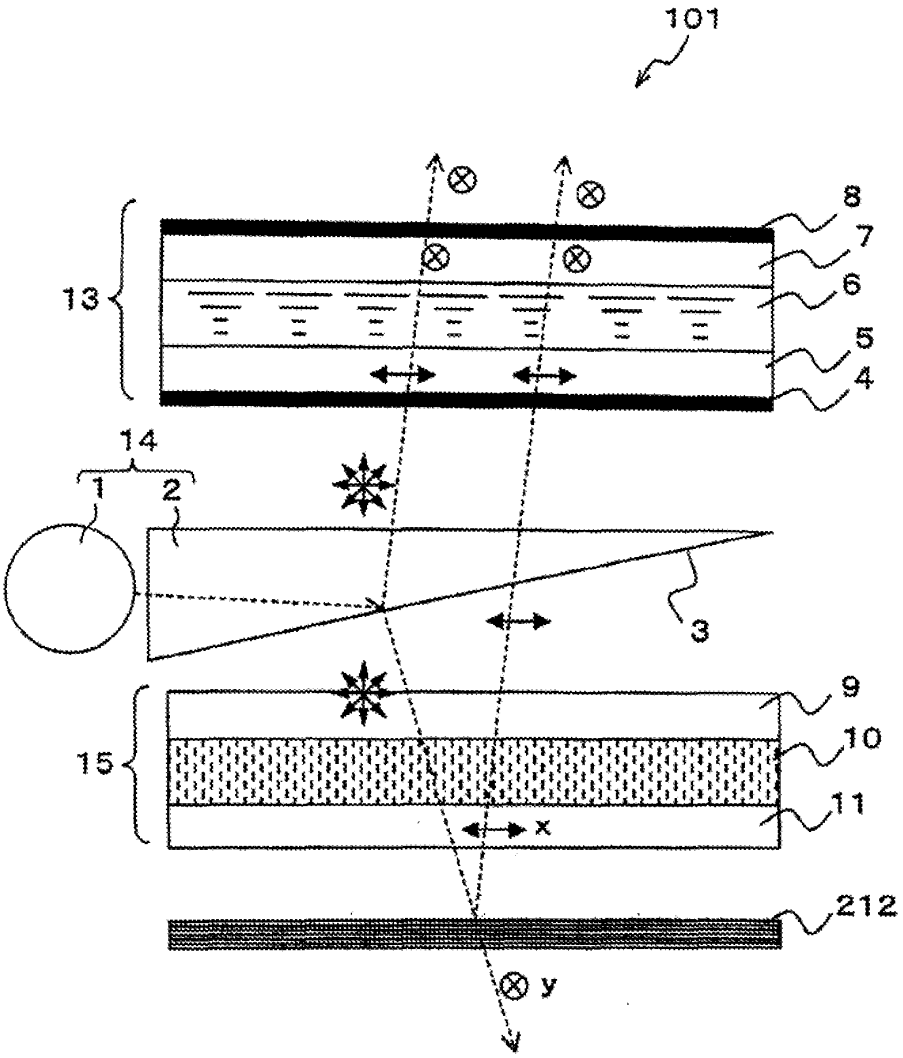


图 9

Microsoft Exhibit 1002 - Page 824
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

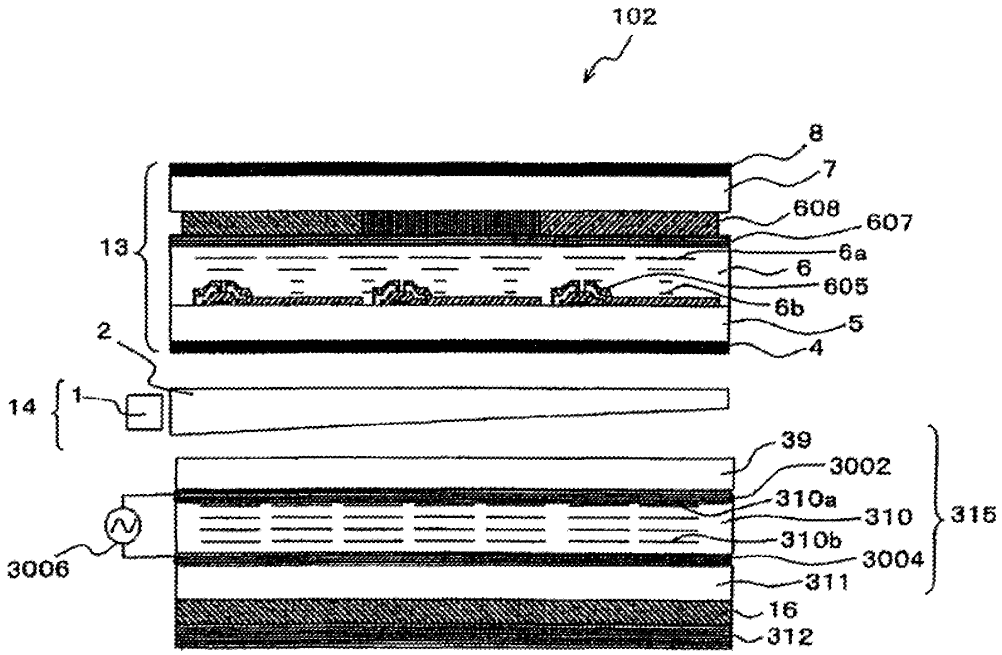


图 10

Microsoft Exhibit 1002 - Page 825
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

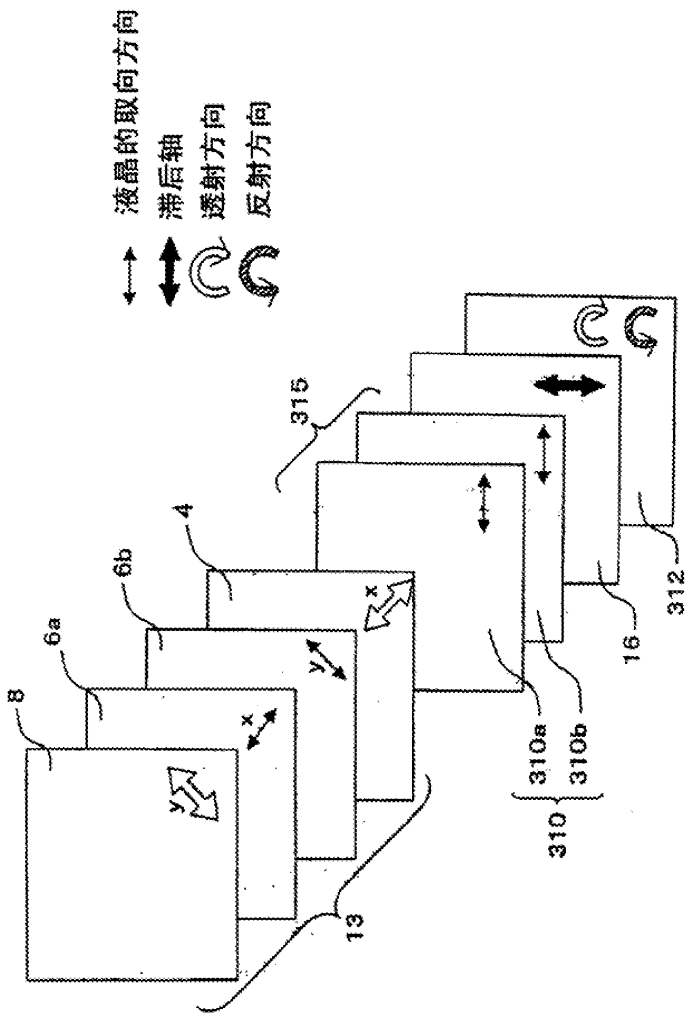


图 11

Microsoft Exhibit 1002 - Page 826
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

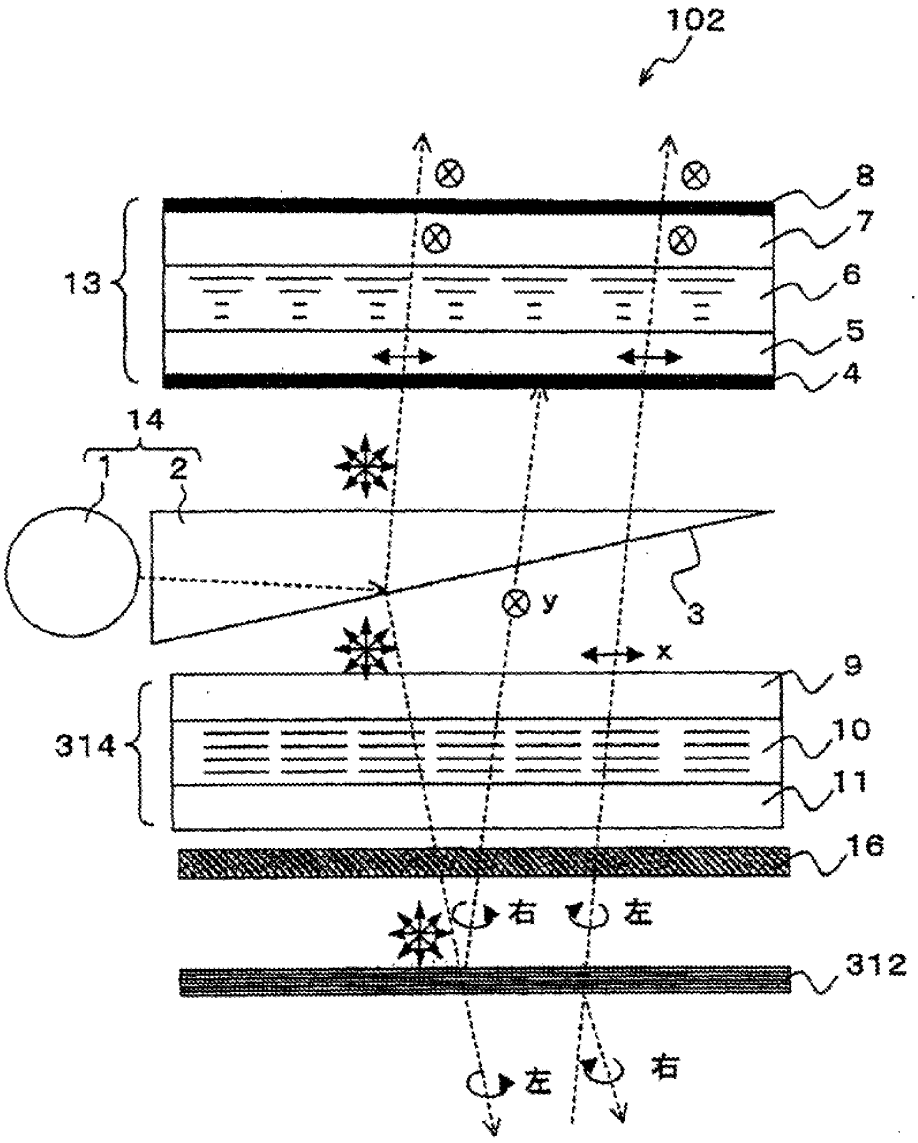


图 12

Microsoft Exhibit 1002 - Page 827
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

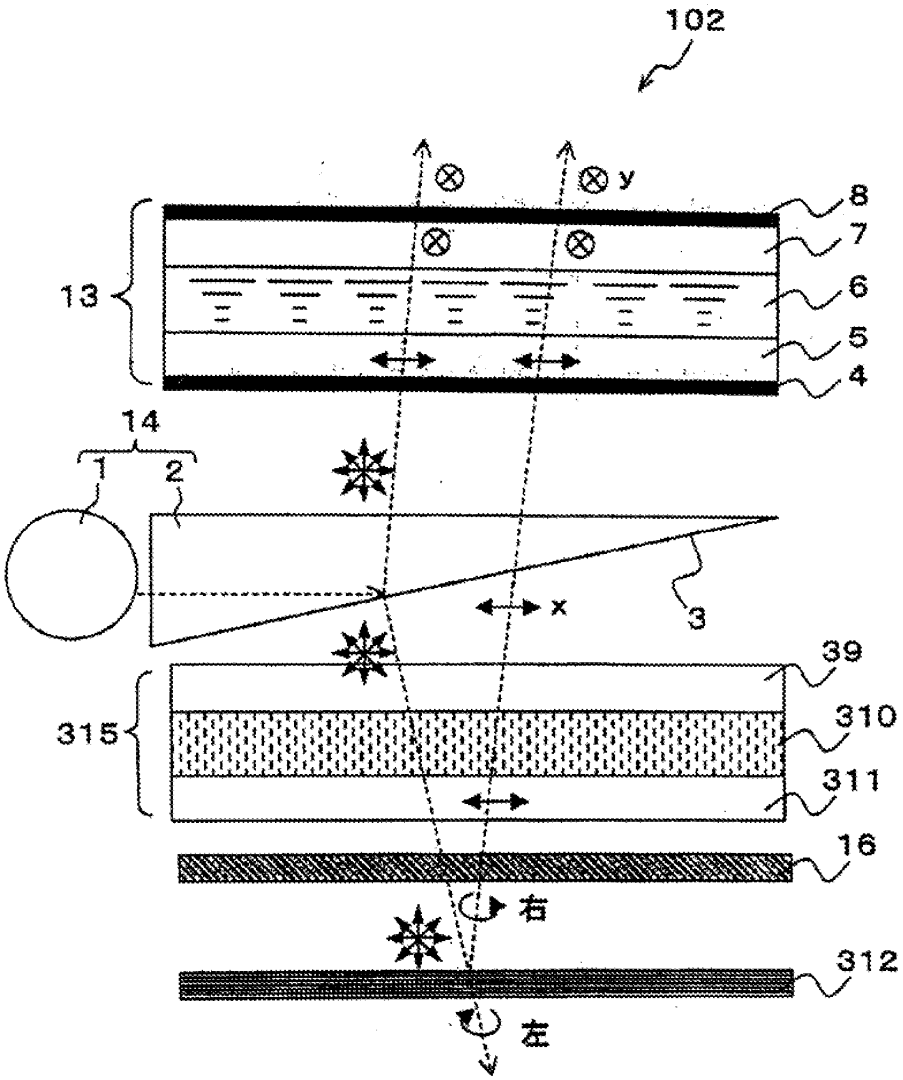


图 13

Microsoft Exhibit 1002 - Page 828
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

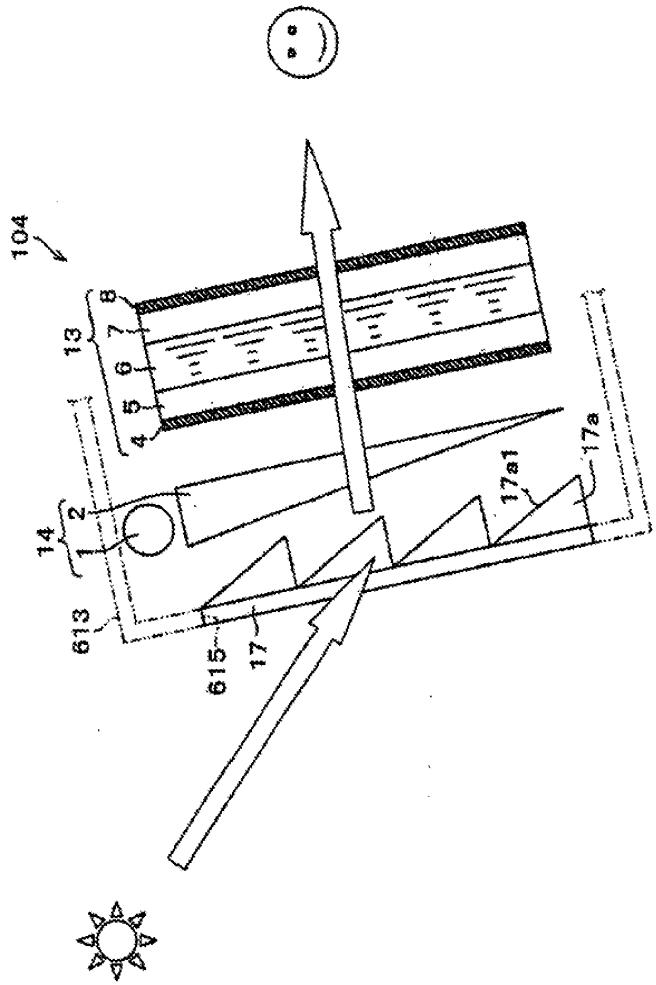


图 14

Microsoft Exhibit 1002 - Page 829
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Espacenet

Bibliographic data: CN1900785 (A) — 2007-01-24

Light conductive plate and back light module

Inventor(s): YANG XINGPENG YAN [CN] ± (XINGPENG,YAN YANG, ; YANG XINGPENG, ; YAN YINBAI, ; JIN GUOFAN)

Applicant(s): UNIV TSINGHUA [CN] ± (TSINGHUA UNIV)

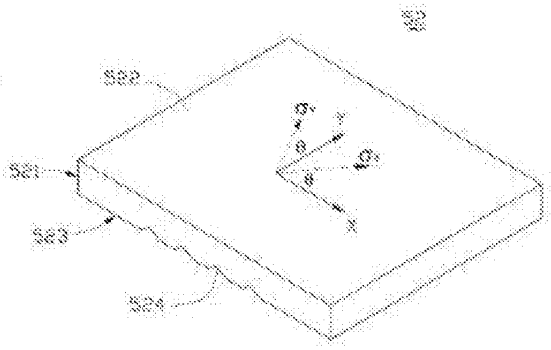
Classification: - international: *G02F1/1335*
- cooperative: **G02B6/0056**; G02B6/0038

Application number: CN2005136118 20050720

Priority number (s): CN2005136118 20050720

Also published as: CN100376970 (C) JP2007025699 (A) JP4516055 (B2) US2007076432 (A1) US7806537 (B2)

Abstract of CN1900785 (A)



Purpose of the disclosed light guiding plate is to solve issue of lower use ratio of light energy in current light guiding plate. The light guiding plate is birefringence light guiding plate of stress or strain. There are two principal stresses or two principal strains along two directions perpendicular to each other inside light guiding plate. Included angle between direction from one principal stress or principal strain and incident light face of the light guiding base plate is larger than 0 degree and smaller than 90 degree. Deference of principal stress between two principal stresses or Deference of principal strain between two principal strains generates approximate same phase delay for lights in multiple lengths inside the light guiding base plate. The phase delay is near to halfwave plate. The invention also discloses back light module of using the light guiding plate.

Microsoft Exhibit 1002 - Page 830
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Microsoft Exhibit 1002 - Page 831
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

[19] 中华人民共和国国家知识产权局

[51] Int. Cl.
G02F 1/1335 (2006.01)

[12] 发明专利申请公布说明书

[21] 申请号 200510036118.0

[43] 公开日 2007 年 1 月 24 日

[11] 公开号 CN 1900785A

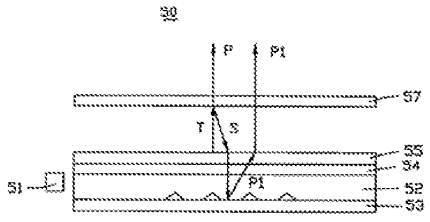
[22] 申请日 2005.7.20
[21] 申请号 200510036118.0
[71] 申请人 清华大学
地址 100084 北京市海淀区清华大学物理系
共同申请人 鸿富锦精密工业（深圳）有限公司
[72] 发明人 杨兴朋 严瑛白 金国藩
权利要求书 4 页 说明书 10 页 附图 3 页

[54] 发明名称

导光板与背光模组

[57] 摘要

本发明涉及一种导光板，旨在解决现有技术的导光板的光能利用率较低的问题。该导光板为应力或应变双折射导光板，其内具有分别沿着两个相垂直的方向的两个主应力或主应变，该主应力或主应变之一的方向和导光板入光面的夹角大于 0 度小于 90 度，该两个主应力或主应变的主应力差或主应变差对导光板内的多个波长光产生近似相同的相位延迟，且该相位延迟接近半波片的性能。本发明还涉及一种采用该导光板的背光模组。



Microsoft Exhibit 1002 - Page 832
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

1. 一种导光板，包括入光面、连接于该入光面的出光面和相对于该出光面的底面，其特征在于：该导光板为应力或应变双折射导光板，其内具有分别沿着两个相垂直的方向的两个主应力或主应变，该主应力或主应变之一的方向和入光面的夹角大于 0 度小于 90 度，该两个主应力或主应变的主应力差或主应变差对该导光板内的多个波长光中的每两个波长光的相位延迟满足以下条件：

$$\delta_1 = 2k_1\pi + \pi \quad k_1=0,1,2,3,4,\ldots\ldots$$

$$\delta_2 = 2k_2\pi + \pi \quad k_2=0,1,2,3,4,\ldots\ldots$$

$$\delta_1 - \delta_2 = 2\pi d\Delta\left(\frac{C_1}{\lambda_1} - \frac{C_2}{\lambda_2}\right) = 2m\pi \quad m=0,1,2,3,4,\ldots\ldots$$

其中，δ_1和δ_2分别表示以第一波长光和第二波长光表示的该两个波长光的相位延迟，d为导光板的厚度、C_1和C_2分别表示该两个波长光的应力光学常数或应变光学常数，Δ表示主应力差或主应变差，λ_1和λ_2分别表示该两个波长光的波长。

2. 如权利要求 1 所述的导光板，其特征在于：该夹角优选为 45 度。

3. 如权利要求 1 所述的导光板，其特征在于：当该导光板内共有三个波长光时，该主应力差或主应变差对该导光板内的三个波长光的相位延迟满足以下条件，

$\delta_1 = 2k_1\pi + \pi \quad k_1=0,1,2,3,4,\ldots\ldots$；$\delta_2 = 2k_2\pi + \pi \quad k_2=0,1,2,3,4,\ldots\ldots$；$\delta_3 = 2k_3\pi + \pi \quad k_3=0,1,2,3,4,\ldots\ldots$；

$$\begin{cases} \delta_1 - \delta_3 = 2\pi d\Delta\left(\frac{C_1}{\lambda_1} - \frac{C_3}{\lambda_3}\right) = 2m\pi & m=0,1,2,3,4,\ldots\ldots \\ \delta_2 - \delta_3 = 2\pi d\Delta\left(\frac{C_2}{\lambda_2} - \frac{C_3}{\lambda_3}\right) = 2n\pi & n=0,1,2,3,4,\ldots\ldots \end{cases}$$

其中，δ_3表示第三波长光的相位延迟，λ_3表示第三波长光的波长，C_3表示第三波长光的应力光学常数或应变光学常数。

4. 如权利要求 3 所述的导光板，其特征在于：该主应力差或主应变差的最佳值可进一步通过对目标函数 y 求解极小值得到，该

Microsoft Exhibit 1002 - Page 833
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

目标函数 y 如下，

$$y = w_1 \times abs[\mathrm{mod}(\delta_1, 2\pi) - \pi] + w_2 \times abs[\mathrm{mod}(\delta_2, 2\pi) - \pi] + w_3 \times abs[\mathrm{mod}(\delta_3, 2\pi) - \pi]$$

其中，mod表示求余数，abs 表示取绝对值，w_1, w_2, w_3 分别表示第一，第二和第三波长光对应的权重。

5. 如权利要求 4 所述的导光板，其特征在于：当该导光板的厚度为 0.8mm，材料为 BAPC，且应力光学常数 $C_1 = C_2 = C_3 = 8.9 \times 10^{-12} Pa^{-1}$，第一、第二和第三波长光的波长分别为 486.1nm、589.3nm 和 656.3nm，第一、第二和第三波长光具有相同的权重 $w_1 = w_2 = w_3 = 1$ 时，该主应力差Δ在 0 至 5×10^7Pa 的范围内的局部最优解为 $\Delta = 3.927 \times 10^7$Pa。

6. 如权利要求 1 所述的导光板，其特征在于：该导光板的底面具有微结构。

7. 如权利要求 6 所述的导光板，其特征在于：该微结构为自底面突出或者凹进的圆柱形、半圆球形、金字塔形、削去尖端部分的金字塔形。

8. 如权利要求 6 所述的导光板，其特征在于：该微结构为 V 形槽。

9. 如权利要求 6 所述的导光板，其特征在于：该微结构在底面是均匀分布或者沿远离入光面的方向逐渐变大和/或变密设置。

10. 如权利要求 1 所述的导光板，其特征在于：该出光面为平面。

11. 如权利要求 1 所述的导光板，其特征在于：该导光板为平板形或者楔形。

12. 一种背光模组，包括光源、导光板、反射片和反射式偏振分光器，该导光板包括入光面、连接于该入光面的出光面和相对于该出光面的底面，该光源相对导光板的入光面设置，该反射片、导光板和反射式偏振分光器依次设置，其特征在于：该导光板为应力或应变双折射导光板，其内具有分别沿着两个相垂直的方向的两个主应力或主应变，该主应力或主应变之一的方向和入光面的夹角大于 0 度小于 90 度，该两个主应力或主应变的主应力差或主应变差对该导光板内的多个波长光中的每两个波长光的相位延迟满足以下条件：

Microsoft Exhibit 1002 - Page 834
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

$$\delta_1 = 2k_1\pi + \pi \quad k_1=0,1,2,3,4,\ldots\ldots$$

$$\delta_2 = 2k_2\pi + \pi \quad k_2=0,1,2,3,4,\ldots\ldots$$

$$\delta_1 - \delta_2 = 2\pi d\Delta(\frac{C_1}{\lambda_1} - \frac{C_2}{\lambda_2}) = 2m\pi \quad m=0,1,2,3,4,\ldots\ldots$$

其中，δ_1和δ_2分别表示以第一波长光和第二波长光表示的该两个波长光的相位延迟，d为导光板的厚度，C_1和C_2分别表示该两个波长光的应力光学常数或应变光学常数，Δ表示主应力差或主应变差，λ_1和λ_2分别表示该两个波长光的波长。

13. 如权利要求 12 所述的背光模组，其特征在于：该夹角为 45 度。

14. 如权利要求 12 所述的背光模组，其特征在于：当该导光板内共有三个波长光时，该主应力差或主应变差对该导光板内的三个波长光的相位延迟满足以下条件，

$\delta_1 = 2k_1\pi + \pi$ $k_1=0,1,2,3,4,\ldots\ldots$；$\delta_2 = 2k_2\pi + \pi$ $k_2=0,1,2,3,4,\ldots\ldots$；$\delta_3 = 2k_3\pi + \pi$ $k_3=0,1,2,3,4,\ldots\ldots$；

$$\begin{cases} \delta_1 - \delta_2 = 2\pi d\Delta(\frac{C_1}{\lambda_1} - \frac{C_2}{\lambda_2}) = 2m\pi & m=0,1,2,3,4,\ldots\ldots \\ \delta_2 - \delta_3 = 2\pi d\Delta(\frac{C_2}{\lambda_2} - \frac{C_3}{\lambda_3}) = 2n\pi & n=0,1,2,3,4,\ldots\ldots \end{cases}$$

其中，δ_3表示第三波长光的相位延迟，λ_3表示第三波长光的波长，C_3表示第三波长光的应力光学常数或应变光学常数。

15. 如权利要求 14 所述的背光模组，其特征在于：该主应力差或主应变差的最佳值可进一步通过对目标函数 y 求解极小值得到，该目标函数 y 如下，

$$y = w_1 \times abs[\mathrm{mod}(\delta_1, 2\pi) - \pi] + w_2 \times abs[\mathrm{mod}(\delta_2, 2\pi) - \pi] + w_3 \times abs[\mathrm{mod}(\delta_3, 2\pi) - \pi]$$

其中，mod表示求余数，abs表示取绝对值，w_1、w_2、w_3分别表示第一，第二和第三波长光对应的权重。

16. 如权利要求 15 所述的背光模组，其特征在于：当该导光板的厚度为 0.8mm，材料为 BAPC，且应力光学常数 $C_1 = C_2 = C_3 = 8.9\times10^{-12}Pa^{-1}$、第一、第二和第三波长光的波长分别为 486.1nm、589.3nm 和 656.3nm，第一、第二和第三波长光具有相同的权重 $w_1 = w_2 = w_3 = 1$ 时，该主应力差 Δ 在 0 至 5×10^7Pa 的范围

Microsoft Exhibit 1002 - Page 835
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

内的局部最优解为 $\Delta = 3.927 \times 10^7 Pa$。

17. 如权利要求 12 所述的背光模组，其特征在于：该导光板的底面具有微结构。

18. 如权利要求 17 所述的背光模组，其特征在于：该微结构为自底面突出或者凹进的圆柱形、半圆球形、金字塔形、削去尖端部分的金字塔形。

19. 如权利要求 17 所述的背光模组，其特征在于：该微结构为 V 形槽。

20. 如权利要求 17 所述的背光模组，其特征在于：该微结构在底面是均匀分布或者沿远离入光面的方向逐渐变大和/或变密设置。

21. 如权利要求 12 所述的背光模组，其特征在于：该出光面为平面。

22. 如权利要求 12 所述的背光模组，其特征在于：进一步包括层叠设置在该导光板出光面上方的扩散片和棱镜片，该反射式偏振分光器设置在出光面与扩散片之间，或者该反射式偏振分光器设置在扩散片与棱镜片之间，或者该反射式偏振分光器设置在棱镜片上方。

23. 如权利要求 12 所述的背光模组，其特征在于：该导光板为平板形或者楔形。

24. 如权利要求 12 所述的背光模组，其特征在于：该光源为发光二极管或者冷阴极荧光灯管。

Microsoft Exhibit 1002 - Page 836
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

导光板与背光模组

【技术领域】

本发明涉及一种可实现对多波长光的偏振光转换且光能利用率高的导光板，以及一种采用该导光板的背光模组。

【背景技术】

由于液晶显示面板中的液晶本身不具有发光特性，因而，为达到显示效果，需要给液晶显示面板提供背光模组，该背光模组的功能在于向液晶显示面板供应具有充分亮度而且均匀分布的面光源。

一种现有技术的背光模组如图 1 所示，该背光模组 20 与液晶显示面板 10 组成液晶显示装置 100。该背光模组 20 包括光源 21、导光板 22、反射片 23、扩散片 24 和棱镜片 25。该液晶显示面板 10 的上、下两个表面分别设置上偏光片 11 和下偏光片 12。该背光模组 20 中的光源 21 相对导光板 22 的侧面(即入光面)设置，该反射片 23、导光板 22、扩散片 24 和棱镜片 25 依次层叠设置。该液晶显示面板 10 位于背光模组 20 的上方。

该背光模组 20 工作时，光源 21 发出自然光，该自然光经导光板 22、反射片 23、扩散片 24 和棱镜片 25 转换为面光源后以自然光 T 投射在下偏光片 12 上。该自然光 T 可以看作由振幅相同且电矢量相互垂直的线偏振光 P 与线偏振光 S。其中，该线偏振光 P 的偏振方向与偏光片 12 的透光轴方向相同，该线偏振光 S 的偏振方向与偏光片 12 的透光轴方向垂直。故，仅线偏振光 P 能通过偏光片 12，而线偏振光 S 不能通过偏光片 12 且被具有吸收性能的偏光片 12 吸收。由于近 50%的光被偏光片 12 吸收，这大大降低了光能利用率。

另一种现有技术的背光模组如图 2 所示，该背光模组 40 与液晶显示面板 30 组成液晶显示装置 300。该背光模组 40 包括光源 41、导光板 42、反射片 43、扩散片 44、棱镜片 45、1/4 波片

Microsoft Exhibit 1002 - Page 837
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

46 和反射式偏振分光器(Polarizing Beam Splitter, PBS) 47。该液晶显示面板 30 的上、下两个表面分别设置上偏光片 31 和下偏光片 32。该背光模组 40 中的光源 41 相对导光板 42 的侧面设置，该反射片 43、1/4 波片 46、导光板 42、扩散片 44、棱镜片 45 和反射式偏振分光器 47 依次层叠设置。该液晶显示面板 30 位于背光模组 40 的上方。

该背光模组 40 工作时，光源 41 发出自然光，其中一部分自然光经导光板 42、扩散片 44 和棱镜片 45 转换为面光源后以自然光 T 投射在反射式偏振分光器 47 上。该自然光 T 中的线偏振光 P 能通过反射式偏振分光器 47 并进而通过偏光片 32，而线偏振光 S 则不能通过反射式偏振分光器 47，其被反射式偏振分光器 47 反射回背光模组 40。被反射回的线偏振光 S 依次通过棱镜片 45、扩散片 44、导光板 42 和 1/4 波片 46，然后投射到反射片 43 上并被反射片 43 反射再次通过 1/4 波片 46，由于 1/4 波片 46 的作用，线偏振光 S 两次通过 1/4 波片 46 后转换为线偏振光 P1(线偏振光 P1 与线偏振光 P 具同种偏振方向)，从而使该线偏振光 P1 也可以通过反射式偏振分光器 47 和偏光片 32。由于该背光模组 40 实现了光能的复用，光能利用率得到提高。理论上，该背光模组 40 的亮度可以为上述的背光模组 20 的两倍。

当上述的背光模组 40 应用在彩色液晶显示装置中时，由于彩色液晶显示装置的背光模组必须是宽光谱或者多波长的，因此偏振分光和偏振光转换必须工作于宽光谱或者多波长的条件下，此时，上述的 1/4 波片 46 应为消色差波片，其对于多个波长光都可以起到近似相同的相位延迟。

但是，由于该背光模组 40 中被反射式偏振分光器 47 反射的线偏振光 S 必须从导光板 42 射出，然后才能被 1/4 波片 46 转换成线偏振光 P1，而 1/4 波片 46 和导光板 42 的界面处会产生反射和散射损失，这仍然不利于光能利用率的提高。

【发明内容】

以下，将以实施例说明一种可提高光能利用率的导光板，

Microsoft Exhibit 1002 - Page 838
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

以及，一种采用所述导光板的光能利用率高的背光模组。

为实现上述实施例的内容提供一种导光板，该导光板包括入光面、连接于该入光面的出光面和相对于该出光面的底面。该导光板为应力或应变双折射导光板，其内具有分别沿着两个相垂直的方向的两个主应力或主应变，该主应力或主应变之一的方向和入光面的夹角大于0度小于90度。该两个主应力或主应变的主应力差或主应变差对该导光板内的多个波长光中的每两个波长光的相位延迟满足以下条件：$\delta_1 = 2k_1\pi + \pi$ $_{k_1=0,1,2,3,4,\ldots\ldots}$；$\delta_2 = 2k_2\pi + \pi$ $_{k_2=0,1,2,3,4,\ldots\ldots}$；$\delta_1 - \delta_2 = 2\pi d\Delta(\frac{C_1}{\lambda_1} - \frac{C_2}{\lambda_2}) = 2m\pi$ $_{m=0,1,2,3,4,\ldots\ldots}$，其中，$\delta_1$和$\delta_2$分别表示该两个波长光的相位延迟，$d$为导光板的厚度，$C_1$和$C_2$分别表示该两个波长光的应力光学常数或应变光学常数，Δ表示主应力差或主应变差，λ_1和λ_2分别表示该两个波长光的波长。

优选的，该夹角为45度。

以及，提供一种背光模组，该背光模组包括光源、导光板、反射片和反射式偏振分光器，该导光板包括入光面、连接于该入光面的出光面和相对于该出光面的底面。该光源相对导光板的入光面设置，该反射片、导光板和反射式偏振分光器依次设置。其中，该导光板为应力或应变双折射导光板，其内具有分别沿着两个相垂直的方向的两个主应力或主应变，该主应力或主应变之一的方向和入光面的夹角大于0度小于90度。该两个主应力或主应变的主应力差或主应变差对该导光板内的多个波长光中的每两个波长光的相位延迟满足以下条件：$\delta_1 = 2k_1\pi + \pi$ $_{k_1=0,1,2,3,4,\ldots\ldots}$；$\delta_2 = 2k_2\pi + \pi$ $_{k_2=0,1,2,3,4,\ldots\ldots}$；$\delta_1 - \delta_2 = 2\pi d\Delta(\frac{C_1}{\lambda_1} - \frac{C_2}{\lambda_2}) = 2m\pi$ $_{m=0,1,2,3,4,\ldots\ldots}$，其中，$\delta_1$和$\delta_2$分别表示该两个波长光的相位延迟，$d$为导光板的厚度，$C_1$和$C_2$分别表示该两个波长光的应力光学常数或应变光学常数，Δ表示主应力差或主应变差，λ_1和λ_2分别表示该两个波长光的波长。

优选的，该夹角为45度。

Microsoft Exhibit 1002 - Page 839
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

相较于现有技术，由于本实施例所提供的导光板为应力或应变双折射导光板，通过对其内主应力差或主应变差的限定，使得该导光板对多个波长的光均具有近似相同的相位延迟，并接近或者等同于消色差 1/4 波片的性能，从而应用本实施例导光板的背光模组不再需要额外的消色差 1/4 波片，即可将线偏振光 S 在导光板内部转换成线偏振光 P，无界面处的反射及散射损失，光能利用率进一步提高。

同样，本实施例所提供的背光模组结合反射式偏振分光器，可以实现发射液晶面板需用的多波长的偏振光，提高光能利用率。

【附图说明】

图 1 是一种现有技术的背光模组与液晶显示面板组成的液晶显示装置的平面示意图。

图 2 是另一种现有技术的背光模组与液晶显示面板组成的液晶显示装置的平面示意图。

图 3 是本发明第一实施例的导光板的立体示意图。

图 4 是图 3 所示导光板的光路示意图。

图 5 是本发明第一实施例的导光板内的主应力差与一目标函数的关系曲线图。

图 6 是本发明第二实施例的背光模组的平面示意图。

【具体实施方式】

如图 3 所示，是本发明第一实施例导光板的立体示意图。该导光板 52 为平板形，其包括入光面 521、连接于该入光面 521 的出光面 522，和相对该出光面 522 的底面 523。该导光板 52 的底面 523 设置有微结构 524。本实施例中，该导光板 52 为双酚 A 聚碳酸酯材料(Bisphenol-A Polycarbonate, BAPC)，该微结构 524 为 V 形槽，该出光面 522 为平面。

该导光板 52 是利用光弹性效应，被施加应力制得的应力双折射导光板。如图 3 所示，首先定义垂直该导光板 52 入光面 521 的方向为 X 轴，垂直于 X 轴并平行于出光面 522 的方向为 Y 轴，

Microsoft Exhibit 1002 - Page 840
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

则该导光板 52 中的主应力 σ_x 和 σ_y 的方向分别沿着图中虚线所示的两个方向，σ_x 和 X 轴方向的夹角为 θ，σ_y 和 Y 轴方向的夹角为 θ。该 θ 角度在 0 度到 90 度之间，优选的为 45 度。且，该两个主应力 σ_y 与 σ_x 的应力差 Δσ 对该导光板 52 内的多个波长光中的每两个波长光的相位延迟满足以下条件：$\delta_1 = 2k_1\pi + \pi \quad k_1=0,1,2,3,4,\ldots\ldots$；$\delta_2 = 2k_2\pi + \pi \quad k_2=0,1,2,3,4,\ldots\ldots$；$\delta_1 - \delta_2 = 2\pi Cd\Delta\sigma(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}) = 2m\pi \quad m=0,1,2,3,4,\ldots\ldots$，其中，$\delta_1$ 和 δ_2 分别表示该两个波长光的相位延迟，C 表示应力光学常数，Δσ 表示主应力差，λ_1 和 λ_2 分别表示该两个波长光的波长。

由于该导光板 52 被施加应力，并通过对其内主应力差 Δσ 的限定，使得该导光板 52 对多波长光均具有近似相同的相位延迟，并接近或者等同于消色差 1/4 波片的性能，从而应用本发明导光板 52 的背光模组不再需要额外的消色差 1/4 波片，即可将多波长光的线偏振光 S 在导光板 52 内部分别转换成线偏振光 P，无界面处的反射及散射损失，光能利用率进一步提高。

下面结合图 4，对该导光板 52 对线偏振光 S 的转换过程进行论证。

一起参照图 3 和图 4 所示，假设入射光在 XZ 平面内，线偏振光 P 电矢量方向在 XZ 平面内，线偏振光 S 电矢量方向在 XZ 平面法线方向，与导光板 52 配合的反射式偏振分光器(图未示)的透光轴沿着 X 轴方向。导光板 52 底面 523 的微结构 524 改变入射角 θ_i，当此入射角 θ_i 的角度较小时，光线才能从导光板 52 出光面 522 射出，由于 θ_i 较小，在如下分析中，为了简化问题，假设 $\theta_i = 0$，即出射光沿着出光面 522 法线方向。线偏振光 S 的琼斯(Jones)矢量 $E_i = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$，根据布儒斯特(Brewster)定律，折射率变化量和主应力差大小成线性关系，有：

$$n_{\sigma y} - n_{\sigma x} = C(\sigma_x - \sigma_y) \qquad (1.1)$$

其中 $n_{\sigma x}$ 和 $n_{\sigma y}$ 分别表示在两个主应力方向的折射率，C 表示相对应力光学常数。

Microsoft Exhibit 1002 - Page 841
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

光波通过厚度为 d 的导光板 52 后有一光程差 l，根据式 1.1 有：

$$l = Cd(\sigma_y - \sigma_x) \tag{1.2}$$

入射光波长为 λ，得到相位延迟 δ 为：

$$\delta = 2\pi Cd(\sigma_y - \sigma_x)/\lambda \tag{1.3}$$

上述两个式子 1.2 与 1.3 称为平面光弹性的应力－光学定律。施加应力后，导光板 52 变成了相位延迟器。

在光弹性实验中，一般定义 $f_\sigma = \lambda/C$，f_σ 称为材料应力条纹值，所以相位延迟 δ 也可以改写为：

$$\delta = 2\pi d(\sigma_y - \sigma_x)/f_\sigma \tag{1.4}$$

在 XY 坐标系下，琼斯矩阵 T 为：

$$T = \begin{bmatrix} \cos^2\theta + \sin^2\theta e^{i\delta} & \sin\theta\cos\theta - \sin\theta\cos\theta e^{i\delta} \\ \sin\theta\cos\theta - \sin\theta\cos\theta e^{i\delta} & \sin^2\theta + \cos^2\theta e^{i\delta} \end{bmatrix} \tag{1.5}$$

穿过此相位延迟器(即导光板 52)后琼斯矢量 E_o 为：

$$E_o = \begin{bmatrix} E_{ox} \\ E_{oy} \end{bmatrix} = TE_i = \begin{bmatrix} \sin\theta\cos\theta - \sin\theta\cos\theta e^{i\delta} \\ \sin^2\theta + \cos^2\theta e^{i\delta} \end{bmatrix} \tag{1.6}$$

$$E_x = \mathrm{Re}[E_{ox}] = \sin 2\theta \sin(\delta/2)\cos(\omega t + \delta/2 + \pi/2) \tag{1.7}$$

经过反射式偏振分光器后，透射光强 I_x 为：$I_x = \sin^2 2\theta \sin^2(\delta/2)$，带入式 1.4 得到：

$$I_x = \sin^2 2\theta \sin^2[\pi d(\sigma_y - \sigma_x)/f_\sigma] = \sin^2 2\theta \sin^2(\pi d\Delta\sigma/f_\sigma) \tag{1.8}$$

显然如下条件满足时，I_x 得到最大值：

$$\begin{cases} 2\theta = \pi/2 \\ \pi d\Delta\sigma/f_\sigma = k\pi + \pi/2 \end{cases}_{k=0,1,2,3,4\ldots} \tag{1.9}$$

因此，应力双折射导光板 52 设计中，为得到最大的光利用率，应使主应力 σ_y 方向与 X 轴的夹角 θ 为 45 度。当然，该主应力 σ_y 方向与 X 轴的夹角 θ 在 0 度到 90 度之间并不等于 45 度时，虽然不能达到最大的光利用率，但仍然可以实现部分线偏振光 S 的复用。

接下来，首先基于单色光波长 λ 来推论主应力差 $\Delta\sigma$。

主应力差 $\Delta\sigma$ 大小可以由 $d\Delta\sigma/f_\sigma = k + 0.5$ 确定，带入应力条纹值

Microsoft Exhibit 1002 - Page 842
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

表达式，可以依据光弹性应力—光学定律得到：

$$dC\Delta\sigma=(k+0.5)\lambda_{k=0,1,2,3,4,\ldots} \qquad (1.10)$$

同样，本发明中也可以根据光塑性应变—光学定律得到类似的表达式。光塑性应变—光学定律表示为：

$$\delta_\varepsilon=2\pi C_\varepsilon d(\varepsilon_y-\varepsilon_x)/\lambda \qquad (1.11)$$

即：某一材料某一点施加主应变 ε_x 和 ε_y 所引起的光程差 δ_ε，与该点的主应变差 $(\varepsilon_y-\varepsilon_x)$ 和厚度 d 成比例。其中 C_ε 为应变—光学常数，与特定的材料有关。类似于式子 1.10，可以根据应变光学定律，得到应该施加的应变差，以产生特定的相位延迟：

$$dC_\varepsilon\Delta\varepsilon=(k+0.5)\lambda_{k=0,1,2,3,4,\ldots} \qquad (1.12)$$

接下来，假设该导光板 52 需要对 c(656.3nm)，d(589.3nm)，f(486.1nm)三种波长光产生相同的偏振光转换功能，以下以 c, d, f 三波长光为例，设计具有消色差 1/4 波片功能的双折射导光板 52。假设在可见光波段，应力光学常数 C 为常数。因此，应力双折射导光板 52 为了对 c, d, f 三波长光产生近似相同的相位延迟，需满足：

$$\begin{cases}\delta_d-\delta_c=2\pi Cd\Delta\sigma\left(\dfrac{1}{\lambda_d}-\dfrac{1}{\lambda_c}\right)=2m\pi & m=0,1,2,3,4,\ldots\\ \delta_f-\delta_d=2\pi Cd\Delta\sigma\left(\dfrac{1}{\lambda_f}-\dfrac{1}{\lambda_d}\right)=2n\pi & n=0,1,2,3,4,\ldots\end{cases} \qquad (1.13)$$

同时要满足相位延迟最接近半波片 $2k\pi+\pi$。如何取得最佳的主应力差 $\Delta\sigma$ 的问题可以通过转换成目标函数(Objective Function)求解极小值来解决，目标函数如下：

$$y=w_c\times abs[\mathrm{mod}(\delta_c,2\pi)-\pi]+w_d\times abs[\mathrm{mod}(\delta_d,2\pi)-\pi]+w_f\times abs[\mathrm{mod}(\delta_f,2\pi)-\pi] \qquad (1.14)$$

其中，mod 表示求余数，abs 表示取绝对值，w_c，w_d，w_f 分别表示 c，d，f 三波长光对应的权重。当 $\delta_c=2k_c\pi+\pi$，$\delta_d=2k_d\pi+\pi$，$\delta_f=2k_f\pi+\pi$ 时，上式取得最小值 0。

在本实施例中，该导光板 52 厚度为 $d=0.8mm$，导光板材料为 BAPC，其应力光学常数 $C=8.9\times10^{-12}Pa^{-1}$。假设 c，d，f 三波长光具

Microsoft Exhibit 1002 - Page 843
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

有相同的权重 $w_c = w_d = w_f = 1$。则目标函数与主应力差 $\Delta\sigma$ 的关系如图 5 所示。根据图 5，可以看出主应力差 $\Delta\sigma$ 在 0 至 5×10^7 Pa 范围内，局部最优解为 $\Delta\sigma = 3.927\times10^7$ Pa。此时和 c，d，f 所对应的相位延迟分别为：

$$\begin{cases}\delta_c = 16\pi + 1.04\pi \\ \delta_d = 18\pi + 0.98\pi \\ \delta_f = 22\pi + 1.0\pi\end{cases}$$

显然，优化所得主应力差 $\Delta\sigma$ 满足使导光板 52 具有消色差 1/4 波片的功能，最大误差仅为 4%。

上述实施例中假设在可见光波段，应力光学常数 C 为常数。如果此假设不能满足、即当应力光学常数 C 随着不同波长光而变化时，上述设计方法仍然适用，可以将相位延迟 δ 写成如下的形式：

$$\begin{cases}\delta_c = 2\pi C_{const} d\Delta\sigma \dfrac{1}{\lambda_c'} \\ \delta_d = 2\pi C_{const} d\Delta\sigma \dfrac{1}{\lambda_d'} \\ \delta_f = 2\pi C_{const} d\Delta\sigma \dfrac{1}{\lambda_f'}\end{cases} \qquad (1.15)$$

其中：

$$\begin{cases}\lambda_c' = \lambda_c \dfrac{C_{const}}{C_c} \\ \lambda_d' = \lambda_d \dfrac{C_{const}}{C_d} \\ \lambda_f' = \lambda_f \dfrac{C_{const}}{C_f}\end{cases}。$$

其中，C_{const} 为不随波长变化的常数，C_c、C_d、C_f 分别为 c，d，f 三波长光对应的应力光学常数。

对上述导光板 52 施加应力的方式多种多样，例如可以在导光板 52 注模成型时施加应力，然后通过应力冻结技术，实现应力保存。

如图 6 所示，是本发明第二实施例的背光模组的平面示意

Microsoft Exhibit 1002 - Page 844
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

图。该背光模组 50 采用上述的导光板 52，并可以进一步包括光源 51、反射片 53、扩散片 54、棱镜片 55 和反射式偏振分光器 57。该背光模组 50 中的光源 51 相对导光板 52 的入光面 521 设置、该反射片 53、导光板 52、扩散片 54、棱镜片 55 和反射式偏振分光器 57 依次设置。本实施例中，该光源 51 为发光二极管。

该背光模组 50 工作时，光源 51 发出多波长的自然光，其中一部分自然光经导光板 52、扩散片 54 和棱镜片 55 转换为面光源后以自然光 T 投射在反射式偏振分光器 57 上。该每一波长的自然光 T 中的线偏振光 P 能通过反射式偏振分光器 57 并进而提供给液晶显示面板(图未示)适用的光，而线偏振光 S 则不能通过反射式偏振分光器 57，其被反射式偏振分光器 57 反射回背光模组 50。被反射回的线偏振光 S 依次通过棱镜片 55、扩散片 54 和导光板 52，然后投射到反射片 53 上并被反射片 53 反射再次通过导光板 52，由于导光板 52 的作用，线偏振光 S 转换为线偏振光 P1，从而使该线偏振光 P1 也可以通过反射式偏振分光器 57。该背光模组 50 结合反射式偏振分光器 57，可以实现发射液晶面板需用的多波长的偏振光，提高光能利用率。

本发明导光板还可以有其它实施例，例如：

该导光板的形状为楔形。

该导光板底面的微结构为自底面突出或者凹进的圆柱形、半圆球形、金字塔形、削去尖端部分的金字塔形等形状，该微结构在底面是均匀分布或者沿远离入光面的方向逐渐变大和/或变密设置。

该导光板是其它塑料，如聚甲基丙烯酸甲酯(PMMA)，聚苯乙烯(Polystyrene)，聚砜(Polysulfone)，聚醚酰亚胺(polyetherimide)等，也可以是玻璃。

本发明导光板以 c，d，f 三波长为例，将导光板优化设计成消色差 1/4 波片，但是也不限于这三个波长。可以结合光源，选择其它波长优化设计所需的主应力差。

Microsoft Exhibit 1002 - Page 845
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

本发明以光弹性应力双折射为例，优化得到主应力差。相关技术人员应该明白，上述优化过程也适用于光塑性应变双折射。可以根据所选用材料的力学特性，可以得到应变与双折射的关系，以及用应变表示的相位方程，并最终得出最佳主应变差。

本发明背光模组还可以有其它实施例，例如：

采用冷阴极荧光灯管作为光源。

将反射式偏振分光器设置在导光板的出光面和扩散片之间。

将反射式偏振分光器设置在扩散片和棱镜片之间。

Microsoft Exhibit 1002 - Page 846
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

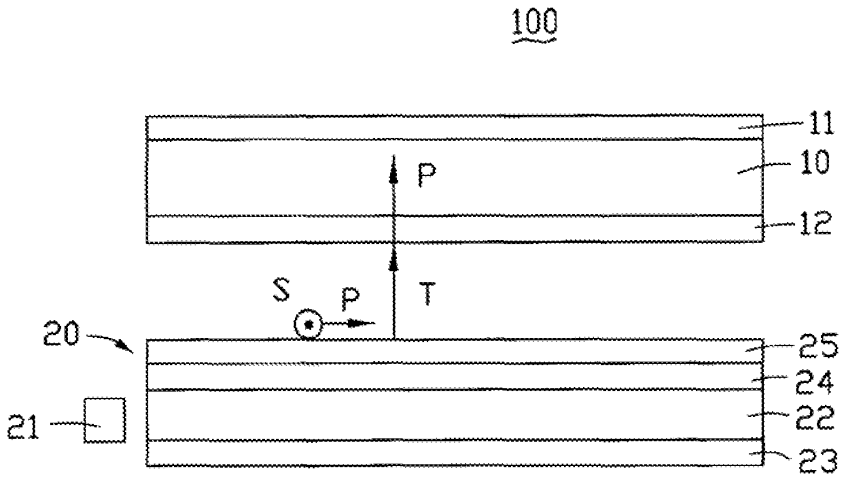


图 1

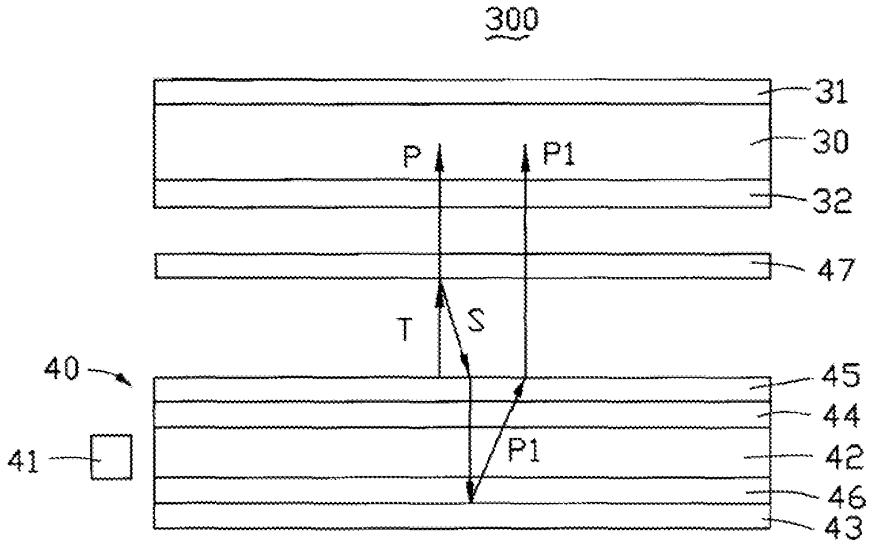


图 2

Microsoft Exhibit 1002 - Page 847
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

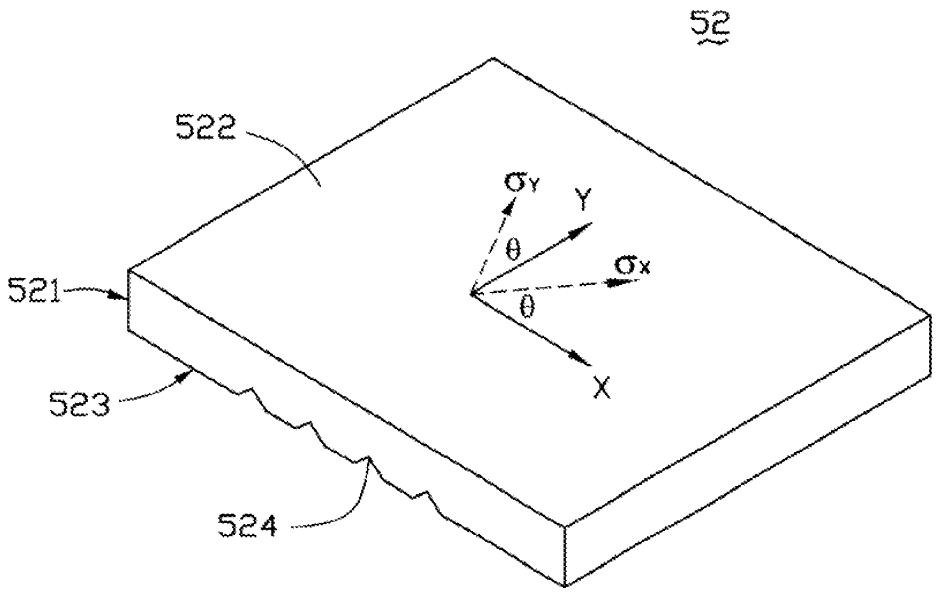


图 3



图 4

Microsoft Exhibit 1002 - Page 848
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

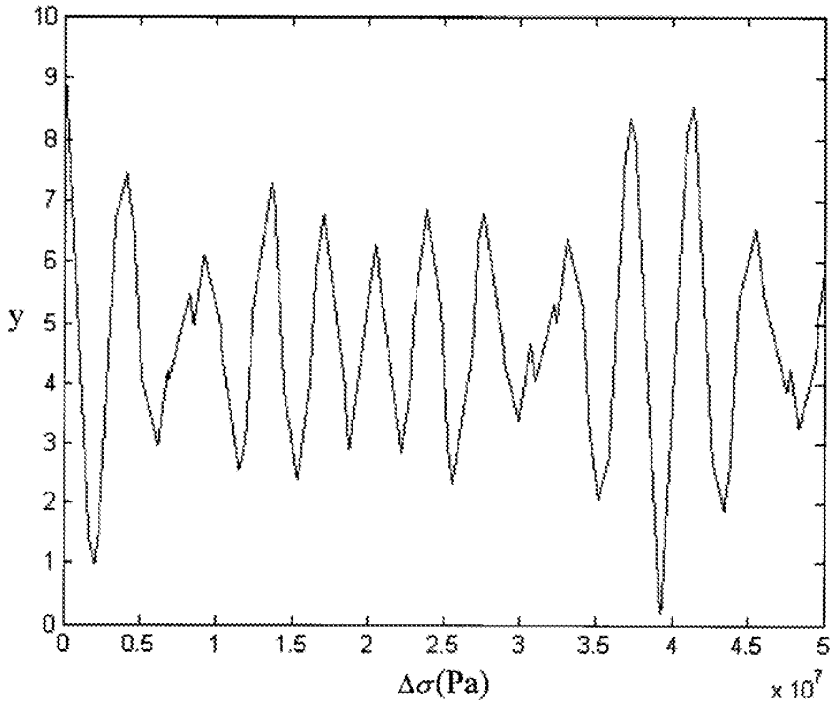


图 5

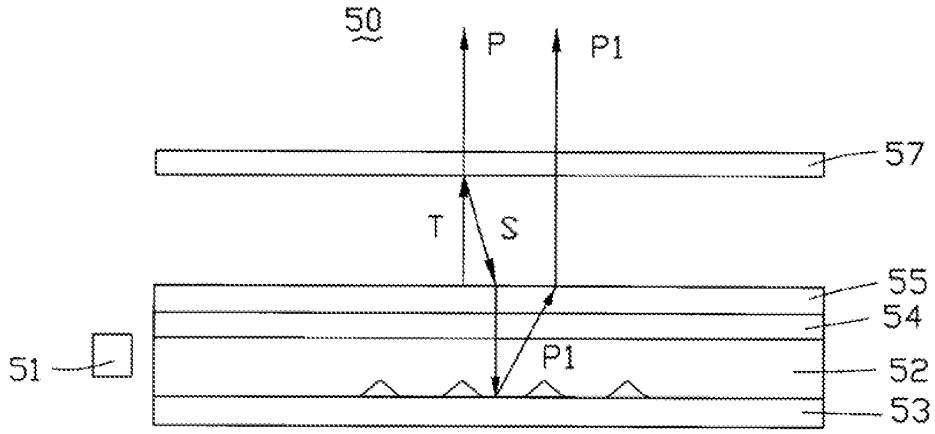


图 6

Microsoft Exhibit 1002 - Page 849
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Espacenet

Bibliographic data: CN1908753 (A) — 2007-02-07

Polarized light converter, method for fabrication and backlight component

Inventor(s): ZHANG RENCONG [CN] ± (RENCONG ZHANG)

Applicant(s): HONGFUJIN PREC IND [CN] ± (HONGFUJIN PRECISION INDUSTRY (SHENZHEN) CO., LTD)

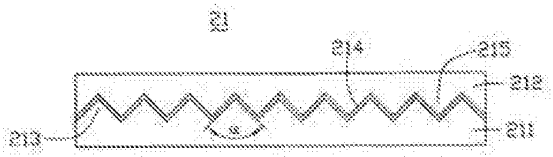
Classification: - international: *G02F1/1335*
- cooperative: G02B27/285

Application number: CN2005136428 20050805

Priority number (s): CN2005136428 20050805

Also published as: US2007030566 (A1) US7494234 (B2)

Abstract of CN1908753 (A)



The related back light module comprises: a guide plate with an incidence plane and an opposite emergent plane and bottom plane, a light source on one side of incidence plane, a 1/4 slide between the plate and reflector, a reflector on the bottom plane, and a polarization light converter with the first/second lens plate and polarization splitting film near the emergent plane, wherein the lenses of the first and second lens plates engage with each other to clamp the light splitting film together. This invention has simple structure and convenient to assemble.

Microsoft Exhibit 1002 - Page 850
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

[19] 中华人民共和国国家知识产权局

[51] Int. Cl.
G02F 1/1335 (2006.01)

[12] 发明专利申请公布说明书

[21] 申请号 200510036428.2

[43] 公开日 2007 年 2 月 7 日

[11] 公开号 CN 1908753A

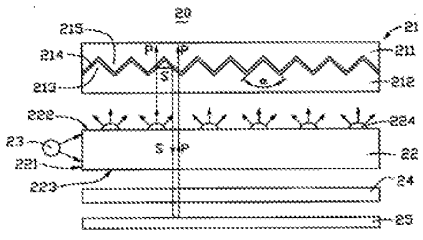
[22] 申请日 2005.8.5
[21] 申请号 200510036428.2
[71] 申请人 鸿富锦精密工业（深圳）有限公司
地址 518109 广东省深圳市宝安区龙华镇油松第十工业区东环二路 2 号
共同申请人 鸿海精密工业股份有限公司
[72] 发明人 张仁淙
权利要求书 2 页 说明书 5 页 附图 2 页

[54] 发明名称

偏振光转换器、其制造方法及背光模组

[57] 摘要

本发明涉及一种偏振光转换器、该偏振光转换器的制造方法以及使用该偏振光转换器的背光模组，该背光模组包括导光板、光源、四分之一波片、反射装置及偏振光转换器。该导光板包括一入光面、一与该入光面相连的出光面，一与该出光面相对应的底面。光源位于导光板入光面的一侧，反射装置位于导光板底面的一侧，四分之一波片位于导光板与反射装置之间。该偏振光转换器位于导光板出光面的一侧，其包括具有若干微棱镜的第一棱镜板、具有若干微棱镜的第二棱镜板及偏振分光膜，该第一、第二棱镜板的若干微棱镜相互交错啮合并将偏振分光膜夹在其间形成一体结构。本发明的背光模组具有结构简单、组装方便，选材容易的优点。



Microsoft Exhibit 1002 - Page 851
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

1. 一种偏振光转换器，其包括第一棱镜板、第二棱镜板，该第一棱镜板的一个表面具有若干个微棱镜，该第二棱镜板的一个表面具有若干个微棱镜，其特征在于该偏振光转换器近一步包括偏振分光膜，第一棱镜板、第二棱镜板的若干个微棱镜相互交错啮合并将该偏振分光膜夹在其间形成一体结构。

2. 如权利要求1所述的偏振光转换器，其特征在于第一棱镜板、第二棱镜板材料相同，为玻璃或塑胶透光材料。

3. 如权利要求1所述的偏振光转换器，其特征在于第一棱镜板的微棱镜具有一顶角，该顶角为90度。

4. 如权利要求1所述的偏振光转换器，其特征在于第二棱镜板的微棱镜具有一顶角，该顶角为90度。

5. 如权利要求1所述的偏振光转换器，其特征在于偏振分光膜材料为二氟化镁、二氧化硅或五氧化二钽。

6. 一种偏振光转换器制造方法，其包括以下步骤：

提供一形成有若干个微棱镜的第一棱镜板；

在第一棱镜板的若干个微棱镜表面上形成一偏振分光膜；

提供一形成有若干个微棱镜的第二棱镜板，该第二棱镜板的若干个微棱镜可与第一棱镜板的若干个微棱镜相互交错啮合；

将第二棱镜板的若干个微棱镜压合在偏振分光膜上，并与第一棱镜板组合形成偏振光转换器。

7. 如权利要求6所述的偏振光转换器制造方法，其特征在于第一棱镜板、第二棱镜板是通过射出成型方法制成。

8. 如权利要求6所述的偏振光转换器制造方法，其特征在于第一棱镜板、第二棱镜板是在玻璃或塑胶透光板上进行蚀刻制成。

9. 如权利要求6所述的偏振光转换器制造方法，其特征在于偏振分光膜是镀制在第一棱镜板的微棱镜表面上。

10. 一种背光模组，其包括导光板、光源、偏振光转换器、反射装置及四分之一波片，导光板包括一入光面、一与该入光面相连的出光面，一与该出光面相对应的底面，光源位于导光板入光面的一侧，偏振光转换器位于导

Microsoft Exhibit 1002 - Page 852
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

光板出光面的一侧，反射装置位于导光板底面的一侧，四分之一波片位于导光板与反射装置之间，上述偏振光转换器包括第一棱镜板、第二棱镜板，该第一棱镜板的一个表面具有若干个微棱镜，该第二棱镜板的一个表面具有若干个微棱镜，其特征在于该偏振光转换器近一步包括偏振分光膜，第一棱镜板、第二棱镜板的若干个微棱镜相互交错啮合并将该偏振分光膜夹在其间形成一体结构。

11. 如权利要求10所述的背光模组，其特征在于第一棱镜板、第二棱镜板材料相同，为玻璃或塑胶透光材料。

12. 如权利要求10所述的背光模组，其特征在于第一棱镜板的微棱镜具有一顶角，该顶角为90度。

13. 如权利要求10所述的背光模组，其特征在于第二棱镜板的微棱镜具有一顶角，该顶角为90度。

14. 如权利要求10所述的背光模组，其特征在于偏振分光膜材料为二氟化镁、二氧化硅或五氧化二钽。

15. 如权利要求10所述的背光模组，其特征在于导光板出光面设置有微结构，用于控制光出射方向。

16. 如权利要求10所述的背光模组，其特征在于反射装置为反射片或在四分之一波片背向导光板底面的表面上形成的反射膜。

Microsoft Exhibit 1002 - Page 853
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

偏振光转换器、其制造方法及背光模组

【技术领域】

本发明涉及一种偏振光转换器、该偏振光转换器的制造方法以及使用该偏振光转换器的背光模组。

【背景技术】

由于液晶显示器为非发光性的显示装置，需要利用背光模组才能产生显示功能。背光模组性能的好坏，往往会直接影响液晶显示器的显像品质，所以，背光模组成为液晶显示器中较重要的组件。随着液晶显示器在诸如手机、车载显示器、个人数字助理(Personal Digital Assistant, PDA)以及电视机等应用领域的拓展，对背光模组提出了更高要求，主要表现在：高亮度、低成本、低能耗、轻薄化等。

请参阅图1，一种现有技术的背光模组10包括一导光板12、一光源14、一四分之一波片13、一向上棱镜板16及一向下棱镜板18。光源14位于导光板12入光面121一侧，向上棱镜板16设置在导光板12出光面122上，向下棱镜板18位于向上棱镜板16背向导光板12一侧，四分之一波片13设置在导光板12的底面123一侧，且其背向导光板12一侧底面132镀有反射膜(图未示)。

该向上棱镜板16背向导光板12一侧表面连续均匀设置有若干个向上微棱镜162，该向下棱镜板18包括若干个向下微棱镜182，且与若干个向上微棱镜162相互啮合，在该若干个向上、向下微棱镜162、182两相对表面163、183之间可预留有一定间隔19或不预留间隔。

该种结构的背光模组10通过若干个向上、向下微棱镜162、182可以实现导光板22出射光的P方向偏振光透过向下微棱镜182，而S方向偏振光被反射，并经由四分之一波片13转换为P方向偏振光后透过向下微棱镜182，从而使背光模组10具有偏振光转换功能。

但是，当若干个向上、向下微棱镜162、182两相对表面163、183之间预留有一定间隔19时，进行组装时需要定位机构将向下棱镜板18定位，用来与向上棱镜板16之间保持一定间隔19，这样存在结构复杂，组装繁琐，花费时

Microsoft Exhibit 1002 - Page 854
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

间较多，定位精度要求较高等问题；并且若干个向上、向下微棱镜162、182与间隔19的折射率差在0.001至0.2之间，因此存在制造时选材较难的问题。

当若干个向上、向下微棱镜 162、182 之间不保留间隔 19，则要求向上棱镜板 16 与向下棱镜板 18 的材质不同，其折射率差要设置在 0.001 至 0.2 之间，此种结构存在制造时选材较难的问题。

【发明内容】

下面将以若干个实施例说明一种偏振光转换器、该偏振光转换器的制造方法以及使用该偏振光转换器的背光模组。

为实现上述内容，提供一种偏振光转换器，其包括第一棱镜板、第二棱镜板及偏振分光膜，第一棱镜板的一个表面具有若干个微棱镜，第二棱镜板的一个表面具有若干个微棱镜，该第一棱镜板、第二棱镜板的若干个微棱镜相互交错啮合并将该偏振分光膜夹在其间形成一体结构。

以及，提供一种偏振光转换器的制造方法，该方法包括下列步骤：提供一形成有若干个微棱镜的第一棱镜板；在第一棱镜板的若干个微棱镜表面上形成一偏振分光膜；提供一形成有若干个微棱镜的第二棱镜板，该第二棱镜板的若干个微棱镜与第一棱镜板的若干个微棱镜相互交错啮合；将第二棱镜板的若干个微棱镜压合在偏振分光膜上，并与第一棱镜板组合形成偏振光转换器。

以及，提供一种背光模组，该背光模组包括导光板、光源、偏振光转换器、反射装置及四分之一波片。导光板包括一入光面、一与该入光面相连的出光面，一与该出光面相对应的底面，光源位于导光板入光面的一侧，偏振光转换器位于导光板出光面的一侧，反射装置位于导光板底面的一侧，四分之一波片位于导光板与反射装置之间，其中该偏振光转换器包括第一棱镜板、第二棱镜板及偏振分光膜，第一棱镜板的一个表面具有若干个微棱镜，第二棱镜板的一个表面具有若干个微棱镜，该第一棱镜板、第二棱镜板的若干个微棱镜相互交错啮合并将该偏振分光膜夹在其间形成一体结构。

与现有技术相比，本实施例的偏振光转换器为一体结构，不必使用定位机构将其第一、第二棱镜板之间预留一段间隔，并且该偏振光转换器的第一、第二棱镜板材料相同，可为玻璃或塑胶透光材料，因此本实施例的偏振光转换器具有结构简单、组装方便、选材容易的优点，相应，使用该偏振光转换

Microsoft Exhibit 1002 - Page 855
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

器的背光模组也具有上述优点，该偏振光转换器制造方法简单。

【附图说明】

图1是现有技术背光模组的示意图。

图2是本发明偏振光转换器的示意图。

图3至图5是本发明偏振光转换器制造方法的示意图。

图6是本发明背光模组的示意图。

【具体实施方式】

下面将结合附图对本发明的偏振光转换器、该偏振光转换器的制造方法以及使用该偏振光转换器的背光模组作进一步的详细说明。

请参阅图2，本发明的偏振光转换器21包括一具有若干个微棱镜215的上棱镜板211、一具有若干个微棱镜213的下棱镜板212及偏振分光膜214。下棱镜板212的若干微棱镜213顶角α为90度，该上、下棱镜板211、212材料相同，可为玻璃或塑胶透光材料，该偏振光分光膜214材料为二氟化镁(MgF_2)、二氧化硅(SiO_2)，五氧化二钽(Ta_2O_5)等。该上、下棱镜板211、212将偏振分光膜214夹在其间并组合形成一体结构，根据偏振分光膜214的不同，该偏振光转换器21可仅透过P方向偏振光(或S方向偏振光)，而S方向偏振光(或P方向偏振光)被反射，不能透过偏振光转换器21。

请参阅图3至图5，是本发明偏振光转换器的制造方法示意图。该方法包括下列步骤：

首先提供两块材料为玻璃或透光塑胶的平板。

使用蚀刻的方法形成一下棱镜板212 (如图3所示)，该下棱镜板212上的若干微棱镜213顶角α为90度。

在该若干微棱镜213的表面上镀上一层仅可以穿透P方向偏振光或仅可以穿透S方向偏振光的偏振分光膜214(如图4所示)，该偏振分光膜214材料为二氟化镁、二氧化硅、五氧化二钽等。

使用蚀刻的方法形成一上棱镜板211(如图5所示)，该上棱镜板211的若干微棱镜215的顶角也为90度，其与下棱镜板212的若干微棱镜213可以相互交错啮合。

最后将上棱镜板211的若干微棱镜215压合在偏振分光膜214上，并与下棱镜板212组合形成偏振光转换器21(如图2所示)。

Microsoft Exhibit 1002 - Page 856
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

可以理解，上述偏振分光膜214也可镀在上棱镜板211的若干微棱镜215的表面上，再用蚀刻的方法形成一下棱镜板212，该下棱镜板212的若干微棱镜213与上棱镜板211的若干微棱镜215可以相互啮合，最后将下棱镜板212的若干微棱镜213压合在偏振分光膜214上，并与上棱镜板211组合形成偏振光转换器21。

可以理解，上述上棱镜板211与下棱镜板212也可用一具有微棱镜阵列的模具射出成型制成。

请参阅图6，本发明的背光模组20包括导光板22、光源23、四分之一波片24、反射装置25及偏振光转换器21。该导光板22包括一入光面221、一与该入光面221相连的出光面222，一与该出光面222相对应的底面223。光源23位于导光板22入光面221的一侧，四分之一波片24位于导光板22底面下方，反射装置25位于四分之一波片24下方。该偏光转换器21位于导光板22出光面222上方，其包括具有若干微棱镜215的上棱镜板211、具有若干微棱镜213的下棱镜板212及偏振分光膜214，该上、下棱镜板211、212的若干微棱镜215、213相互交错啮合并将偏振分光膜214夹在其间形成一体结构。

自光源23发出的光线经导光板22的入光面221入射至导光板22，通过导光板22耦合，光线由导光板22的出光面222出射，在导光板22的出光面222上分布有微结构224，用于控制出射光的出射方向。当导光板22的出射光入射至偏振光转换器21的偏振分光膜214时，仅P方向偏振光(或仅S方向偏振光)穿透偏振分光膜214，而另一S方向偏振光(或P方向偏振光)被偏振分光膜214反射至微棱镜213另一边，通过微棱镜213的另一边再一次反射后进入导光板22中，再通过导光板22的底面后，进入四分之一波片24，通过四分之一波片24后，再由反射装置25反射回四分之一波片24，S方向(或P方向)偏振光在来回两次通过四分之一波片24之后，其偏振方向被旋转90度而变成P方向(或S方向)偏振光反射回导光板22，经由导光板22再出射至偏振光转换器21，该束反射回的P方向(或S方向)偏振光与前述透射出的P方向(或S方向)偏振光组合形成液晶显示器的明亮面光源。

可以理解，本发明的背光模组20中导光板22出光面222用于控制光出射方向的微结构224，可以包括三角形长条形状，半圆形长条形状及网点结构等。本发明背光模组20的导光板22可采用平板型或楔型，该导光板22可由聚碳酸

Microsoft Exhibit 1002 - Page 857
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

酯(PC)、聚甲基丙烯酸甲酯(PMMA)等合成树脂材料制成。本发明背光模组20的光源23可采用发光二极管(Light Emitting Diode, LED)或冷阴极荧光灯(Cold Cathode Fluorescent Lamp, CCFL)。本发明背光模组20的反射装置25可为反射片或在四分之一波片背向导光板22底面223的表面上形成的反射膜。

另外，本领域技术人员还可以在本发明精神内做其他变化，当然，这些依据本发明精神所做的变化，都应包含在本发明所要求保护的范围内。

Microsoft Exhibit 1002 - Page 858
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

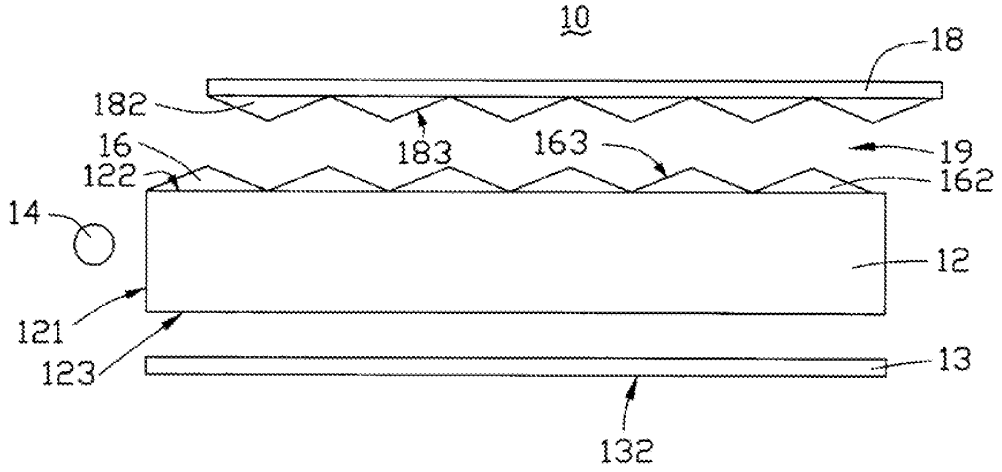


图 1

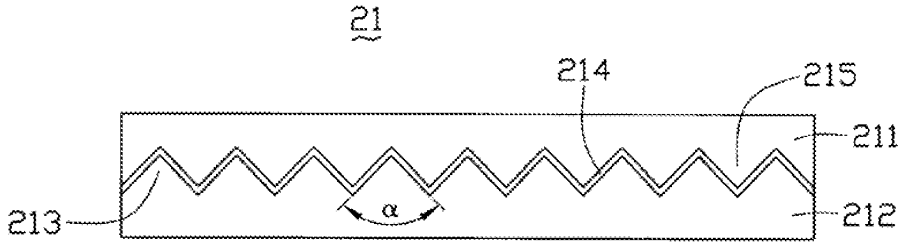


图 2

Microsoft Exhibit 1002 - Page 859
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

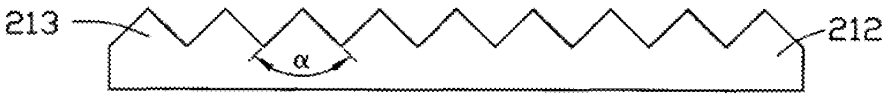


图 3

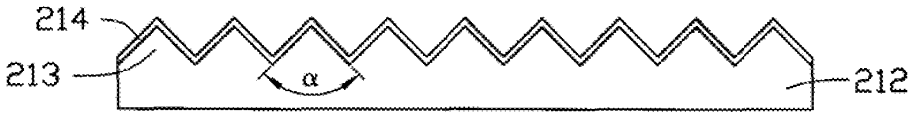


图 4



图 5

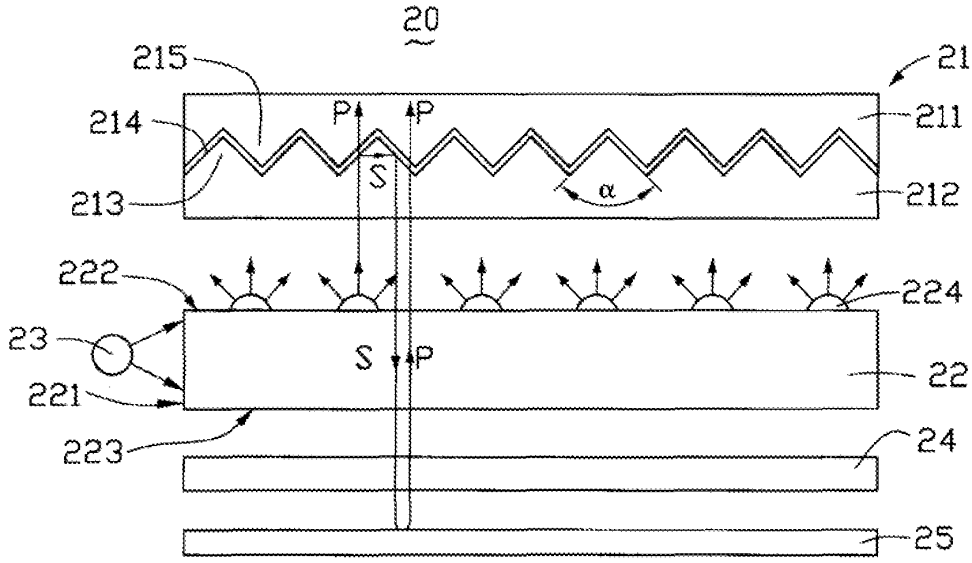


图 6

Microsoft Exhibit 1002 - Page 860
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 653 891 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **94308334.5**

(22) Date of filing : **11.11.94**

(51) Int. Cl.[6] : **H04N 13/04**

(30) Priority : **12.11.93 GB 9323402**

(43) Date of publication of application :
17.05.95 Bulletin 95/20

(84) Designated Contracting States :
DE FR GB

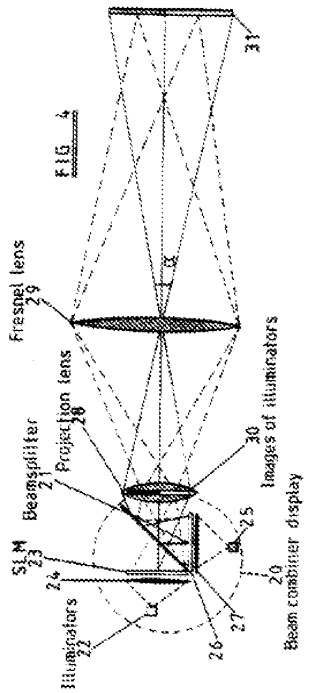
(71) Applicant : **SHARP KABUSHIKI KAISHA**
22-22 Nagaike-cho
Abeno-ku
Osaka 545 (JP)

(72) Inventor : **Woodgate, Graham John**
77 Greys Road
Henley-on-Thames, Oxon, RG9 1TD (GB)
Inventor : **Ezra, David**
19 Monks Mead,
Brightwell-cum-Sotwell
Wallingford, Oxon (FR)
Inventor : **Harrold, Jonathan**
1 Yeftly Drive
Sandford-on-Thames, Oxford (GB)
Inventor : **Omar, Basil Arthur**
2 Frogmore Lane
Stanford-in-the-Vale, Oxon, SN7 8LG (GB)

(74) Representative : **White, Martin David et al**
MARKS & CLERK,
Alpha Tower,
Suffolk Street Queensway
Birmingham B1 1TT (GB)

(54) Three-dimensional projection display apparatus.

(57) A 3D projection display comprises an autostereoscopic image producing means (22-27) which directs light beams corresponding to respective 2D views in different directions towards a projection lens (28). The projection lens (28) co-operates with the image producing means (22-27) to image the light beams at respective different regions (30) in the aperture of the projection lens (28). A light-transmissive screen co-operates with the image producing means (22-27) and the projection lens (28) to image the views at the screen. The screen may comprise a Fresnel lens (29) or where a magnified image of increased angular spread is required, a double lenticular screen angular amplifier (33).



EP 0 653 891 A1

Microsoft Exhibit 1002 - Page 861
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

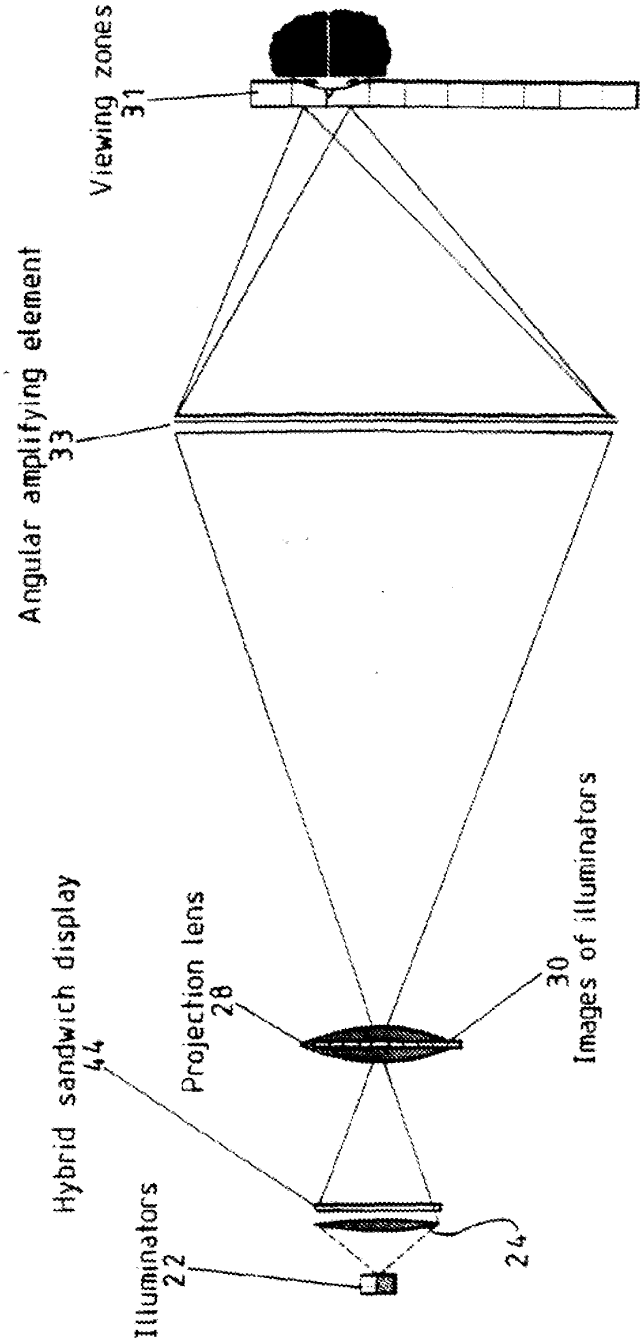


FIG 9

Microsoft Exhibit 1002 - Page 862
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

The present invention relates to a three-dimensional (3D) projection display apparatus.

Figure 1 of the accompanying drawings shows a known large screen 3D display comprising a plurality of projectors 1, each of which projects an image representing a two-dimensional (2D) view. The output light beams of the projectors 1 are directed to an autocollimating lenticular array 3. The 2D views are imaged at the array 3 and the light beams from the projectors are directed in different directions by the array 3 such that each eye of an observer 4 sees a different 2D view across the whole of the array 3, thus creating an autostereoscopic 3D image. Similar displays are disclosed in: "Survey of three dimensional television", James F. Butterfield, page 40 Proc. SPIE vol. 212 Optics and Photonics Applied to Three Dimensional Imagery (1979); and "Electronic Registration for an Autostereoscopic Lenticular 3D TV on a CRT: An equivalent of a Varifocal lens for an electronic 3D display", M. Okada, J. Hamasaki, S. Utsunomiya, O. Takeuchi, First International Symposium on 3D Images (Paris 26-28 September, 1991).

A display of this type can provide a large 3D image, for instance of about 1 metre diagonal size, but requires a relatively large number of projectors in order to provide an acceptable number of 2D views. Such a display is therefore prohibitively bulky and expensive. Further, without the use of expensive anamorphic correcting optics in the projectors 1, such a display suffers from keystone distortions between the projected images. Alternatively, real time electronic correction for keystone distortions may be necessary.

Figure 2 of the accompanying drawings shows another known type of projection 3D display using a single projector comprising a light source (not shown), a spatial light modulator (SLM) 5, and a projection lens 6. A plurality of spatially multiplexed 2D views is formed by the SLM and projected via the projection lens 6 on to a lenticular screen 7. However, in order to provide a large display with an adequate number of 2D views, the SLM 5 is required to provide a spatially multiplexed image having a resolution which is greater than can be provided by currently available devices. Further, very accurate control of registration of the images with respect to the lenticular screen is required which, in turn, requires a very well corrected projection lens 6. A similar type of system is disclosed in "50 inch autostereoscopic full colour 3D TV display system", Isono, Yasuda, Takemori, Kanayama, Yamada & Chiba, page 176 Proc. SPIE vol. 1669 Stereoscopic Displays and Applications III (1992).

Figure 3 of the accompanying drawings shows another known type of 3D autostereoscopic projection display comprising a cathode ray tube 8, a projection lens 9, a liquid crystal display (LCD) shutter 10, and a Fresnel lens 11. "The Design and Evaluation of a CRT based Autostereoscopic 3D Display", A.R.L. Travis, S.R. Lang, Proc. SID vol. 32/4, 1991. A temporally multiplexed image is provided on the screen of the cathode ray tube 8 and is imaged by projection lens 9 via the LCD shutter 10 on to the surface of the Fresnel lens 11. The temporally multiplexed image comprises a plurality of 2D views displayed in sequence on the screen of the tube 8. The shutter 10 provides a plurality of laterally displaced and sequentially transparent regions for controlling the directions in which the 2D views are visible to an observer. The shutter 10 is disposed as close to the projection lens 9 as possible and in the focal plane of the Fresnel lens 11, so that collimated light is imaged from each point in the shutter plane by the lens 11. However, this type of display is capable of providing only a limited size of image and a limited field of view.

GB 851 404 discloses a stereo viewer in which an optical system is provided for permitting two transparencies carrying left-eye and right-eye views to be seen by the left and right eyes, respectively, of an observer. Various techniques are described for enabling the left and right images corresponding to the left and right views to overlap at an image plane formed by a field lens. One such technique involves the use of a lens to control the overlapping of the images.

EP-A-0 309 630 discloses an arrangement in which the images from two halves of an object are imaged via different optical paths into one eye of an observer.

WO 88/08146 discloses an arrangement in which several display elements are imaged by an optical system to produce real intermediate images. A magnifying lens produces a real image of field diaphragms in the field of vision of an observer.

US 4 756 601 discloses a display in which images from a pair of cathode ray tubes are focused by lenses to form real images at a plane intermediate the lenses and a mirror. The images are then projected towards an observer by a common optical system comprising a concave mirror and a lens.

According to the invention, there is provided a 3D projection display apparatus as defined in the appended Claim 1.

Preferred embodiments of the invention are defined in the other appended claims.

It is thus possible to provide a 3D projection display apparatus which is capable of providing full colour or monochrome still or moving autostereoscopic images having a relatively large size and with an adequate number of views to provide an acceptable 3D image. Such an apparatus may be used for 3D television, 3D computer aided design and graphics, 3D medical imaging, virtual reality, and computer games. Also, such a display may be used to provide projection of hard copy from a computer peripheral full colour 3D printer. It is further possible to increase the image size of the 3D display while maintaining the required angular separation of the output views of the

Microsoft Exhibit 1002 - Page 863
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

apparatus. This may be achieved with a single relatively low aperture projection lens.

It is also possible to provide a large size 3D display with a large field of view using a single projection lens of relatively small output numerical aperture. Such a display does not require an optical shutter. The use of a single lens to project an autostereoscopic display reduces the cost, complexity, and ease of alignment of the optical system. The lower complexity compared with equivalent known systems makes the present invention more suitable for the projection of a larger number of views, thus improving the quality of the 3D display obtained.

Where an angular amplifying screen is provided, a larger degree of freedom of movement of the observer is permitted. This allows several observers to view the 3D image. Also, the display may be readily adapted to track the position of at least one observer so as to allow an even greater degree of movement while still being able to see an autostereoscopic 3D image.

As mentioned hereinbefore, known projection displays may suffer from keystone distortions or other image distortions in the plane of the screen. In the absence of expensive anamorphic correcting optics or complex electronic correction of images, keystone distortion may be at least partially corrected by offsetting SLMs with respect to the axes of the projection lenses, for instance in systems of the type shown in Figure 1. Such offsetting causes a reduction in the image quality. However, such problems are avoided with the present invention because there is no need for keystone distortion correction.

The present invention will be further described, by way of example, with reference to the accompanying drawings, in which:

Figures 1 to 3 illustrate respective known types of projection autostereoscopic 3D displays; and

Figures 4 to 13 are diagrammatic cross-sectional views of 3D displays constituting a first to ninth embodiments, respectively, of the invention.

The 3D autostereoscopic display shown in Figure 4 comprises a beam combiner display 20 in which 2D views are combined by means of a beam splitter 21. One or more illuminators 22 illuminate a SLM 23 via a lens 24 to provide one or more 2D views which are transmitted through the beam splitter 21. Similarly, one or more illuminators 25 illuminate a SLM 26 via a lens 27 to supply one or more 2D views which are reflected by the beam splitter 21 in such a way that the view provided by the SLMs 23 and 26 are spatially multiplexed. For the purposes of illustration in Figure 4, a single illuminator 22 and a single illuminator 25 are shown.

The output light beams from the beam combiner display 20 are imaged by a projection lens 28 and supplied to an output screen in the form of a fresnel lens 29. Two imaging processes take place in the display. In accordance with the first imaging process, each of the illuminators 22 and 25 is imaged into a separate position, shown at 30, in the aperture of the projection lens 28. The images of the illuminators are re-imaged by the Fresnel lens 29 to form an image 31 of the illuminators at an observer located at a defined image distance from the Fresnel lens 29.

In accordance with the second imaging process, the 2D images formed on the SLMs 23 and 26 are imaged by the projection lens 28 onto a front surface of the Fresnel lens 29. Thus, a different 2D view will be seen by the eyes of an observer when located at the images 31 of the illuminators 22 and 25. The image will appear in the plane of the Fresnel lens 29.

By imaging the illuminators at different positions in the aperture of the projection lens 28, the need for a shutter is eliminated, thus simplifying the display compared, for instance, with the display shown in Figure 3. A relatively large displayed image can be provided utilising SLMs of readily available type with acceptable resolution. Although Figure 4 illustrates a display in which only two 2D views are provided to form the 3D image, additional views can readily be provided. For instance, further beam splitters may be provided with additional illuminators, lenses, and SLMs. Alternatively, as mentioned hereinbefore, several illuminators may be provided for each SLM with the illuminators being illuminated one at a time and supplying light in respective different directions, with different 2D views being provided in sequence by each SLM, so as to provide temporal multiplexing of the 2D views. Beam combiner displays of this type are, for instance, disclosed in EP-A-0 602 934 based on British Patent Application No.9226272.4.

Using the Fresnel lens 29 as the output screen of the display, the angular spread of views is limited by the output numerical aperture of the projection lens 28. If a large magnification of the images produced by the SLMs is required, then the output numerical aperture has to be reduced, thus limiting the range of angles available. It is generally impractical to use very large projection lenses of sufficient imaging quality because of the expense.

To illustrate the problem, if the LCD size is 50 millimetres, with a 5:1 magnification by a 80 millimetre focal length projection lens of aperture f/1.9, then the image distance of the projection lens is 480 millimetres and the output numerical aperture $\alpha/2$ is 2.5 degrees. For four 2D views and a separation of the views at the observer of 65 millimetres, the observer will see a 3D image of size 250 millimetres at a distance of approximately 3,000 millimetres from the screen. This would be an unacceptable viewing distance for this image size.

The 3D display shown in Figure 5 overcomes this problem by using a double lenticular screen angular amplifier 33 as the output screen in place of the Fresnel lens 29. Also, the beam combiner display is shown

Microsoft Exhibit 1002 - Page 864
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

as having two illuminators 22 and two illuminators 25 for providing four 2D views.

The double lenticular screen angular amplifier 33 is of a similar type to an arrangement disclosed in GB 541 753 and by Hutley and Stevens in an article entitled "The formation of Integral Images by Afocal Pairs of Lens Arrays ("Super-Lenses")", page 147 IOP Short Meetings No.30, 1st May, 1992. The angular amplifier 33 comprises a first lenticular array 34 having a focal length f1 arranged to image each of the illuminators 22 and 25 at a plane diffuser 35. The images are re-imaged by a second lenticular array 36 having a focal length f2 which is less than f1. The shorter focal length of the second lenticular array results in the angular spread of the views being increased, so that the separation of the 2D views at the observer is increased and a reasonable angular spread is obtained. The aperture of the projections lens 28 may therefore be reduced while maintaining the appropriate separation of views at the observer.

Continuing the previously described numerical example, the output numerical aperture of the projection lens 28 in Figure 5 may be 2.5 degrees. For an observer distance from the screen of 1,000 millimetres and with four views with a spacing between adjacent views of 65 millimetres, a total output angular spread from the angular amplifier 33 of 1 5 degrees is required. A lenticular screen having a ratio f1:f2 of focal lengths equal to approximately 3:1 and with the lenses having substantially the same pitch would achieve this. For instance, f1 may be 5.7 millimetres and f2 may be 1.9 millimetres. The size of the image of the lens aperture behind each lenticular element (assuming a refractive index of 1.5) is approximately 0.5 millimetres, which defines the minimum lenticular pitch. The pixel sizes for a 500 x 500 pixel display at the 250 millimetre image projected on to the angular element 33 is 0.5 millimetres. Thus, it is possible to provide a 3D display of large size providing a large magnification and large angular spread of 2D views.

Another advantage provided by the use of the angular amplifier 33 is that a relatively large central lobe i.e. subtending a relatively large angle at the angular amplifier 33, is provided, thus allowing greater freedom of movement of the observer. In addition, the illuminators 22 and 25 may be made laterally movable and means provided for tracking the position of one or more observers. The large central lobe provides the possibility of more than one observer being able to view the display and the provision of observer tracking facilities may allow even greater freedom of movement.

The 3D display shown in Figure 6 differs from that shown in Figure 5 in that a field lens 37 of the Fresnel type is provided adjacent the angular amplifier 33 on the side thereof facing the projection lens 28. The field lens 37 is arranged to image the ray bundles in the appropriate directions on to the angular amplifier 33 such that, for each particular source, a single image is generated by the angular amplifying screen at the observer plane. Although such an arrangement may be provided without a field lens by controlling the relative pitch of the lenticular screens 34 and 36, the manufacturing tolerances required to achieve this are very tight. The same result can be achieved with the Fresnel field lens 37 with the position and focal length thereof suitably adjusted and such an arrangement requires lower manufacturing tolerances.

The display shown in Figure 7 differs from that shown in Figure 4 in that the beam combiner display 20 is replaced by a temporally multiplexed display. The temporally multiplexed display comprises contiguous illuminators 22 which illuminate a fast switching SLM 23 via a lens 24 to provide two temporally multiplexed 2D views. First and second 2D views are alternately displayed by the SLM 23 in synchronism with illumination of first and second of the illuminators, respectively.

The display shown in Figure 8 differs from that shown in Figure 5 in that the beam combiner display is replaced by a spatially multiplexed display. The spatially multiplexed display comprises a viewpoint corrected lenticular screen 42 disposed on the surface of a SLM 23 in the form of a liquid crystal device (LCD). The LCD displays spatially multiplexed 2D images such that strips of the images are interlaced in groups with each group aligned with a respective lenticule of the screen 42. The LCD 23 is suitably illuminated, for instance by a diffuse light source (not shown).

The display shown in Figure 9 differs from that shown in Figure 5 in that the beam combiner display is replaced by illuminators 22, a lens 24, and a hybrid sandwich display 44. The display 44 is of the type disclosed in European Patent Application No.93303590.9 published as EP-A-0 570 179 and for instance comprises an input lenticular screen, an SLM, a diffuser, and an output lenticular screen. The display 44 provides both spatially and temporally multiplexed 2D views.

The display shown in Figure 10 differs from that shown in Figure 4 in that the fresnel lens 29 is replaced by an angular amplifier 33 and the projection lens 28 is replaced by first and second projection lenses 28a and 28b. The lens 28a is disposed between the beam splitter 21 and the SLM 23 whereas the lens 28b is disposed between the beam splitter 21 and the SLM 26.

As shown in Figure 11, the projection display may be used to project a printed image. The printed image comprises a lenticular screen 40 on which is printed a view point corrected image comprising spatial multiplexed 2D views, for instance produced by means of the techniques disclosed in GB 9222346.0 and EP-A-0 596 629 (EP 93308447.7). By suitably illuminating

Microsoft Exhibit 1002 - Page 865
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

from the back or the front the lenticular screen 40, the image is projected on to the angular amplifier 33.

The projection display shown in Figure 12 comprises a beam combiner display 20 and projection lens 28 which are of the type shown in Figure 4 and which will not be described further. The display of Figure 12 differs from the previous displays in that the light transmitting screens in the forms of the Fresnel 29 and angular amplifier 33 are replaced by a reflective arrangement in the form of a direction preserving screen 50. The screen 50 comprises a lenticular screen 51 having a rear diffusing surface 52. The beam combiner display 20 may be replaced by any other suitable type of display, such as one of the types shown in the other drawings.

In use, the beam combiner display 20 images into a higher order lobe of the lenticular screen 51 with observation in the zeroth lobe. However, other modes may be used. For instance, the beam combiner display 20 and the projection lens 28 may be disposed above the viewing zone 31 so that vertical diffusion at the diffusing surface 52 allows observation of the 3D image.

The direction preserving screen 50 may be flat or curved as described by R. Borner, "Progress in Projection of Parallax Panoramagrams onto Wide Angle Lenticular Screens", page 35, SPIE vol. 761 "True 3D Imaging Techniques and Display Technologies" (1987). The use of the beam combiner display 20 can simplify reflective mode projection displays by replacing the plurality of projectors used in known systems and hence reducing problems with "keystone" distortion.

The display shown in Figure 13 differs from that shown in Figure 6 in that the diffuser 35 is omitted, the lenticular screen 36 is replaced by a lenticular screen 60 comprising optically diverging elements, and a further field correction lens 61 is provided on the opposite side of the angular amplifying screen 33 from the first field correction lens 37. Although two field correction lenses 37 and 61 are shown in Figure 13, it is possible to use a single field correction element, such as a single lens. Each lens of the screen 34 cooperates with the corresponding lens of the screen 60 to form a Galilean telescope, so that the angular amplifier 33 shown in Figure 13 effectively functions in the same way as the angular amplifier 33 of Figure 6.

The image plane of the lenticular screen 34 coincides with the object plane of the lenticular screen 60, these coincident planes being disposed to the right of the screen 60 in Figure 13. Thus, the focal length of the diverging lenses of the screen 60 is less than the focal length of the converging lenses of the screen 34.

Claims

1. A three-dimensional projection display apparatus, comprising autostereoscopic image producing means (20; 22-27; 40) for directing light beams corresponding to respective views in different directions, characterized by at least one projection lens (28) co-operating with the image producing means (20; 22-27; 40) to image the light beams at respective different regions in the aperture of the projection lens (28), and a light-transmissive or light-reflective screen (29; 34-36; 50) co-operating with the image producing means and the projection lens (28) to image the views at the screen (29; 34-36; 50).

2. An apparatus as claimed in Claim 1, characterized in that the screen (29) comprises a converging lens (29).

3. An apparatus as claimed in Claim 2, characterized in that the converging lens (29) is a Fresnel lens.

4. An apparatus as claimed in Claim 1, characterized in that the screen comprises a diffuser (35), a first array (34) of converging lenses disposed on a first side of the diffuser (35) for receiving light from the or each projection lens (28), and a second array (36) of converging lenses disposed on a second side of the diffuser (35), the lenses of the second array (36) having a focal length less than that of the lenses of the first array (34).

5. An apparatus as claimed in Claim 1, characterized in that the screen comprises a first array (34) of converging lenses for receiving light from the or each projection lens (28), a second array (60) of diverging lenses having a focal length less than that of the lenses of the first array (34), and a field correction element (37).

6. An apparatus as claimed in Claim 4 or 5, characterized in that each of the first and second arrays (34, 36; 34, 60) comprises a lenticular screen comprising cylindrical lenticules.

7. An apparatus as claimed in Claim 4, characterized in that a field lens (37) is disposed between the projection lens and the first array.

8. An apparatus as claimed in Claim 7, characterized in that the field lens (37) is a Fresnel lens.

9. An apparatus as claimed in Claim 1, characterized in that the screen comprises a direction-preserving lenticular screen (50) having a rear diffusing surface (52).

Microsoft Exhibit 1002 - Page 866
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

10. An apparatus as claimed in any one of the preceding claims, characterized in that the image producing means (20) comprises at least one spatial light modulator (24, 27) and a plurality of light sources (22, 25) arranged such that the light sources are imaged at the respective different regions in the aperture of the projection lens (28) and the or each spatial light modulator (22, 27) is imaged at the screen (29).

11. An apparatus as claimed in Claim 10, in which the image producing means (20) comprises a beam combiner (21) co-operating with first and second display means (22-24; 25-27).

12. An apparatus as claimed in Claim 11, characterized in that the at least one projection lens comprises first and second projection lenses (28a, 28b) disposed between the beam combiner (21) and the first and second display means (22-24, 25-27), respectively.

13. An apparatus as claimed in Claim 11 or 12, characterized in that each of the first and second display means (22-24, 25-27) comprises a spatial light modulator (23, 26) and at least one light source (22, 25).

14. An apparatus as claimed in any one of Claims 10 to 13, characterized in that the or each spatial light modulator (23, 26) is arranged to display temporally multiplexed 2D views and the plurality of light sources (22, 25) are arranged to illuminate the or each respective spatial light modulator (23, 26) in respective different directions corresponding to the 2D views.

15. An apparatus as claimed in any one of Claims 10 to 13, characterized in that the or each spatial light modulator (23, 26) is arranged to display spatially multiplexed 2D views and co-operates with a respective parallax screen (42).

16. An apparatus as claimed in Claim 15, characterized in that the parallax screen comprises a lenticular screen (42).

17. An apparatus as claimed in any one of Claims 10 to 13, characterized in that the or each spatial light modulator (23, 26) is disposed between an input lenticular screen and an output lenticular screen whose pitch is greater than that of the input lenticular screen.

18. An apparatus as claimed in any one of Claims 1 to 9, characterized in that the image producing means comprises a substrate carrying a spatially multiplexed image of the views and a lenticular screen (40).

19. An apparatus as claimed in Claim 18, in which the lenticular screen (40) is the substrate.

Microsoft Exhibit 1002 - Page 867
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

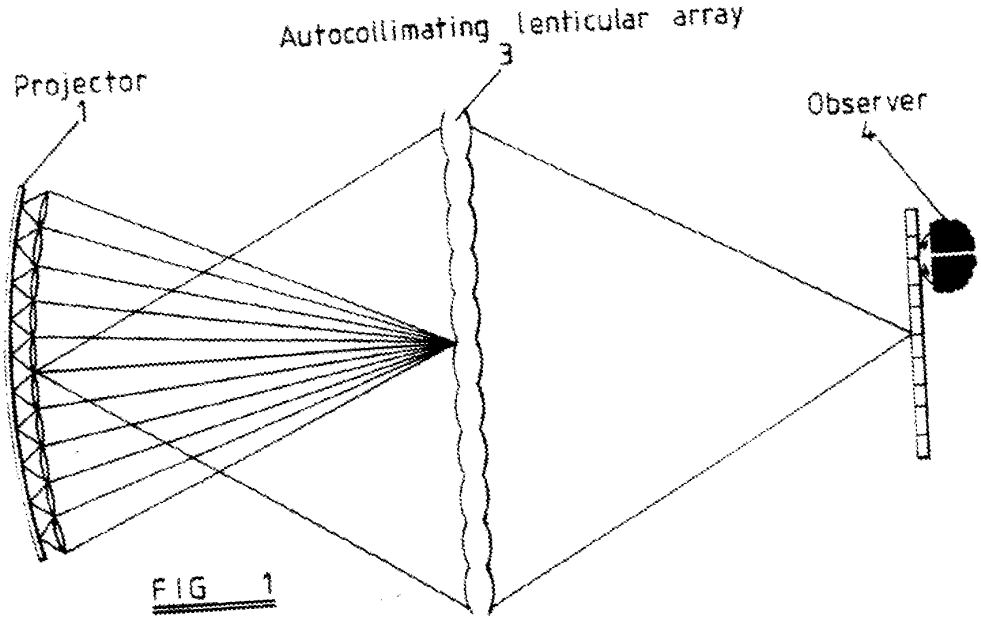


FIG 1

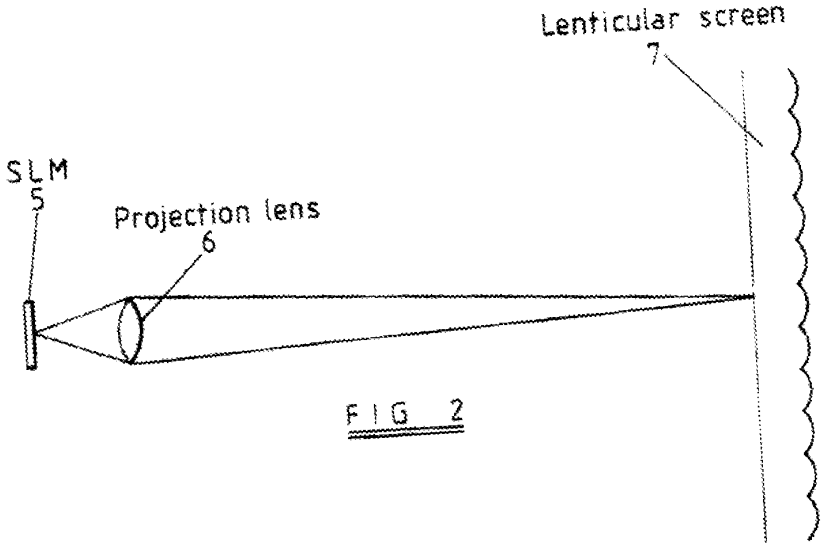


FIG 2

Microsoft Exhibit 1002 - Page 868
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG 3

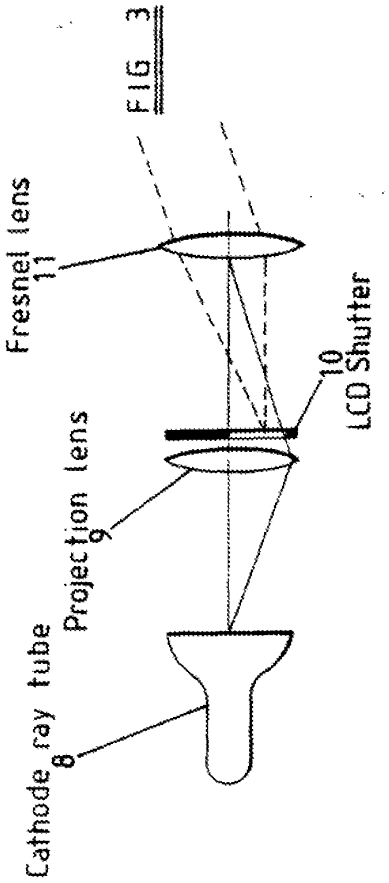
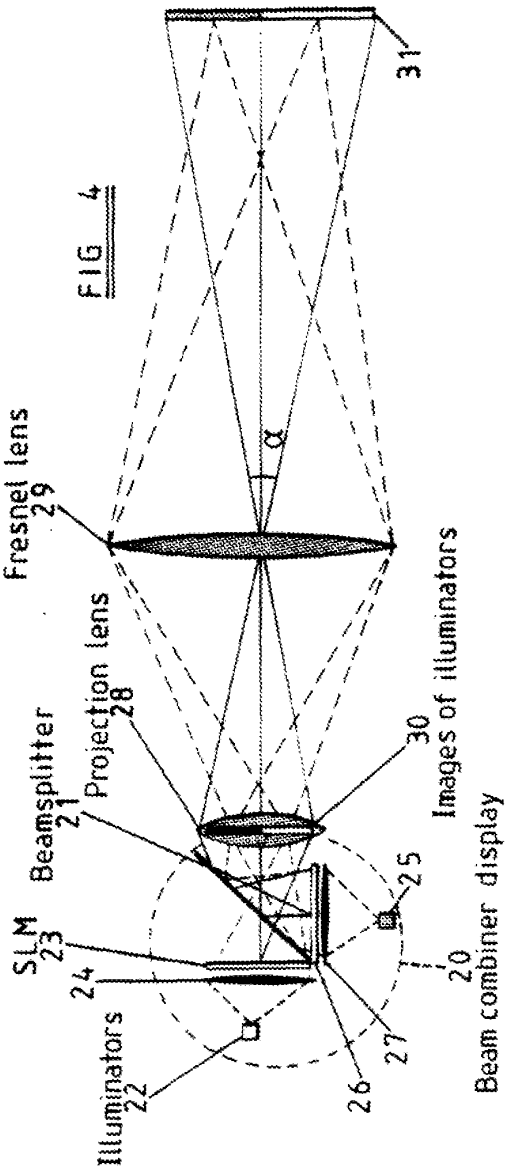
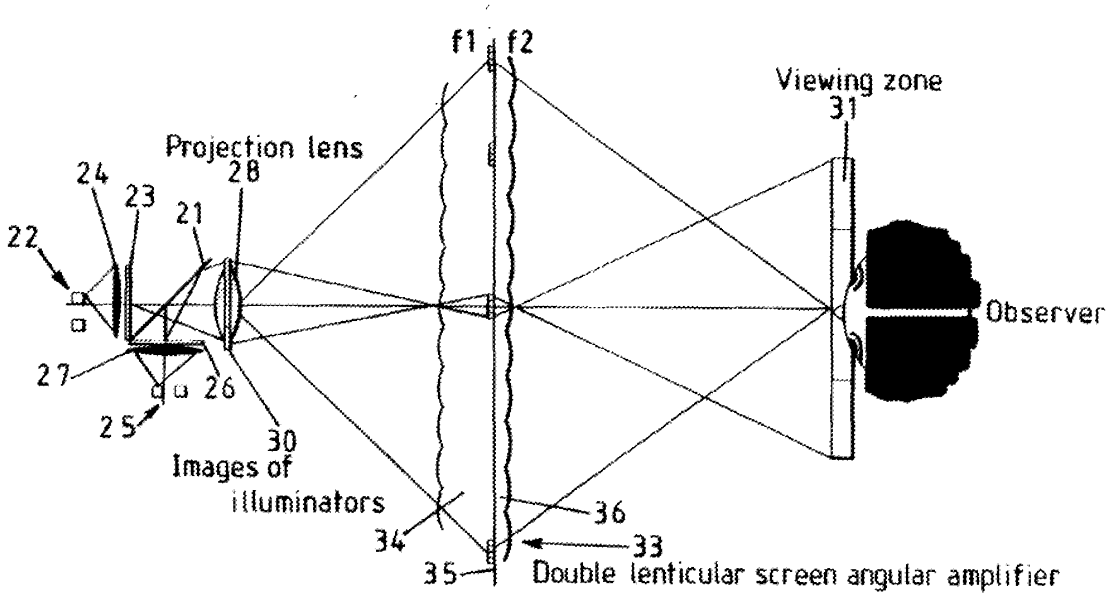


FIG 4



Microsoft Exhibit 1002 - Page 869
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG 5



Microsoft Exhibit 1002 - Page 870
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

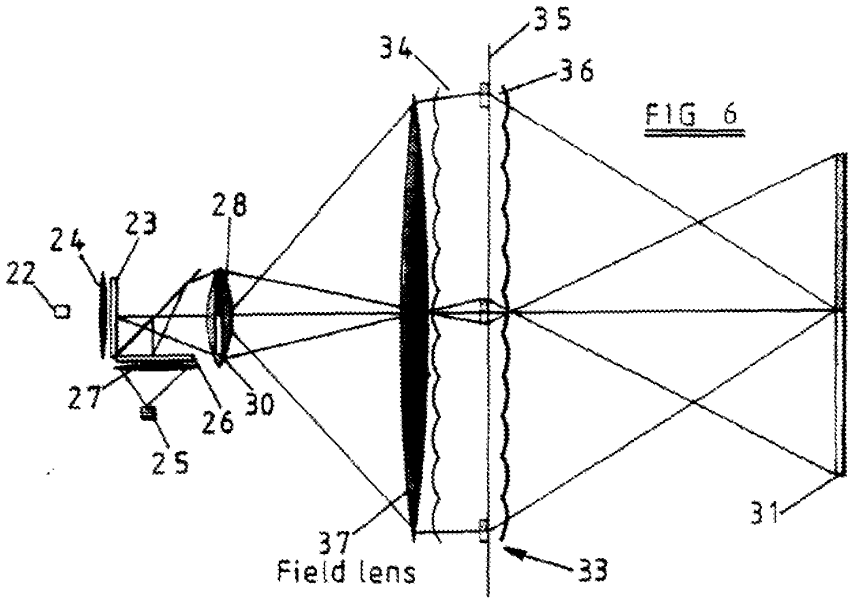


FIG 6

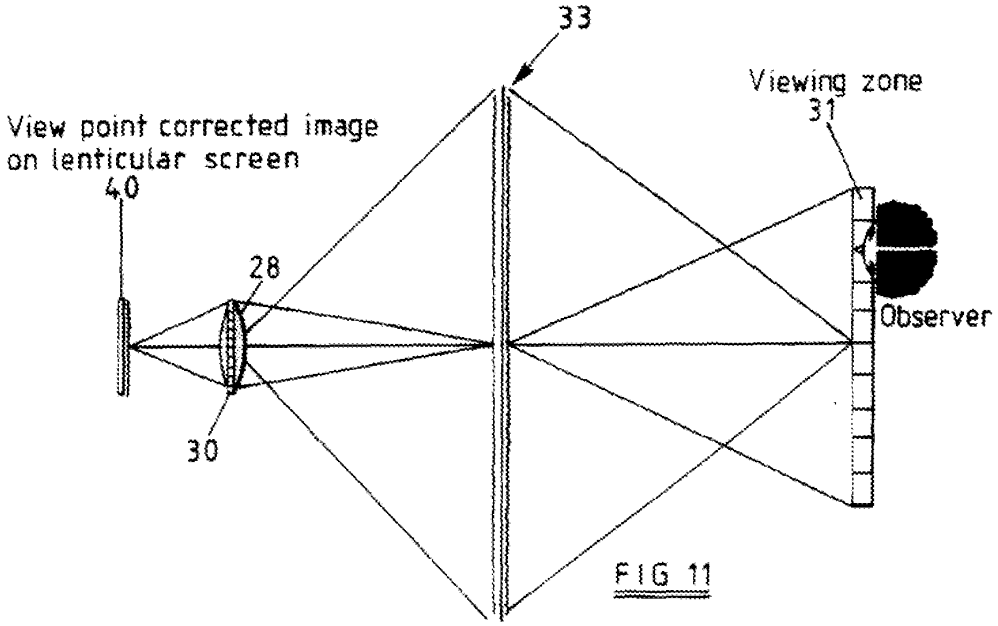


FIG 11

Microsoft Exhibit 1002 - Page 871
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

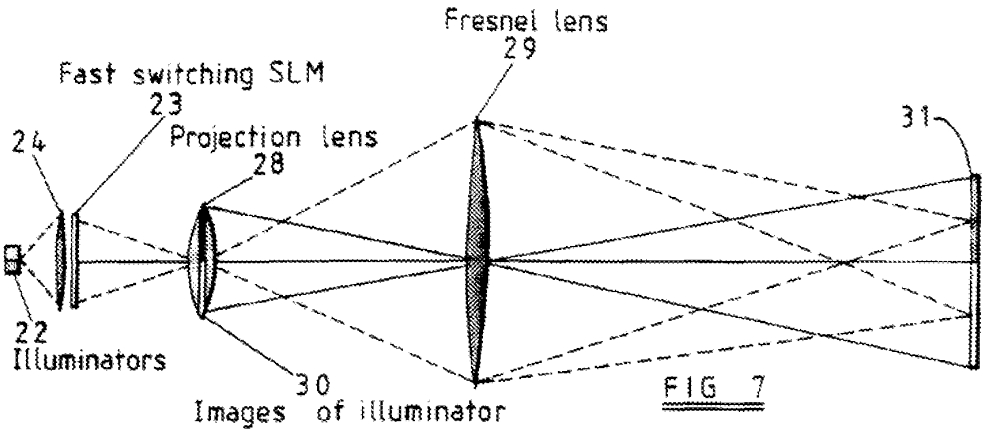


FIG 7

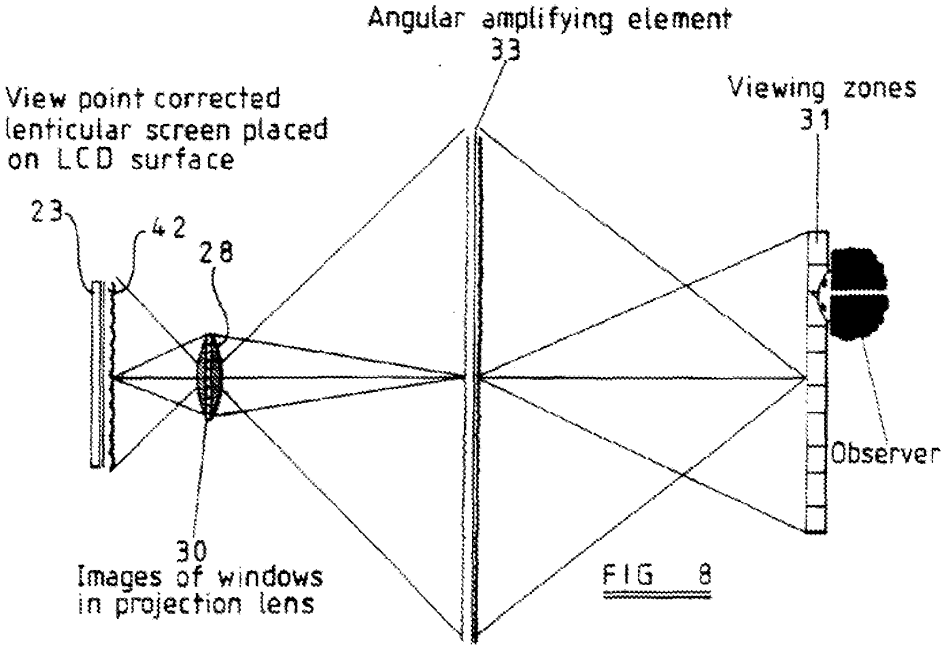


FIG 8

Microsoft Exhibit 1002 - Page 872
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

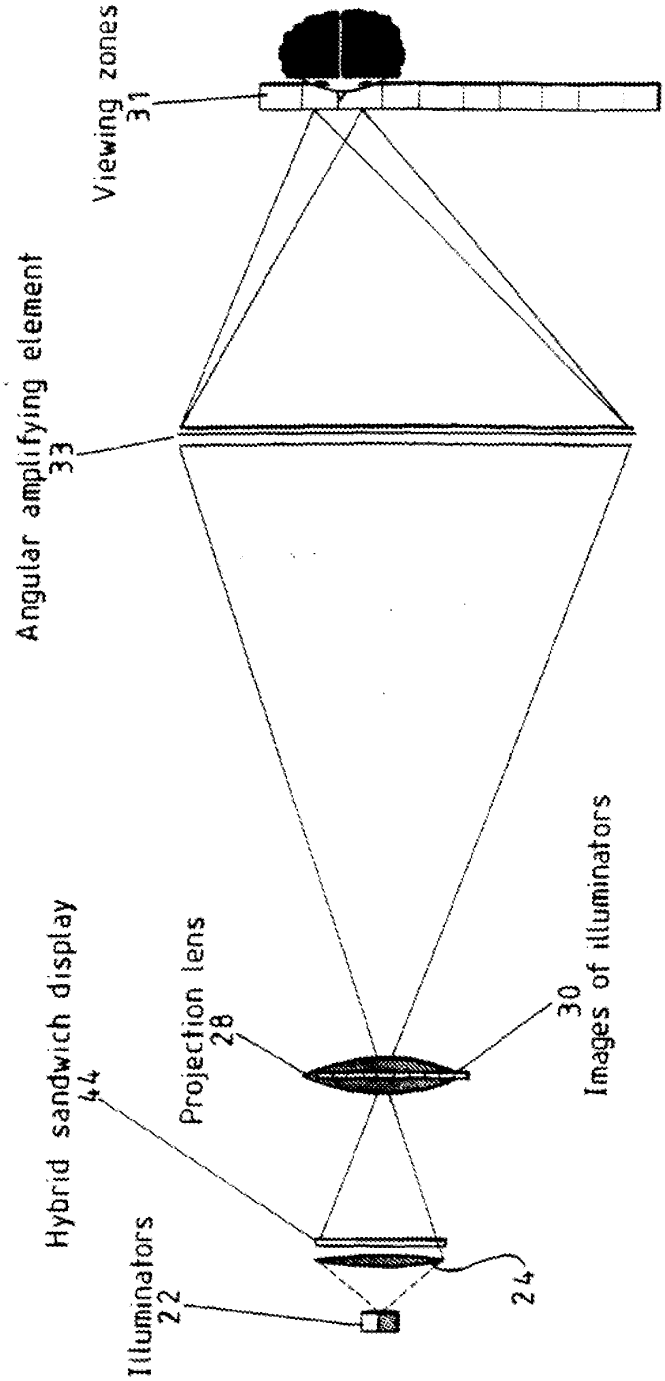


FIG 9

Microsoft Exhibit 1002 - Page 873
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

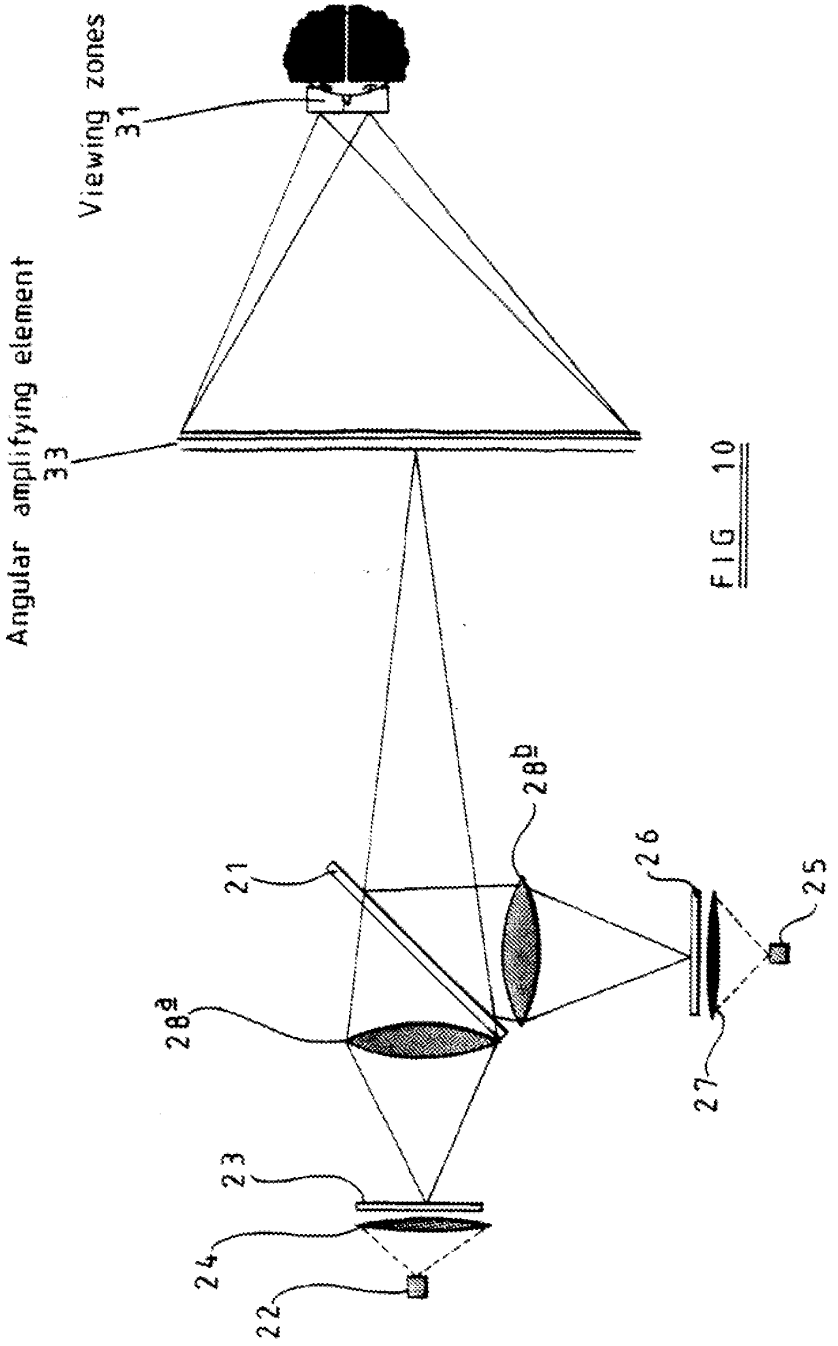


FIG 10

Microsoft Exhibit 1002 - Page 874
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

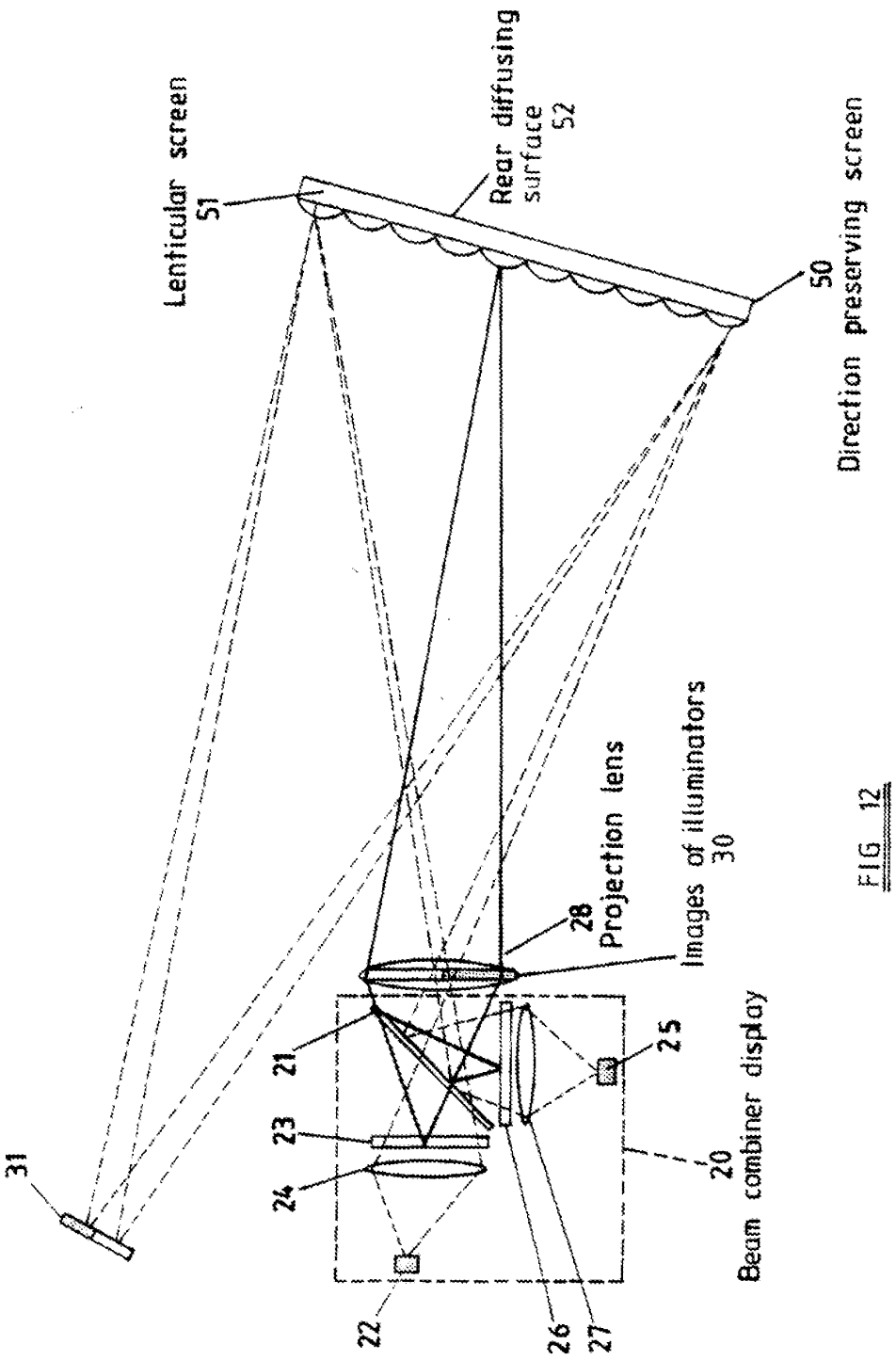


FIG 12

Microsoft Exhibit 1002 - Page 875
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

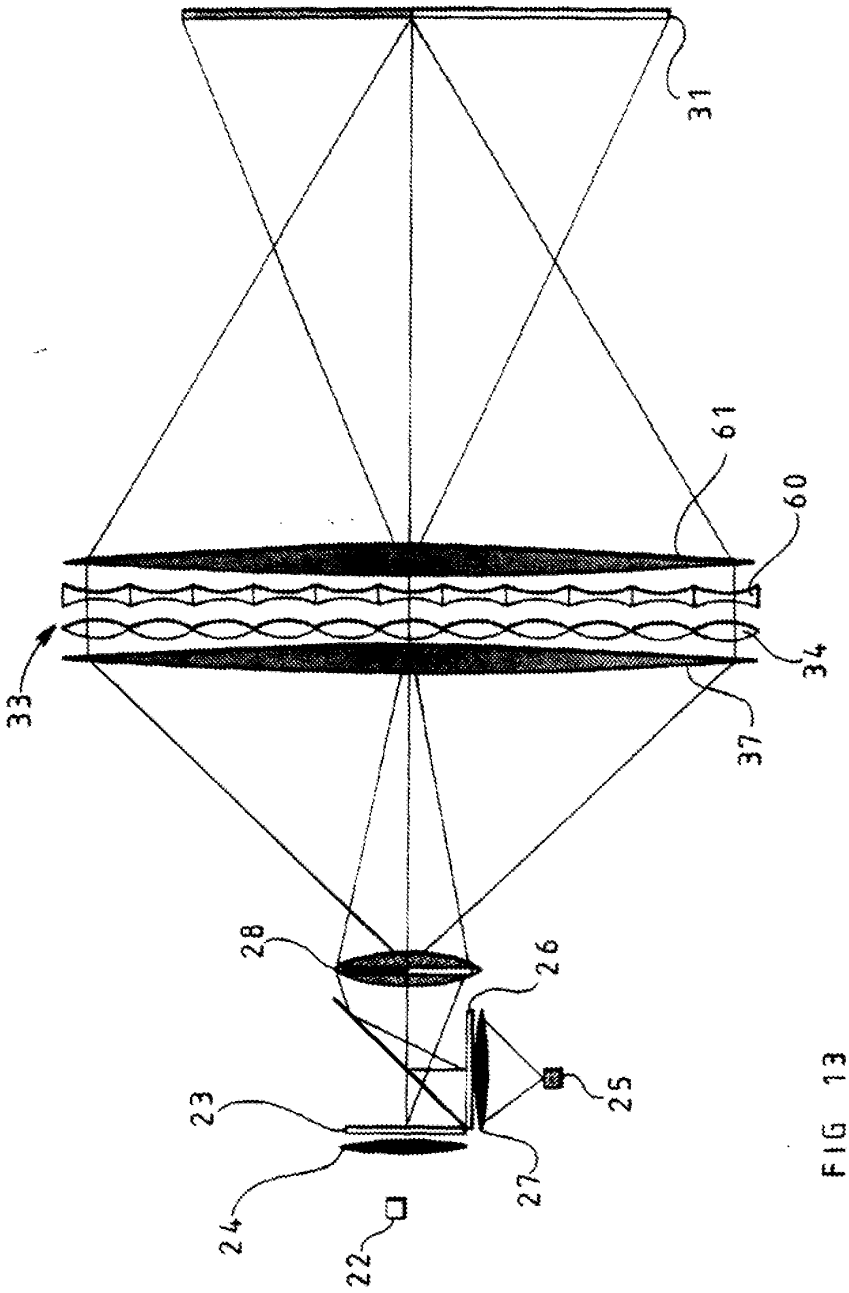


FIG 13

Microsoft Exhibit 1002 - Page 876
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 8334

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	GB-A-2 206 763 (A.R.L. TRAVIS) * page 2, line 28 - page 3, line 30; claims; figures 1,4,5 *	1-3,10, 14	H04N13/04
Y	WO-A-88 08146 (HOLTRONIC GESELLSCHAFT FUR HOLOGRAPHIE UND ELEKTRO-OPTIK MBH) * page 7, line 25 - page 8, line 16; figure 1 * * page 13, line 24 - page 14, line 2; figures 3,4 *	1-3,10, 14	
A	EP-A-0 063 252 (TOKYO SHIBAURA DENKI KABUSHIKI KAISHA) * page 3, line 21 - line 29; figure 1 *	4-9,15, 16	
P,D, A	EP-A-0 570 179 (SHARP KABUSHIKI KAISHA) * figures 1,2 *	14-19	
P,D, A	EP-A-0 602 934 (SHARP KABUSHIKI KAISHA) * figure 1 *	11	TECHNICAL FIELDS SEARCHED (Int.Cl.6) H04N G02B
A	US-A-4 469 415 (RADL)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 February 1995	Montanari, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

Microsoft Exhibit 1002 - Page 877
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

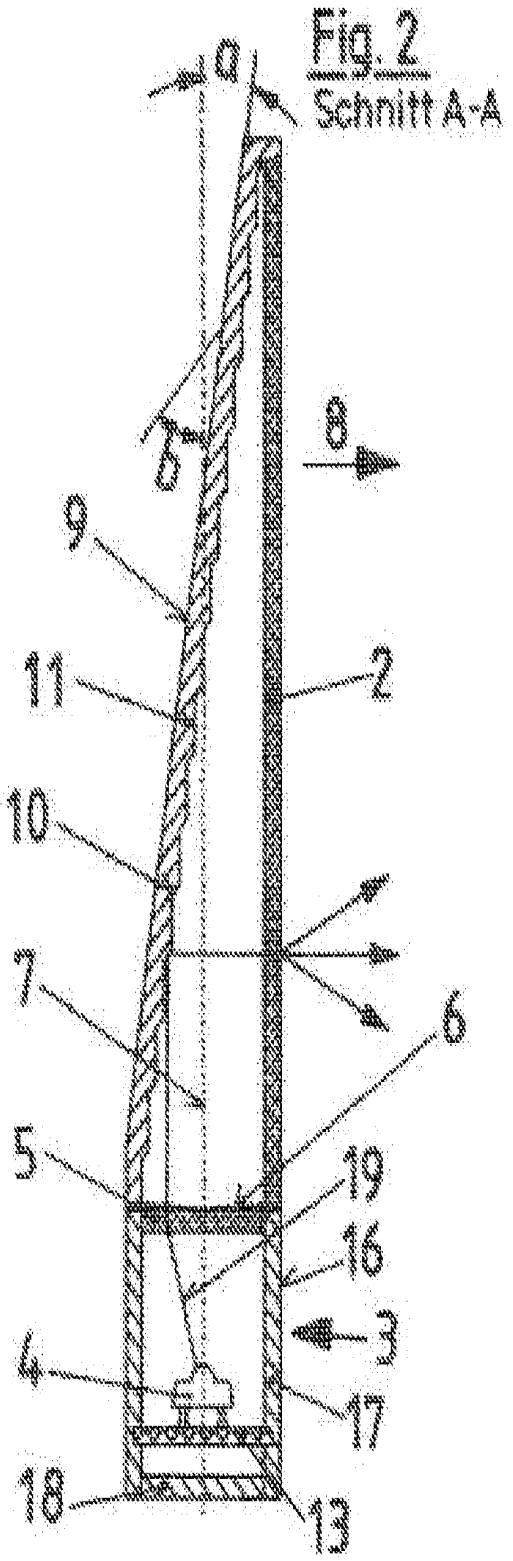
Abstract of EP0830984 (A2)

Translate this text into

Select language

Get machine translation powered by EPO and Google

The lamp has at least one lamp cell for a signal function with a transparent cover (2) with at least one light system (3). The system consists of a light source (4) with an intermediate cover (5) in front of it which contains Fresnel lens type segments (6) to concentrate the light. The longest dimension of the transparent cover and the optical axis (7) of the light system lie across the light exit direction (8). A mirror (9) has deflecting surfaces (10) deflecting the light beam in the direction of the transparent cover with its reflective surface lying at an acute angle (a) of less than forty five degrees to the optical axis. The lamp cell functioning as a signalling device has several adjacent optical systems with optical axes enclosed in an area lying across the direction of exit of the light



(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 830 984 A2

(12) EUROPÄISCHE PATENTANMELDUNG

(43) Veröffentlichungstag:
25.03.1998 Patentblatt 1998/13

(51) Int. Cl.[6]: **B60Q 1/26**

(21) Anmeldenummer: **97115322.6**

(22) Anmeldetag: **04.09.1997**

(84) Benannte Vertragsstaaten:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Benannte Erstreckungsstaaten:
AL LT LV RO SI

(30) Priorität: **19.09.1996 DE 19638081**

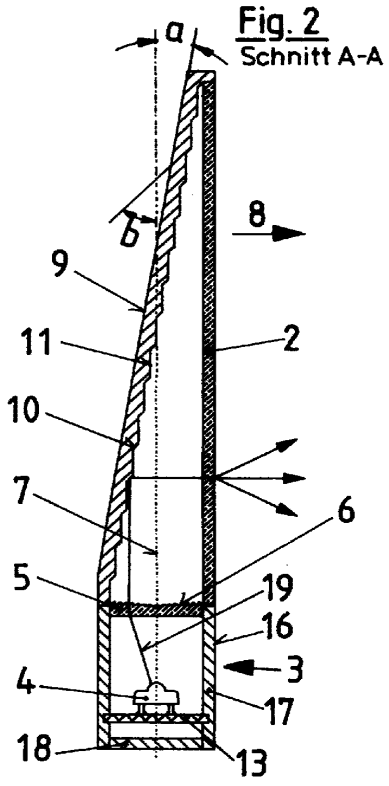
(71) Anmelder: **Hella KG Hueck & Co.**
59552 Lippstadt (DE)

(72) Erfinder:
- **Decker, Detlef**
  59558 Lippstadt (DE)
- **Jost, Franz-Gerhard**
  59821 Arnsberg (DE)

(54) Leuchte für Fahrzeuge

(57) Die Leuchte für Fahrzeuge weist eine Leuchtenkammer auf, welche durch eine lichtdurchlässige Lichtscheibe abgedeckt ist. In die Leuchtenkammer sind mehrere nebeneinander angeordnete optische Lichtsysteme eingesetzt. Die Lichtsysteme weisen eine als Lichtquelle dienende Leuchtdiode und eine der Leuchtdiode nachgeschaltete Zwischenscheibe auf, welche mit das Licht bündelnden optischen Elementen besetzt ist. Die Lichtsysteme verlaufen mit ihren optischen Achsen und die Lichtscheibe in ihrer Hauptausdehnung quer zur Lichtaustrittsrichtung der Leuchte. In die gebündelten Lichtstrahlen der Lichtsysteme ist ein Umlenkspiegel eingesetzt, welcher zu den optischen Achsen der Lichtsysteme in einem spitzen Winkel verläuft, welcher kleiner als 45° ist. Der Umlenkspiegel ist partiell mit Umlenkflächen versehen, auf welche die gebündelten Lichtstrahlen der Lichtsysteme auftreffen.

Fig. 2
Schnitt A-A



EP 0 830 984 A2

Printed by Xerox (UK) Business Services
2.15.12/3.4

Microsoft Exhibit 1002 - Page 879
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Beschreibung

Die Erfindung betrifft eine Leuchte für Fahrzeuge mit mindestens einer Leuchtenkammer für eine Signalfunktion, mit einer die Leuchtenkammer abdeckenden lichtdurchlässigen Lichtscheibe, mit mindestens einem optischen Lichtsystem, welches eine Lichtquelle und eine der Lichtquelle nachgeschaltete Zwischenscheibe aufweist, die mit das Licht bündelnden optischen Elementen besetzt ist, wobei die lichtdurchlässige Lichtscheibe mit ihrer Hauptausdehnung und die optische Achse des optischen Lichtsystems quer zur Lichtaustrittsrichtung der Leuchte verläuft und mit einem das gebündelte Licht reflektierenden Umlenkspiegel, welcher in einem spitzen Winkel zur optischen Achse des Lichtsystems verläuft und das Licht in Richtung der Lichtscheibe reflektiert.

Eine Leuchte für Fahrzeuge dieser Art ist aus der DE 30 05 883 A1 bekannt. Die Leuchte ist seitlich neben einem Scheinwerfer für Fahrzeuge in eine Karosserieöffnung eingesetzt und weist eine Signalfunktion für Blinklicht auf. Eine äußere Lichtscheibe der Leuchte verläuft mit ihrer Außenseite bündig zur angrenzenden Außenseite des Fahrzeugs. Die Lichtscheibe der Leuchte ist außen gewölbt und verläuft ebenso wie eine optische Achse eines optischen Lichtsystems der Leuchte quer zur Lichtaustrittsrichtung der Leuchte. Das Lichtsystem der Leuchte ist in Lichtaustrittsrichtung gesehen seitlich neben der lichttechnisch wirksamen Signalfläche der Lichtscheibe angeordnet und weist ein Gehäuse für einen schalenförmigen Reflektor, eine im Brennort des Reflektors angeordnete Lichtquelle und eine der Lichtquelle nachgeschaltete Zwischenscheibe auf. Die Zwischenscheibe weist im zentralen Bereich an der Innenseite optische Elemente auf, welche das direkt von der Lichtquelle ausgehende Licht bündeln. Die optischen Elemente der Zwischenscheibe sind von Fresnellinsen gebildet, durch welche die gebündelten Lichtstrahlen parallel zueinander verlaufen. Durch den äußeren umlaufenden breiten Randbereich der Lichtscheibe gehen die durch den schalenförmigen Reflektor reflektierten und parallel gerichteten Lichtstrahlen hindurch. Ein solches Lichtsystem weist zwar eine hohe Beleuchtungsstärke auf, jedoch baut es in Richtung der Lichtaustrittsrichtung der Leuchte entsprechend groß.

Die gebündelten Lichtstrahlen des optischen Lichtsystems treffen auf eine plattenartigen Umlenkspiegel auf, welcher in einem spitzen Winkel von ca. 45° zur optischen Achse des optischen Lichtsystems verläuft. An der Spiegelfläche des Umlenkspiegels reflektieren die gebündelten Lichtstrahlen des optischen Lichtsystems zur äußeren Lichtscheibe der Leuchte hin. In Lichtaustrittsrichtung gesehen ist die Signalfläche der Lichtscheibe nicht größer als die Lichtaustrittsfläche des Lichtsystems im Bereich seiner Zwischenscheibe. Je größer die Signalfläche der Lichtscheibe sein soll um so größer ist die Lichtaustrittsfläche des Lichtsystems und somit die Bautiefe in Lichtaustrittsrichtung der Leuchte.

Aufgabe der Erfindung ist es, die im Oberbegriffs des Anspruchs 1beschriebene Leuchte für Fahrzeuge derart zu gestalten, daß die Leuchte bei einer kleinen Bautiefe eine Lichtscheibe mit einer großen Signalfläche aufweist. Diese Aufgabe wird nach der Erfindung dadurch gelöst, daß

- in der für eine Signalfunktion dienenden Leuchtenkammer mehrere optische Lichtsysteme nebeneinander angeordnet sind, deren optische Achsen in einer quer zur Lichtaustrittsrichtung der Leuchte verlaufenden Fläche liegen;

- der spitze Winkel zwischen dem Umlenkspiegel und den optischen Achsen der Lichtsysteme kleiner als 45° ist;

- der Umlenkspiegel partiell mit Umlenkflächen versehen ist, auf welche die gebündelten Lichtstrahlen der Lichtsysteme auftreffen.

Wegen der Verwendung von mehreren nebeneinander angeordneten optischen Lichtsystemen und weil bei jedem optischen System eine Leuchtdiode als Lichtquelle dient, können die optischen Lichtsysteme in Lichtaustrittsrichtung klein bauen. Die Leuchtdioden sollten einen aus divergierend zueinander verlaufenden Lichtstrahlen bestehenden Lichtkegel aufweisen, welcher die Zwischenscheibe annähernd bis zu ihrem Rand ausleuchtet. Die Zwischenscheibe sollte etwa bis zum Rand mit den die Lichtstrahlen bündelnden optischen Elementen besetzt sein. Die Zwischenscheibe kann sehr flach bauen, wenn die das Licht bündelnden optischen Elemente von fresnellinsenartigen Segmenten gebildet sind. Durch fresnellinsenartige Segmente kann das gebündelte Licht parallel zueinander verlaufen. Je kleiner der spitze Winkel zwischen dem Umlenkspiegel und den optischen Achsen der Lichtsysteme ist, um so länger ist die Signalfläche der lichtdurchlässigen Lichtscheibe. Der Umlenkspiegel kann in seiner Hauptausdehnung eben oder gewölbt ausgeführt sein. Bei einer besonders vorteilhaften Ausführung der Leuchte beträgt der Winkel zwischen dem Umlenkspiegel und den optischen Achsen der Lichtsysteme maximal 20°. Dadurch ist es möglich, die Leuchte in ein flache Mulde des Fahrzeugs einzusetzen. Diese Mulde kann durch Tiefziehen des Fahrzeugblechs hergestellt sein.

Die optischen Achsen der Lichtsysteme können in einem äquvidistanten Abstand zu der Lichtscheibe verlaufen, wenn die Umlenkflächen zu der optischen Achse der Lichtsysteme in einem spitzen Winkel verlaufen, welcher etwa 45° beträgt. Zwischen den Umlenkflächen sollte der Umlenkspiegel Flächenabschnitte aufweisen, welche annähernd parallel zu der optischen Achse der Lichtsysteme verlaufen. Hierbei sollten die durch die Lichtsysteme gebündelten Lichtstrahlen parallel zueinander verlaufen.

Microsoft Exhibit 1002 - Page 880
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Die Umlenkflächen und die zwischen ihnen verlaufenden Flächenabschnitte sind besonders einfach gestaltet, wenn sie streifenförmig ausgeführt sind und in ihrer Längsausdehnung quer zu den optischen Achsen der Lichtsysteme verlaufen.

Wenn möglich sollten die Umlenkflächen in einem solchen Winkel verlaufen, daß sie das von den Lichtsystemen gebündelte Licht total reflektieren. Ist letzteres nicht möglich, so sollten die an der Innenseite des Umlenkspiegels angebrachten Umlenkflächen mit einer die gebündelten Lichtstrahlen der Lichtsysteme reflektierenden Beschichtung versehen sein.

Die Signalfläche der Lichtscheibe ist weitestgehend homogen ausgeleuchtet, wenn die Umlenkflächen konvex ausgeführt sind und das Licht gestreut zu Lichtscheibe hin reflektieren.

Bei Lichtscheiben, welche lichtdurchlässige Öffnungen und zwischen den Öffnungen lichtundurchlässige Bereiche aufweisten, ist es vorteilhaft, wenn die Umlenkflächen konkav ausgeführt sind und das Licht durch die lichtdurchlässigen Öffnungen der Lichtscheibe hindurchlenken.

Die optischen Lichtsysteme der Leuchte sind einfach aufgebaut, wenn die von den Leuchtdioden gebildeten Lichtquellen auf einer streifenförmigen Trägerplatte angebracht sind und die das Licht bündelnden optischen Elemente der Lichtsysteme an einer einstückig und streifenförmig ausgeführte Zwischenscheibe angebracht sind.

Bei einer Leuchtenkammer, dessen Lichtscheibe eine besonders große Signalfläche aufweisen soll, ist es vorteilhaft, wenn die Leuchte auf sich gegenüberliegenden Seiten der Lichtscheibe nebeneinander angeordnete Lichtsysteme aufweist, deren Umlenkspiegel mit einem Randbereich aneinander grenzen. Dadurch kann die Leuchtenkammer auch eine sehr große Beleuchtungsstärke aufweisen. Die beiden Umlenkspiegel können einer Signalfunktion dienen, ohne daß zwischen ihnen ein dunkler Streifen von der Vorderseite der Leuchte her zu sehen ist, wenn die Umlenkspiegel mit ihrem Randbereich in einem Abstand zur Innenseite der Lichtscheibe verlaufen. Dienen die beiden Umlenkspiegel unterschiedlichen Signalfunktionen, so ist es vorteilhaft, wenn die Umlenkspiegel mit ihrem aneinander grenzenden Randbereich sich zur Innenseite der Lichtscheibe hin erstrecken und in diesem Randbereich einen lichtundurchlässigen Abschnitt aufweisen.

Zwei Ausführungsbeispiele nach der Erfindung sind in der Zeichnung dargestellt und zwar zeigen

Figur 1 in einer Vorderansicht eine Leucht für Fahrzeuge mit mehreren Leuchtenkammern, welche an einer Seite mehrere nebeneinander angeordnete Lichtsysteme aufweisen;

Figur 2 einen Schnitt nach der Linie A-A der Figur 1;

Figur 3 einen Schnitt durch eine Leuchte für Fahrzeuge, welche auf sich gegenüberliegenden Seiten nebeneinander angeordnete Lichtsysteme aufweist;

Figur 4 eine Teilansicht X der Figur 3 in vergrößertem Maßstab;

Figur 5 einen Schnitt nach der Linie B-B in Figur 3.

Die in den Figuren 1 und 2 dargestellte Leuchte für Fahrzeuge ist eine Heckleuchte für Fahrzeuge, welche eine geringe Bautiefe aufweist und somit in eine nicht dargestellte äußere flache Fahrzeugmulde einsetzbar ist. Die Fahrzeugmulde kann durch Tiefziehen eines Karosserieblechs hergestellt sein. Die Lichtscheiben der Leuchtenkammern (1,15) sind rechteckförmig gestaltet und verlaufen in ihrer Hauptausdehnung annähernd in einem rechten Winkel zur Lichtaustrittsrichtung (8) der Leuchte. Entgegen der Lichtaustrittsrichtung (8) gesehen ist seitlich neben den Lichtscheiben (2) der Leuchtenkammern (1,15) ein langgestrecktes Gehäuse (16) für nebeneinander angeordnete Lichtsysteme (3) angeordnet. Die vordere Seitenwand (17) des Gehäuses (16) verläuft mit ihrer Außenseite zur Außenseite der Lichtscheiben (2) bündig. Die vordere Seitenwand (17) des Gehäuses (16) kann auch von einem seitlichen Randabschnitt der Lichtscheiben (2) gebildet sein. Letzterer Randabschnitt oder ein dem Randabschnitt vorgeschaltetes Zwischenelement sollte aus lichtundurchlässigem Werkstoff bestehen. Die seitlich nebeneinander angeordneten Lichtsysteme (3) weisen von Leuchtdioden gebildete Lichtquellen (4) und eine den Lichtquelle (4) nachgeschaltete Zwischenscheibe (5) auf. Die Zwischenscheiben (5) der optischen Systeme sind in jeder Leuchtenkammer (1,15) einstückig aus lichtdurchlässigem Material hergestellt und streifenförmig ausgeführt. Die von Leuchtdioden gebildeten Lichtquellen (4) sind in jeder Leuchtenkammer (1,15) an einer streifenförmig ausgeführten Trägerplatte (13) angebracht, welche durch einen eine Öffnung des Gehäuses (16) verschließenden Deckel (18) in dem Gehäuse (16) gehaltert ist. Die von den Lichtquellen (4) ausgehenden Strahlen verlaufend divergierend zueinander und bilden einen Lichtkegel, welcher die Zwischenscheibe (5) zumindest bis nahe an ihren äußeren Rand ausleuchtet. In die als Lichtquellen (4) dienenden Leuchtdioden können das Licht reflektierende Elemente integriert sein. Die Zwischenscheibe (5) ist mit optischen Elementen (6) versehen, welche die Lichtstrahlen (19) der Lichtsysteme (3) bündeln. Die optischen Elemente (6) sind auf der den Lichtquellen (4) abgewandten Seite der Zwischenscheibe (5) angebrachte Fresnellinsen, durch welche die Lichtstrahlen (19) parallel zu den optischen Achsen (7) der Lichtsysteme (3) verlaufen. Die optischen Achsen (7) liegen in einer Fläche, welche in einem äquvidistanten Abstand zu der Hauptfläche der Lichtscheibe (2) verläuft. In den Strahlengang der parallel gerichteten Lichtstrahlen (19) ist

Microsoft Exhibit 1002 - Page 881
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

ein Umlenkspiegel (9) eingesetzt, welcher plattenförmig ausgeführt ist und in einem spitzen Winkel (a) zu den optischen Achsen (7) bzw. den parallel gerichteten Lichtstrahlen (19) verläuft. Der Umlenkspiegel (9) ist mit einem Rand mit der Lichtscheibe (2) und mit dem anderen Rand mit einer rückwärtigen Seitenwand des Gehäuses (16) der Lichtsysteme (3) verbunden. Der spitze Winkel (a) beträgt etwa 45°. Der Umlenkspiegel (9) weist auf seiner der Lichtscheibe (2) zugewandten Innenseite Umlenkflächen (10) auf, welche in einem spitzen Winkel (b) zu den optischen Achsen (7) bzw. zu den parallel zueinander verlaufenden Lichtstrahlen (19) verlaufen. Der spitze Winkel (b) ist etwa 45° groß. Zwischen den Umlenkflächen (10) verlaufen die Flächenabschnitte (11), welche etwa parallel zu den optischen Achsen (7) der Lichtsysteme (3) verlaufen. Die Umlenkflächen (10) und die Flächenabschnitte (11) sind streifenförmig ausgeführt und verlaufen in ihrer Längsausdehnung in einem äquvidistanten Abstand zu der Fläche, in welcher die optischen Achsen (7) der Lichtsysteme (3) liegen. Die Flächenabschnitte (11) und die Umlenkflächen (10) sind mit einer die Lichtstrahlen (19) reflektierenden Beschichtung versehen. Die von den optischen Elementen (6) der Zwischenscheibe (5) parallel gerichteten Lichtstrahlen (19) treffen auf die Umlenkflächen (10) auf und reflektieren dort in Richtung der Lichtscheibe (2). Die Lichtstrahlen (19) treffen annähernd in einem rechten Winkel auf die Lichtscheibe (2) auf. Die Lichtscheibe (2) weist an ihrer Innenseite nicht dargestellte optische Mittel auf, welche die Lichtstrahlen (19) streuen.

Der Umlenkspiegel (9) kann sowohl plattenförmig als auch gewölbt verlaufen. Bei einer gewölbten Ausführung des Umlenkspiegels (9) muß dieser zumindest in seinem größten Bereich in jedem Punkt in einem spitzen Winkel (a) zu den optischen Achsen (7) der Lichtsysteme (3) verlaufen.

Die Figuren 3, 4 und 5 zeigen eine Heckleuchte für Fahrzeuge, welche eine Bremsleuchte ist. Die Bremsleuchte weist auf gegenüberliegenden Seiten ihrer Lichtscheibe (2) jeweils nebeneinander angeordnete Lichtsysteme (3) auf. Die den Lichtsystemen (3) zugeordneten Umlenkspiegel (9) grenzen mit ihrem Randbereich (14) aneinander und sind einstückig aus lichtdurchlässigem Kunststoff hergestellt. Die Umlenkflächen (10) der Umlenkspiegel (9) sind Grenzflächen, welche die Lichtstrahlen (19) zum Lot hin brechen. Die Außenseite (12) des Umlenkspiegels (9) ist mit einer die Lichtstrahlen (19) reflektierenden Beschichtung versehen. Nach einer Reflextion der Lichtstrahlen (19) an der reflektierenden Beschichtung gehen die Lichtstrahlen (19) durch die Flächenabschnitte (11) an der Innenseite des Umlenkspiegels (9) hindurch und treffen auf die lichtdurchlässige Lichtscheibe (2) auf, an welcher sie durch an die Innenseite der Lichtscheibe (2) angebrachte optischen Mittel (20) streuen. Obwohl die Umlenkspiegel (9) mit ihrem angrenzenden Bereich sehr nahe zur Innenseite der Lichtscheibe (2) verlaufen, erscheint die Lichtscheibe (2) von der Vorderseite der Leuchte her auch im Randbereich (14) homogen ausgeleuchtet, da die Umlenkspiegel (9) aus einem lichtdurchlässigen Werkstoff hergestellt sind.

Bezugszeichenliste

Leuchte für Fahrzeuge

1	Leuchtenkammer
2	Lichtscheibe
3	Lichtsystem
4	Lichtquelle
5	Zwischenscheibe
6	optische Elemente
7	optische Achse
8	Lichtaustrittsrichtung
9	Umlenkspiegel
10	Umlenkflächen
11	Flächenabschnitte
12	Außenseite
13	Trägerplatte
14	Randbereich
15	Leuchtenkammer
16	Gehäuse
17	vordere Seitenwand
18	Deckel
19	Lichtstrahl
20	optische Mittel

Patentansprüche

1. Leuchte für Fahrzeuge mit mindestens einer Leuchtenkammer (1) für eine Signalfunktion, mit einer die Leuchtenkammer (1) abdeckenden lichtdurchlässigen Lichtscheibe (2), mit mindestens einem optischen Lichtsystem (3), welches eine Lichtquelle (4) und eine der Lichtquelle (4) nachgeschaltete Zwischenscheibe (5) aufweist, die mit das Licht bündelnden optischen Elementen (6) besetzt ist, wobei die lichtdurchlässige Lichtscheibe (2) mit ihrer Hauptausdehnung und das optische Lichtsystem (3) mit seiner optischen Achse (7) quer zur Lichtaustrittsrichtung (8) der Leuchte verlaufen, und mit einem das gebündelte Licht reflektierenden Umlenkspiegel (9), welcher zumindest in seinem größten Bereich in jedem Punkt in einem spitzen Winkel (a) zur optischen Achse (7) des Lichtsystems (3) verläuft und das Licht in Richtung der Lichtscheibe (2) reflektiert, dadurch gekennzeichnet, daß

   - in der für eine Signalfunktion dienenden Leuchtenkammer (1) mehrere optische Lichtsysteme (3) nebeneinander angeordnet sind, deren optische Achsen (7) in einer quer zur Lichtaustrittsrichtung (8) der Leuchte umlaufenden Fläche liegen,

Microsoft Exhibit 1002 - Page 882
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

- der spitze Winkel (a) zwischen dem Umlenkspiegel (9) und den optischen Achsen (7) der Lichtsysteme (3) kleiner als 45° ist,

- der Umlenkspiegel (9) partiell mit Umlenkflächen (10) versehen ist, auf welche die gebündelten Lichtstrahlen der Lichtsysteme (3) auftreffen.

2. Leuchte nach Anspruch 1, dadurch gekennzeichnet, daß der Winkel (a) zwischen 5° und 40° beträgt.

3. Leuchte nach Anspruch 1, dadurch gekennzeichnet, daß der Winkel (a) maximal 20° beträgt.

4. Leuchte nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß die Umlenkflächen (10) zu der optischen Achse (7) der Lichtsysteme (3) in einem spitzen Winkel (b) verlaufen, welcher zwischen 30° und 70° groß ist.

5. Leuchte nach Anspruch 4, dadurch gekennzeichnet, daß der spitze Winkel (b) etwa 45° groß ist.

6. Leuchte nach einem der Ansprüche 1 bis 5, dadurch gekennzeichnet, daß Flächenabschnitte (11) zwischen den Umlenkflächen (10) des Umlenkspiegels (9) angeordnet sind und annähernd parallel zur optischen Achse (7) der Lichtsysteme (3) verlaufen.

7. Leuchte nach einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß die Umlenkflächen (10) und die zwischen ihnen verlaufenden Flächenabschnitte (11) streifenförmig ausgeführt sind und in ihrer Längsausdehnung quer zu den optischen Achsen (7) der Lichtsysteme (3) verlaufen.

8. Leuchte nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß die Umlenkflächen (10) mit einer die gebündelten Lichtstrahlen der Lichtsysteme (3) reflektierenden Beschichtung versehen sind.

9. Leuchte nach einem der Ansprüche 1 bis 8, dadurch gekennzeichnet, daß die Umlenkflächen (10) konvex ausgeführt sind und das Licht gestreut zur Lichtscheibe (2) hin reflektieren.

10. Leuchte nach einem der Ansprüche 1 bis 8, dadurch gekennzeichnet, daß die Umlenkflächen (10) konkav ausgeführt sind und das Licht durch lichtdurchlässige Öffnungen im Bereich der Lichtscheibe (2) hindurchlenken.

11. Leuchte nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß die Umlenkflächen (10) des Umlenkspiegels (9) als Grenzflächen dienen, die die gebündelten Lichtstrahlen der Lichtsysteme (3) zu seiner Außenseite (12) hin brechen, und die Außenseite (12) des Umlenkspiegels (9) eine Reflexionsfläche ist, die das Licht in Richtung der Flächenabschnitte (11) des Umlenkspiegels (9) reflektiert.

12. Leuchte nach Anspruch 11, dadurch gekennzeichnet, daß die Außenseite (12) des Umlenkspiegels (9) mit einer das gebündelte Licht reflektierenden Beschichtung versehen ist.

13. Leuchte nach einem der Ansprüche 1 bis 12, dadurch gekennzeichnet, daß die von Leuchtdioden gebildeten Lichtquellen (4) auf einer streifenförmigen Trägerplatte (13) angebracht sind.

14. Leuchte nach einem der Ansprüche 1 bis 13, dadurch gekennzeichnet, daß die das Licht bündelnden optischen Elemente (6) der Lichtsysteme (3) an eine einstückig und streifenförmig ausgeführte Zwischenscheibe (5) angebracht sind.

15. Leuchte nach einem der Ansprüche 1 bis 14, dadurch gekennzeichnet, daß die Leuchte auf sich gegenüberliegenden Seiten der Lichtscheibe (2) nebeneinander angeordnete Lichtsysteme (3) aufweist, deren Umlenkspiegel (9) mit einem Randbereich (14) aneinander grenzen.

16. Leuchte nach Anspruch 15, dadurch gekennzeichnet, daß die Umlenkspiegel (9) mit ihrem Randbereich (14) in einem Abstand zur Innenseite der Lichtscheibe (2) verlaufen.

17. Leuchte nach Anspruch 15, dadurch gekennzeichnet, daß die Umlenkspiegel (9) mit ihrem aneinander grenzenden Randbereich (14) sich zur Innenseite der Lichtscheibe (2) hin erstrecken und in diesem Randbereich (14) einen lichtundurchlässigen Abschnitt aufweisen.

Microsoft Exhibit 1002 - Page 883
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Fig.1

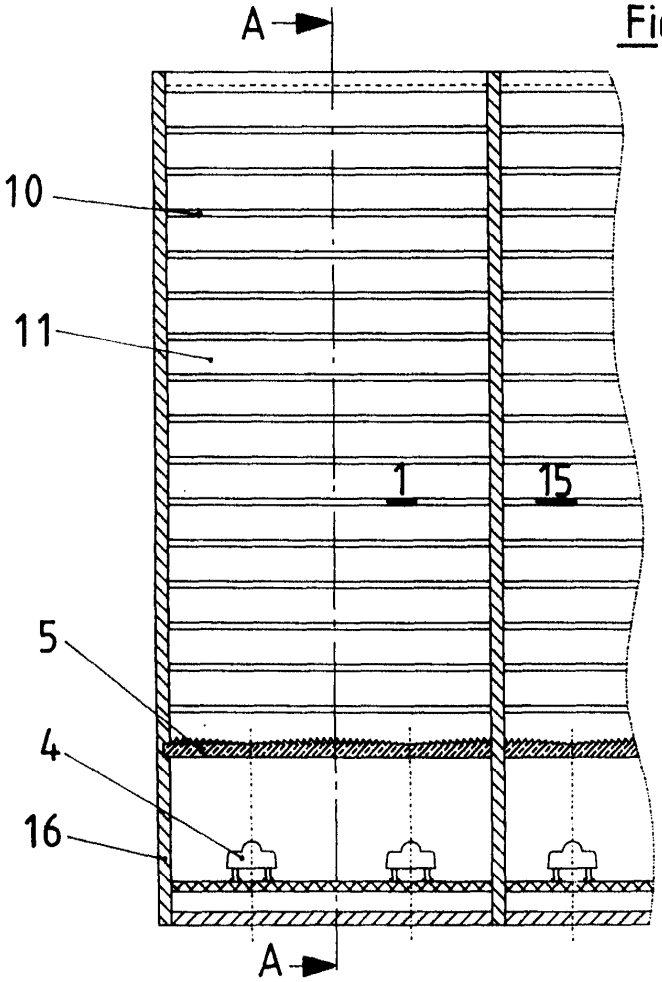
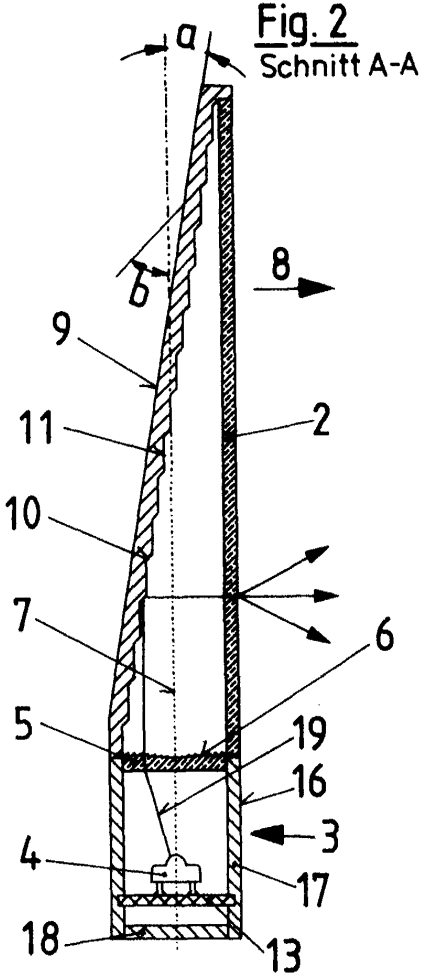


Fig. 2
Schnitt A-A



Microsoft Exhibit 1002 - Page 884
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Fig.5
Schnitt B-B

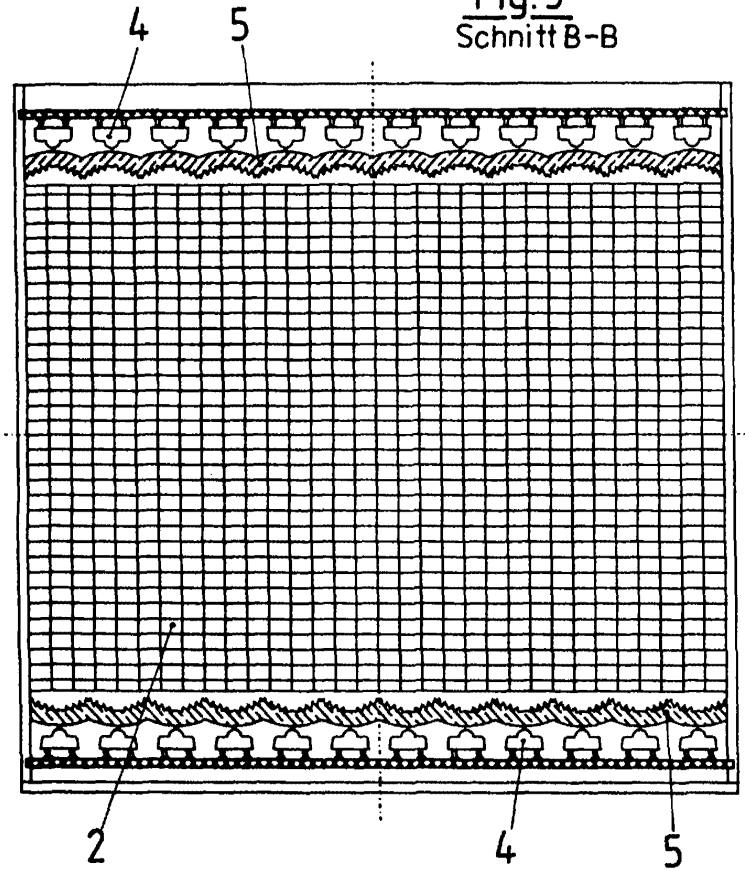


Fig.3

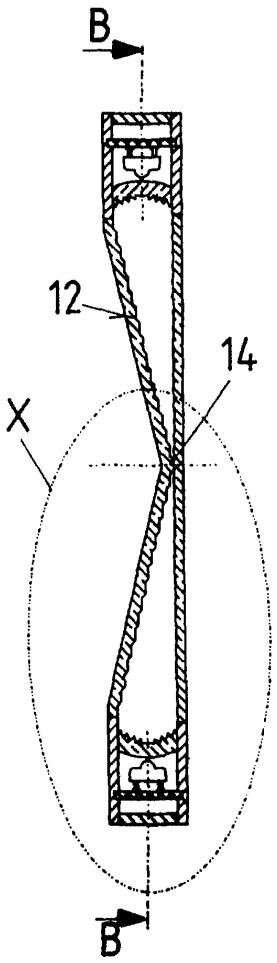
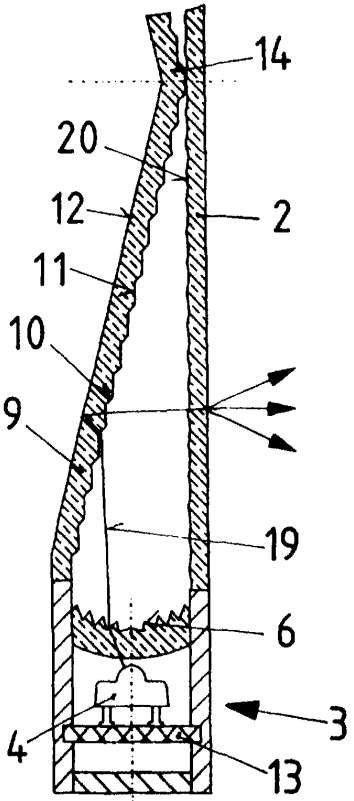


Fig.4
Teilansicht X



Microsoft Exhibit 1002 - Page 885
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 860 729 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
26.08.1998 Bulletin 1998/35

(51) Int Cl.[6]: **G02B 27/22**, H04N 13/00

(21) Application number: **98301174.3**

(22) Date of filing: **18.02.1998**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **20.02.1997 JP 36328/97**

(71) Applicant: **CANON KABUSHIKI KAISHA**
Tokyo (JP)

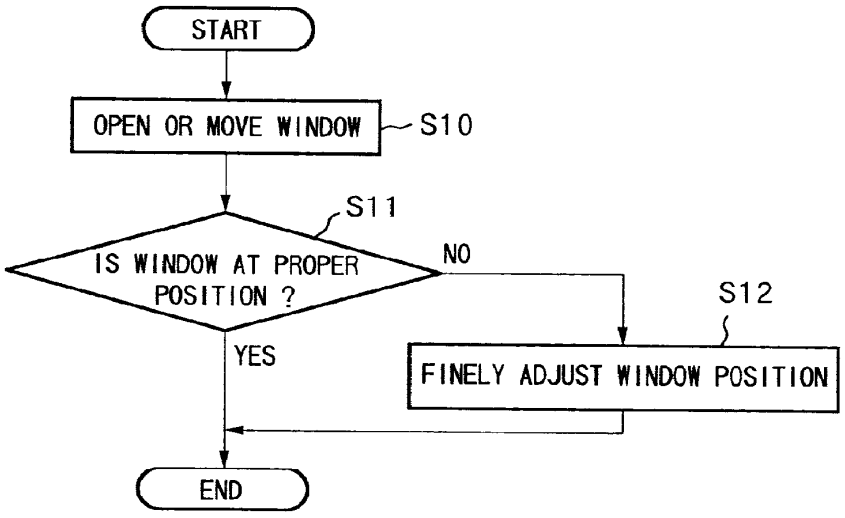
(72) Inventor: **Sudo, Toshiyuki**
Ohta-ku, Tokyo (JP)

(74) Representative:
Beresford, Keith Denis Lewis et al
BERESFORD & Co.
2-5 Warwick Court
High Holborn
London WC1R 5DJ (GB)

(54) Image display system, information processing apparatus, and method of controlling the same

(57) A stereoscopic image display apparatus for displaying a stereoscopic image, which is obtained by alternately arranging stripe parallax images R and L corresponding to the right and left eyes, in a window includes a parallax barrier for a stereoscopic vision. When the display position of a window including a stereoscopic image which is set after the window is opened or moved and the positions of the right-eye and left-eye stripes of a parallax barrier have a relationship which does not allow a proper stereoscopic vision, the display position of the window is moved by one stripe in the horizontal direction.

FIG.8



EP 0 860 729 A2

Printed by Jouve, 75001 PARIS (FR)

Microsoft Exhibit 1002 - Page 886
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a stereoscopic display apparatus which allows an observer to observe a stereoscopic image by using the parallax between the right and left eyes, an information processing apparatus, a host computer for controlling the display apparatus, and a method therefor, thereby providing an operation environment for comfortable stereoscopic display.

RELATED BACKGROUND ART

In general, a stereoscopic image display apparatus of the parallax barrier scheme is known well as an apparatus for displaying a stereoscopic image. The parallax barrier scheme is disclosed in S. H. Kaplan, "Theory of Parallax Barriers.", J. SMPTE, Vol. 59, No. 7, pp. 11 - 21 (1952). According to this scheme, a striped image obtained by alternately arranging at least right and left images of a plurality of parallax images from a plurality of viewpoints into a vertically striped pattern is observed through a slit pattern (called a parallax barrier) having predetermined opening portions placed at a predetermined distance from this image. With this operation, the observer observes images corresponding to the respective eyes with the corresponding eyes. Japanese Patent Laid-Open Nos. 3-119889 and 5-122733 disclose stereoscopic display apparatuses in which a parallax barrier is electronically generated by a transmission type liquid crystal display device and the like, and the shape and position of each stripe are variably controlled to improve the compatibility with conventional 2D image display apparatuses.

Fig. 19 shows the basic arrangement of the stereoscopic image display apparatus disclosed in Japanese Patent Laid-Open No. 3-119889. This stereoscopic image display apparatus includes a transmission type liquid crystal display apparatus 101 for displaying images and an electronic parallax barrier 103 constituted by a transmission type liquid crystal display placed on the liquid crystal display apparatus 101 sandwiching a spacer 102 having a thickness d.

The transmission type liquid crystal display apparatus 101 displays a vertically striped image consisting of parallax images sensed from two or more directions. A parallax barrier pattern is formed at an arbitrary position on the barrier surface of the electronic parallax barrier 103 upon designation of X and Y addresses by a control means such as a microcomputer, thereby allowing a stereoscopic vision based on the principle of the above parallax barrier scheme. Note that when this electronic parallax barrier is made colorless and transparent throughout the entire image display area, a 2D image can be displayed, thus realizing the compatibility between the 2D display and 3D display.

An apparatus capable of performing mixed display of 3D and 2D images within a single frame is disclosed in Japanese Patent Laid-Open No. 5-122733. In this apparatus, as shown in Figs. 20A and 20B, a striped barrier pattern can be generated only in a partial area of the electronic parallax barrier 103.

The lenticular scheme is also known widely as a means for displaying a stereoscopic image by using the parallax between the right and left eyes of an observer as in the parallax barrier scheme. In the lenticular scheme, a lenticular lens constituted by an array of many semicylindrical lenses is placed on the front surface of a display to spatially separate an image into images for the right and left eyes, thereby allowing the observer to observe a stereoscopic image. In the display of the lenticular scheme as well, an image displayed on the screen is a vertically striped image obtained by alternately arranging right and left images.

As a stereoscopic display using a horizontally striped image obtained by alternately arranging right and left images, Cyberbook (trademark) is available from Vrex Inc. In this display, as shown in Fig. 21, a striped polarizing plate 202 obtained by alternately arranging two types of polarizing plates, whose polarization axis directions are perpendicular to each other, in units of horizontal lines is placed on the front surface of the liquid crystal display of a notebook personal computer 201. A displayed image is observed through polarization glasses 203 having the two types of polarizing plates corresponding to those used for the striped polarizing plate 202 arranged for the right and left eyes. (In Fig. 21, the arrows indicate polarizing direction of the polarizing direction of the polarizing plates.) With this arrangement, of the displayed image, lines to be seen with the right and left eyes of the observer can be separated/selected. For example, the odd lines of the liquid crystal display are used a right-eye image display lines, and the even lines are used as left-eye image display lines to allow the observer to separately observe images formed by the respective lines with the corresponding eyes.

Various environments in which 3D displays are used can be conceived. Assume that an entire screen is occupied by a single type of image as in the case of a television set. In this case, the relative positional relationship between a displayed image and each constituent element of the apparatus always remains the same. Once, therefore, the observer sets his/her eyes at an optimal observation position, he/she can continuously obtain a proper stereoscopic vision. Assume that a plurality of windows are opened on one screen, and images are to be displayed in the respective windows like images handled in a computer. In this case, as the positions of the windows change, the relationship between each image and each constituent element of the apparatus changes. As a result, the optimal observation position changes, and hence the observer cannot always obtain

Microsoft Exhibit 1002 - Page 887
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

a proper stereoscopic vision.

When, for example, a barrier 1 of the parallax barrier scheme and a striped image 2 displayed on the image display apparatus maintain a proper relative positional relationship, as shown in Fig. 22, light forming an image for the left eye propagates to a left eye 3, and light forming an image for the right eye propagates to a right eye 4. As a result, the observer can properly recognize a stereoscopic image.

If, however, the relative positions of the barrier 1 and the striped image 2 displayed on the image display apparatus are shifted by one pitch in the horizontal direction with respect to the positions in Fig. 22, as shown in Fig. 23, light forming an image for the left eye propagates to the right eye 4, and light forming an image for the right eye propagates to the left eye 3. As a result, a "reversed stereoscopic vision" for the observer is produced.

When a plurality of windows are opened, and stereoscopic images are displayed in the respective windows, in particular, stereoscopic visions may be properly produced in some windows, but reversed stereoscopic visions may be produced in other windows.

When windows are opened, and images are displayed in the respective windows in this manner, since the relative positions of the barrier 1 and the striped image 2 are likely to change, the possibility of the occurrence of a reversed stereoscopic vision is high. This tendency applies to any stereoscopic display scheme, as well as the parallax barrier scheme, in which the relative positional relationship between a displayed image and other optical parts is important.

The same applies to Cyberbook available from Vrex, which uses a "horizontally striped" parallax image as a striped image. In this case, when, for example, the relative positions of a striped polarizing plate and a striped image displayed on the image display apparatus are shifted by one pitch in the vertical direction, a reversed stereoscopic vision is produced.

SUMMARY OF THE INVENTION

The present invention has been made in consideration of the above problems, and has as its object to provide an image display system and an information processing apparatus which can always allow a proper stereoscopic vision by controlling the arrangement of the stripe parallax images of a stereoscopic image displayed in a window to be suited to a display apparatus, and a method of controlling the system and the apparatus.

It is another object of the present invention to provide an information processing apparatus and method which can always allow an observer to have a proper stereoscopic vision even with a change in the position of each window when several windows are opened on the screen, and images are displayed in the windows like images handled in a computer.

It is still another object of the present invention to allow a stereoscopic vision in units of windows.

It is still another object of the present invention to always allow a proper stereoscopic vision without changing the contents displayed in a window.

It is still another object of the present invention to always allow a proper stereoscopic vision without changing the display position of a window.

It is still another object of the present invention to allow a proper stereoscopic vision while a window is moved.

According to an aspect of the present invention, in order to achieve the above objects, there is provided an image display system capable of performing stereoscopic display, comprising stereoscopic image display means for displaying a stereoscopic image having stripe parallax images arranged for right and left eyes, stereoscopic vision control means for controlling directivity of the stereoscopic image such that stripe images of the stereoscopic image are respectively observed with the right and left eyes, and changing means for, when a relative positional relationship between the stereoscopic image and the stereoscopic vision control means is not a proper relationship with which an observer can obtain a proper stereoscopic vision, changing the relative positional relationship to realize a proper stereoscopic vision.

According to another aspect of the present invention, there is provided an information processing apparatus which can be connected to an image display apparatus having stereoscopic vision control means for controlling directivity of a stereoscopic image to allow an observer to observe stripe images of the stereoscopic image with right and left eyes of the observer, respectively, comprising generation means for generating image data including a window in which stripe parallax images corresponding to the right and left eyes are arranged, determination means for determining whether a relative positional relationship between the window and the stereoscopic vision control means of the image display apparatus is a proper positional relationship which allows a proper stereoscopic vision, and adjustment means for, when the determination means determines that the relationship is not the proper relationship which allows a proper stereoscopic vision, adjusting the relative positional relationship to allow a proper stereoscopic vision.

According to still another aspect of the present invention, there are provided control methods for the above image display system and information processing apparatus.

Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures thereof.

Microsoft Exhibit 1002 - Page 888
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

Fig. 1 is a block diagram showing the arrangement of a computer system according to the first embodiment of the present invention;
Fig. 2 is a view showing an image for the left eye;
Fig. 3 is a view showing an image for the right eye;
Fig. 4 is a view showing a vertically striped parallax image obtained by dividing the parallax images in Figs. 2 and 3 into vertical stripes, and alternately arranging them;
Fig. 5 is a view showing a horizontally striped parallax image obtained by dividing the parallax images in Figs. 2 and 3 into horizontal stripes, and alternately arranging them;
Fig. 6 is a view showing a state in which the positions of right and left stripe images defined by a directivity control means in accordance with the display position of a window for displaying a stereoscopic image coincide with the right and left stripes of the stereoscopic image;
Fig. 7 is a view showing a state in which the positions of right and left stripe images defined by a directivity control means in accordance with the display position of a window for displaying a stereoscopic image do not coincide with the right and left stripes of the stereoscopic image;
Fig. 8 is a flow chart showing an operation procedure performed by a host computer in the first embodiment;
Fig. 9 is a view for explaining fine adjustment of a window position for a vertically striped parallax image;
Fig. 10 is a view for explaining fine adjustment of a window position for a horizontally striped parallax image;
Fig. 11 is a flow chart showing an operation procedure performed by a host computer in the second embodiment of the present invention;
Fig. 12 is a view for explaining how the contents of a displayed image in a window are changed in the second embodiment;
Fig. 13 is a view for explaining how the contents of a displayed image in a window are changed in the second embodiment;
Fig. 14 is a view for explaining how the contents of a displayed image in a window are changed in the second embodiment;
Fig. 15 is a view for explaining how the contents of a displayed image in a window are changed in the second embodiment;
Fig. 16 is a view for explaining how the contents of a displayed image in a window are changed in the second embodiment;
Fig. 17 is a flow chart showing a control procedure performed by a host computer in the third embodiment of the present invention;
Fig. 18 is a flow chart showing a control procedure for preventing a reversed stereoscopic vision during a window dragging operation in the fourth embodiment of the present invention;
Fig. 19 is a view showing the basic arrangement of the stereoscopic image display apparatus disclosed in Japanese Patent Laid-Open No. 3-119889;
Figs. 20A and 20B are views for briefly explaining the stereoscopic image display apparatus disclosed in Japanese Patent Laid-Open No. 5-122733;
Fig. 21 is a perspective view for briefly explaining a stereoscopic image display apparatus using Cyberbook (trademark);
Fig. 22 is a view showing a state in which the relative positions of a barrier and a striped image in the parallax barrier scheme have a proper relationship; and
Fig. 23 is a view showing a state in which the relative positions of the barrier and the striped image in the parallax barrier scheme have an improper relationship.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will now be described in detail in accordance with the accompanying drawings.

<First Embodiment>

Each of the following embodiments will exemplify a stereoscopic display apparatus for allowing an observer to observe a stereoscopic image by using the parallax between the right and left eyes and a computer system including a host computer for controlling the stereoscopic display apparatus.

Fig. 1 is a block diagram showing the arrangement of a computer system according to the first embodiment. Referring to Fig. 1, reference numeral 10 denotes a host computer; 20, a stereoscopic display apparatus; 11, a CPU for realizing various types of control operations performed by the host computer 10; 12, a ROM storing a boot program, which is executed when the CPU 11 is started, and various types of data; and 13, a RAM which serves as a main memory for storing control programs executed by the CPU 11 and provides a work area used when the CPU 11 executes various types of control operations. Reference numerals 14 and 15 respectively denote a keyboard and a pointing device, which are used to input commands from the user. Reference numeral 16 denotes an external memory such as a hard

Microsoft Exhibit 1002 - Page 889
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

disk, which is used to store various application programs and data. Note that each application program stored in the external memory 16 is loaded into the main memory area of the RAM 13 when it is executed by the CPU 11. Reference numeral 17 denotes a display interface, which is connected to the stereoscopic display apparatus 20 in this embodiment; and 18, a bus for connecting the respective components of the host computer 10 to each other.

The stereoscopic display apparatus 20 includes an interface 21 for receiving a video signal and position information indicating a stereoscopic display position from the host computer 10. Note that the video signal and the position information are respectively supplied to drivers 22 and 23. The driver 22 controls a transmission type liquid crystal display 101 of the stereoscopic display apparatus on the basis of the input video signal to display an image corresponding to the video signal. The driver 23 controls an electronic parallax barrier 103 on the basis of the input position information to display a parallax barrier pattern in the stereoscopic display area indicated by the position information. Note that the transmission type liquid crystal display 101 and the electronic parallax barrier 103 are the same as those described with reference to Fig. 19. When the electronic parallax barrier 103 is driven, the stripes of the parallax barrier pattern are formed at fixed positions. That is, the display area for the barrier pattern is controlled in accordance with position information, but the positions at which the black stripes can be produced are fixed.

The communication unit constituted by the above interfaces 17 and 21 transmits the above video signal and position information. This communication unit may be a combination of a conventional video interface and serial interface (RS232C or the like) or a dedicated interface. In addition, the dedicated interface may use unused connector pins of a conventional video interface.

Note that above video signal includes both a general 2D image and a 3D image allowing a stereoscopic vision (e.g., the above striped image constituted by two types of parallax images). In this embodiment, 2D and 3D images are displayed in units of windows. In addition, the above position information indicates the size and position of the area in which the above stereoscopic image is present. If, therefore, a parallax barrier pattern is displayed in the area, of the electronic parallax barrier 103, which is indicated by position information, and the image based on a video signal is displayed on the transmission type liquid crystal display 101, the 3D image contained in the video signal can be stereoscopically viewed, and the general 2D image can be properly displayed.

In this embodiment, an apparatus using the parallax barrier scheme will be mainly described. As is obvious, however, the present invention can also be applied to the Cyberbook (trademark) scheme described with reference to Fig. 21. Note that the Cyberbook scheme does not require the above position information because the host computer 10 and the stereoscopic display apparatus 20 are integrated.

In a stereoscopic display apparatus designed to allow the observer to observe a stereoscopic image by using the parallax between the right and left eyes, the images to be displayed on the image display screen are roughly classified into two types, i.e., a vertically striped parallax image and a horizontally striped parallax image. These images will be further described below. For example, Fig. 2 shows an image for the left eye; and Fig. 3, an image for the right eye. A vertically striped parallax image is obtained by dividing the images in Figs. 2 and 3 into vertical stripes, and alternately arranging and synthesizing them. A horizontally striped image is obtained by dividing the images in Figs. 2 and 3 into horizontal stripes, and alternately arranging and synthesizing them (referring to Figs. 4 and 5, reference symbols L and R denote images for the left and right eyes, respectively).

Each striped image can be divided into right and left images when combined with a directivity control means such as a barrier, a lenticular lens, or a striped polarizing plate. If, however, the directivity control means and a striped image are not set at proper relative positions, the right and left images are not observed with the corresponding eyes, as described with reference to Figs. 22 and 23. Since the directivity control means is a component incorporated in the stereoscopic display apparatus, the position of the means is basically fixed. In general, when an image is to be handled in a computer, a window which can be moved to an arbitrary position is opened, and the image is displayed in the window. For this reason, the directivity control means and the striped image may not be set at proper relative positions depending on the position of the window.

Assume that in a stereoscopic display apparatus using vertically striped parallax images, right-eye strip images (the areas indicated by "R" and surrounded with the solid lines in a window 6) are superimposed on the right-eye image display areas (the areas indicated by "R" and surrounded with the dotted lines in a screen 7) of the directivity control means (coinciding with the screen 7 when viewed from the front surface side), as shown in Fig. 6. In this case, the observer can obtain a proper stereoscopic vision. In contrast to this, assume that the window 6 for displaying an image is located at the position in Fig. 7 within the screen 7, and the right-eye strip images (the areas indicated by "R" and surrounded with the solid lines in the window 6) are superimposed on the left-eye image display areas (the areas indicated by "L" and surrounded with the dotted lines in the screen 7) of the directivity control means. In this case, the observer cannot obtain a proper stereoscopic vision, but has a reversed stereoscopic vision (the left-eye image is seen with the right eye, and the right-eye image is seen with the left eye).

To eliminate this inconvenience, in this embodiment, the following control is performed by the computer. Fig. 8 is a flow chart showing an operation procedure

Microsoft Exhibit 1002 - Page 890
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

performed by the host computer in the first embodiment. In step S10, the host computer 10 detects that a window for stereoscopic image display is opened or its position is moved. In step S11, the host computer 10 checks the position of the window after it is opened or moved to detect whether the window is at a proper position for a stereoscopic vision. That is, if the right-eye and left-eye image display areas determined with respect to the screen 7 coincide with the display positions of the respective images in the window 6, as shown in Fig. 6, the host computer 10 determines that the window is at the proper position. If the right-eye and left-eye image display areas determined with respect to the screen 7 do not coincide with the display positions of the respective images in the window 6, as shown in Fig. 7, the host computer 10 determines that the window is at an improper position. Upon determining that the window is at the proper position, the host computer 10 continues the display state. Otherwise, the flow advances to step S12 to automatically perform fine adjustment of the window position. Although not shown in the flow chart, if the opened or moved window is not for stereoscopic image display, the flow does not advance to step S11 and the subsequent steps.

A method of detecting the generation or movement of a window and checking its position depends on the OS, the application, or the like used in the computer. Assume that an application which operates on "Windows 3.1" (trademark), which is an OS available from Microsoft Corporation, is to be created by using Visual Basic Ver.2.0 (trademark), which is an application development language available from Microsoft Corporation. In this case, a window is recognized as an object called "Form". The generation of a window is defined as an event represented by Form_Load(), and the movement of a window is defined as an event represented by Form_Paint(). If, therefore, a program is created such that when the execution of each event is confirmed, a function for detecting the position of the window (Form) is called, the current position of the window which is moved or generated can be obtained.

A method of finely adjusting the position of a window will be described next with reference to Figs. 9 and 10. Fig. 9 explains fine adjustment of a window position for a vertically striped parallax image. Fig. 10 explains fine adjustment of a window position for a horizontally striped parallax image.

When a vertically striped parallax image is to be displayed, the window is moved to the right or left by one stripe pitch in the horizontal direction, as shown in Fig. 9. In many cases, the period of stripe images coincides with the minimum pixel pitch of an image display surface. In this case, therefore, it suffices if the window is moved to the right or left by one pixel. With this operation, the reversed stereoscopic vision state is corrected to the proper stereoscopic vision state.

When a horizontally striped parallax image is to be displayed, the window is moved up or down by one stripe pitch in the vertical direction within the screen, as shown in Fig. 10. In many cases, the period of stripe images coincides with the minimum pixel pitch of the image display surface. In this case, therefore, it suffices if the window is moved up or down by one pixel. With this operation, the reversed stereoscopic vision state is corrected to the proper stereoscopic vision state.

Assume that assignment information determined by the relative positional relationship with the electronic parallax barrier 103 as a directivity control means and indicating the assignment of positions, on the transmission type liquid crystal display 101, where images for the right and left eyes are to be displayed are stored in the memory of the host computer 10 in advance. The determination processing in step S11 is performed on the basis of this assignment information. The assignment information may be notified from the stereoscopic display apparatus 20 by communication, or may be held in a driver program added to the stereoscopic display apparatus 20.

When a window is automatically moved in this manner, the amount of movement is very small in most cases. For this reason, such movement is hardly recognized by the observer.

As described above, according to the first embodiment, there is provided a stereoscopic display which can automatically maintain a proper stereoscopic vision without attracting observer's attention.

<Second Embodiment>

The second embodiment of the present invention will be described next. In the second embodiment as well, the present invention is applied to a stereoscopic display apparatus 20 which allows an observer to observe a stereoscopic image by using the parallax between the right and left eyes and a computer system including a host computer 10 for controlling the display apparatus.

In the first embodiment, a proper stereoscopic vision state is maintained by automatically moving a window upon detection of the window position. In contrast to this, in the second embodiment, a proper stereoscopic vision is maintained by changing the contents of an image to be displayed after detection of the position of a window.

Fig. 11 is a flow chart showing an operation procedure performed by the host computer in the second embodiment. In step S20, the host computer 10 detects that a window for stereoscopic image display is opened or its position is moved. Opening or movement of a window is detected in the above manner. In step S21, the host computer 10 checks the position of the window to detect whether the window is at a position where a proper stereoscopic vision is realized. If the window position is at a proper position, the current state is maintained. If the window position is not at a proper position, the flow advances to step S22 to automatically change the contents

Microsoft Exhibit 1002 - Page 891
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

of a displayed image.

Processing of changing the contents of the displayed image in step S22 will be described in detail next. Figs. 12 to 16 explain how the contents of the displayed image within the window are changed.

When the displayed image is a vertically striped parallax image, one of the following changing operations is performed.

(1) As shown in Fig. 12, the image in the window is moved to the right by one stripe pitch in the horizontal direction within the screen. Obviously, the image in the window may be moved to the left by one stripe pitch.

(2) The image is displayed upon interchange of the L and R areas.

In method (1), since the period of stripe images coincides with the minimum pixel pitch of an image display screen in most cases, the image is moved to the right or left by one pixel. In this case, the position of the window is not changed, but only the image in the window is moved.

When only the displayed image filling the window is moved, an area without any image data is inevitably displayed. In such a case, this area may be displayed as a solid black area, as shown in Fig. 13.

Alternatively, as shown in Fig. 14, only an area smaller than the original striped image by one stripe in the horizontal direction is displayed in advance in the window, and the data in the area outside the window, which has not been displayed, is displayed when the image needs to be moved. In the case shown in Fig. 14, the image in the window is moved to the left.

In method (2), since the left and right images of the striped image are alternately arranged, the image is displayed upon interchanging the left and right stripes.

When, for example, the left-eye image (Fig. 2) and the right-eye image (Fig. 3) are to be synthesized into a striped image, two types of images, i.e., the image in Fig. 4 and the image in Fig. 15, are generated by changing the order of right and left stripes. If, therefore, one of the images is displayed, and a reversed stereoscopic vision state occurs, a proper stereoscopic vision state can be set by interchanging one image and the other image.

When the display image is a horizontally striped parallax image, one of the following changing operations is performed.

(1) As shown in Fig. 16, the image in the window is moved by one stripe pitch in the vertical direction within the screen (up-and-down direction).

(2) The image is displayed upon interchanging the L and R areas.

Since the contents of the changing operations are the same as those in the case of the vertically striped parallax image, a detailed description thereof will be omitted.

In most cases, the contents of such a displayed image can be automatically changed by slightly moving the image. Therefore, the observer hardly recognize this movement.

According to this embodiment as well, therefore, there is provided a stereoscopic display which can automatically maintain a proper stereoscopic vision without attracting observer's attention.

<Third Embodiment>

The third embodiment of the present invention will be described next. In the third embodiment as well, the present invention is applied to a stereoscopic display apparatus 20 which allows an observer to observe a stereoscopic image by using the parallax between the right and left eyes and a computer system including a host computer 10 for controlling the display apparatus.

In the first and second embodiments, a reversed stereoscopic vision is prevented by moving or changing a displayed image. In contrast to this, in the third embodiment, a stereoscopic vision state is maintained by changing the state of a directivity control means upon detection of the position of a window. The stereoscopic display used in the third embodiment is therefore designed to actively change the relative positional relationship between the image display surface and the directivity control means. In the parallax barrier scheme, for example, if the barrier unit has a mechanism for allowing the unit to mechanically move while keeping parallel to the screen, such a state change can be made. Alternatively, the electronic parallax barrier may be designed to change the stripe display positions.

Fig. 17 is a flow chart showing a control procedure performed by the host computer in the third embodiment. When the host computer 10 detects in step S30 that a window is opened or moved, the flow advances to step S31. In step S31, if it is determined on the basis of the position of the window after it is opened or moved that the window is a window to be subjected to stereoscopic image display, the host computer 10 checks the position of the window after it is opened or moved, and determines whether the window is at a position where a proper stereoscopic vision is obtained. If it is determined that the window is at the proper position, the host computer 10 continues the current state. Otherwise, the flow advances to step S32 to automatically change the state of the directivity control means.

The state of this directivity control means is changed as follows.

When the displayed image is a vertically striped parallax image, the directivity control means is moved to the right or left by one pitch of the periodic structure of the directivity control means in the horizontal direction within the screen. Note that the positions of the window and the image are not changed in this case.

When a stereoscopic display which can generate a striped barrier pattern at an arbitrary position on the display, as disclosed in Japanese Patent Laid-Open No. 5-122733, is used, since a directivity control means can be electronically generated at an arbitrary position, the

Microsoft Exhibit 1002 - Page 892
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

above operation of changing the state of the directivity control means can be performed more easily.

As described above, in the third embodiment, the relative positional relationship between a parallax barrier and a striped parallax image is detected to automatically perform active control on the parallax barrier.

When the displayed image is a horizontally striped parallax image, the directivity control means is moved up or down by one pitch of the periodic structure of the directivity control means in the vertical direction within the screen. The contents of this changing operation are the same as those in the case of the vertically striped parallax image.

In most cases, the contents of such a displayed image can be automatically changed by slightly moving the image. Therefore, the observer hardly recognize this movement. According to this embodiment, similar to the first and second embodiments, therefore, there is provided a stereoscopic display which can automatically maintain a proper stereoscopic vision without attracting observer's attention.

<Fourth Embodiment>

The fourth embodiment of the present invention will be described next. In the first to third embodiments, the position of a window, the contents of an image, and the state of the directivity control means are changed in accordance with the static window position. In the fourth embodiment, even when the position of a window dynamically changes, a proper stereoscopic vision state is maintained by performing the above state changing operations.

In general, when the cursor pointer of a mouse is placed on the title bar on the upper portion of a window and moved to a desired position in a clicked state, the window moves together with the cursor pointer as if the window is restrained by the movement of the mouse. An operation of moving a window together with the cursor pointer is called dragging. An operation of releasing a window by releasing the button at a proper position after dragging is called dropping.

The position of a window dynamically changes in accordance with the movement of the cursor pointer while the window is dragged. This window and the image in the window may be kept displayed during this dragging operation. When, therefore, the image in the window is a striped parallax image, a reversed stereoscopic vision must also be prevented during dragging of the window by some means. Fig. 18 is a flow chart showing a control procedure for preventing a reversed stereoscopic vision during dragging of a window. When the start of the movement of a window by dragging is detected in step S41, it is checked in step S42 whether the current position of the window is a position where a proper stereoscopic vision can be realized. If YES in step S42, the flow advances to step S44.

If it is determined that the window is at a position where a reversed stereoscopic vision occurs, the flow advances to step S43 to execute a corresponding state changing operation. In this case, the "corresponding state changing operation" indicates finely changing the window position (first embodiment), changing the contents of the image in the window (second embodiment), or changing the state of the stereoscopic (third embodiment) which is described in the corresponding embodiment.

The flow then advances to step S44 to check whether the dragging operation is continued. If YES in step S44, the flow returns to step S42. If NO in step S44, this processing is terminated.

Although the basic policy of the above processing does not greatly differ from that in the first to third embodiment, it should be noted that detection of the position of a window, verification of the window position, and a corresponding state changing operation are performed at very high speed. This is because, the position of a window incessantly changes from proper stereoscopic vision position to improper positions while the window position dynamically changes owing to dragging, and the observer cannot continuously obtain a proper stereoscopic vision unless a corresponding state changing operation is performed to prevent a reversed stereoscopic vision every time the window position is set at an improper position. In this embodiment, therefore, the window detection period during dragging is set to be very short to complete verification of the window position and a corresponding state changing operation within a period of time shorter than the above period.

As described above, according to the fourth embodiment, there is provided a stereoscopic display which can automatically maintain a proper stereoscopic vision even while the observer is moving a window.

As described above, according to each embodiment described above, in the computer system including the stereoscopic display apparatus which allows the observer to observe a stereoscopic image by using the parallax between the right and left eyes, and the host computer for controlling the display apparatus, when several windows are opened on the screen, and stereoscopic images are displayed in the windows, the observer can always have a proper stereoscopic vision in a given window even if the position of the window changes.

In both the parallax barrier scheme and the lenticular scheme, position pixel unit width on the image display surface corresponds to the eye width of the observer. Since an image having a size of several μm is enlarged into an image having a size of several cm, a one-pitch shift of the displayed image as in the above embodiments greatly influences the optimal observation position. That is, adjustment by such a one-pitch shift is very effective.

Note that the present invention may be applied to either a system constituted by a plurality of equipments (e.g., a host computer, an interface device, a reader, a

Microsoft Exhibit 1002 - Page 893
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

printer, and the like), or an apparatus consisting of a single equipment (e.g., a copying machine, a facsimile apparatus, or the like).

The objects of the present invention are also achieved by supplying a storage medium, which records a program code of a software program that can realize the functions of the above-mentioned embodiments to the system or apparatus, and reading out and executing the program code stored in the storage medium by a computer (or a CPU or MPU) of the system or apparatus.

In this case, the program code itself read out from the storage medium realizes the functions of the above-mentioned embodiments, and the storage medium which stores the program code constitutes the present invention.

As the storage medium for supplying the program code, for example, a floppy disk, hard disk, optical disk, magneto-optical disk, CD-ROM, CD-R, magnetic tape, nonvolatile memory card, ROM, and the like may be used.

The functions of the above-mentioned embodiments may be realized not only by executing the readout program code by the computer but also by some or all of actual processing operations executed by an OS (operating system) running on the computer on the basis of an instruction of the program code.

Furthermore, the functions of the above-mentioned embodiments may be realized by some or all of actual processing operations executed by a CPU or the like arranged in a function extension board or a function extension unit, which is inserted in or connected to the computer, after the program code read out from the storage medium is written in a memory of the extension board or unit.

As has been described above, according to the present invention, the position of a striped parallax image as a stereoscopic image displayed in a window can be set at a position suited to the display apparatus.

According to the present invention, therefore, when several windows are opened on the screen, and images are displayed in the windows as in the case of images handled in the computer, the observer can always have a proper stereoscopic vision in a given window even if the position of the window changes.

As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the claims.

Claims

1. An image display system capable of performing stereoscopic display, characterized by comprising:

   stereoscopic image display means (10, 21, 22, 101) for displaying a stereoscopic image having stripe parallax images arranged for right and left eyes;

   stereoscopic vision control means (10, 21, 23, 103) for controlling directivity of the stereoscopic image such that stripe images of the stereoscopic image are respectively observed with the right and left eyes; and

   changing means (S11, S12, S21, S22, S31, S32, S42, S43) for, when a relative positional relationship between the stereoscopic image and said stereoscopic vision control means is not a proper relationship with which an observer can obtain a proper stereoscopic vision, changing the relative positional relationship to realize a proper stereoscopic vision.

2. The system according to claim 1, wherein said stereoscopic image display displays a stereoscopic image in a window opened at a desired position within a display screen.

3. The system according to claim 2, wherein said changing means moves the window by a distance corresponding to a stripe pitch of the stripe image in a direction of stripe width of the stripe image (S12).

4. The system according to claim 3, wherein an amount of movement of the window is equal to a minimum pixel pitch of said stereoscopic image display means.

5. The system according to claim 3, wherein the stripe image is constituted by a horizontal stripe image in the screen, and a direction in which the window is moved is a vertical direction in the screen.

6. The system according to claim 3, wherein the striped image is constituted by vertical stripe images in the screen, and a direction in which the window is moved is a horizontal direction in the screen.

7. The system according to claim 2, wherein said changing means moves the stereoscopic image in the window by a distance corresponding to length of a short side of each of the stripe images constituting the stereoscopic image in a direction parallel to a short side of the stripe image (S22).

8. The system according to claim 7, wherein an amount of movement of the stereoscopic image in the window is equal to a minimum pixel pitch of said stereoscopic image display means.

9. The system according to claim 7, wherein the stripe image is constituted by a horizontal stripe image in the screen, and a direction in which the stereoscop-

Microsoft Exhibit 1002 - Page 894
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

ic image in the window is moved is a vertical direction in the screen.

10. The system according to claim 7, wherein the striped image is constituted by vertical stripe images in the screen, and a direction in which the stereoscopic image in the window is moved is a horizontal direction in the screen.

11. The system according to claim 2, wherein said changing means interchanges odd and even stripe images constituting the stereoscopic image displayed in the window.

12. The system according to claim 2, wherein said changing means changes a relative positional relationship between the stereoscopic image and said stereoscopic vision control means by changing said stereoscopic vision control means (S32).

13. The system according to claim 12, wherein said changing means physically moves said stereoscopic vision control means.

14. The system according to claim 12, wherein said stereoscopic vision control means comprises optical directivity control means constituted by a spatial light modulation element which is electronically controlled, and

said changing means electronically controls said optical directivity control means to shift a state of said control means to a state in which an observer can obtain a proper stereoscopic vision.

15. The system according to claim 1, wherein said changing means is executed after the window is opened and a stereoscopic image is displayed therein or the window is moved.

16. The system according to claim 1, wherein said changing means is executed at respective positions between movements of the window while the window is moved.

17. The system according to claim 16, wherein an execution period of said changing means is shortened while the window is moved.

18. An information processing apparatus which can be connected to an image display apparatus having stereoscopic vision control means for controlling directivity of a stereoscopic image to allow an observer to observe stripe images of the stereoscopic image with right and left eyes of the observer, respectively, characterized by comprising:

generation means (11) for generating image data including a window in which stripe parallax images corresponding to the right and left eyes are arranged;

determination means (11, S11, S21, S31, S42) for determining whether a relative positional relationship between the window and said stereoscopic vision control means of said image display apparatus is a proper positional relationship which allows a proper stereoscopic vision; and

adjustment means (11, S12, S22, S32, S43) for, when said determination means determines that the relationship is not the proper relationship which allows a proper stereoscopic vision, adjusting the relative positional relationship to allow a proper stereoscopic vision.

19. The apparatus according to claim 18, wherein said adjustment means moves the window by a distance corresponding to length of a short side of the stripe image in a direction parallel to a short side of the stripe image.

20. The apparatus according to claim 19, wherein an amount of movement of the window is equal to a minimum pixel pitch of said image display apparatus connected to said information processing apparatus.

21. The apparatus according to claim 19, wherein the stripe image is constituted by a horizontal stripe image in the screen, and a direction in which the window is moved is a vertical direction in the screen.

22. The apparatus according to claim 19, wherein the striped image is constituted by vertical stripe images in the screen, and a direction in which the window is moved is a horizontal direction in the screen.

23. The apparatus according to claim 18, wherein said adjustment means moves the stereoscopic image in the window by a distance corresponding to length of a short side of each of the stripe images constituting the stereoscopic image in a direction parallel to a short side of the stripe image.

24. The apparatus according to claim 23, wherein an amount of movement of the stereoscopic image in the window is equal to a minimum pixel pitch of said image display apparatus.

25. The apparatus according to claim 23, wherein the stripe image is constituted by a horizontal stripe image in the screen, and a direction in which the stereoscopic image in the window is moved is a vertical direction in the screen.

Microsoft Exhibit 1002 - Page 895
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

26. The apparatus according to claim 23, wherein the striped image is constituted by vertical stripe images in the screen, and a direction in which the stereoscopic image in the window is moved is a horizontal direction in the screen.

27. The apparatus according to claim 18, wherein said adjustment means interchanges odd and even stripe images constituting the stereoscopic image displayed in the window.

28. The apparatus according to claim 18, wherein said adjustment means changes a relative positional relationship between the stereoscopic image and said stereoscopic vision control means by changing said stereoscopic vision control means.

29. The apparatus according to claim 28, wherein said adjustment means adjusts the relative positional relationship between the stereoscopic image and said stereoscopic vision control means by physically moving said stereoscopic vision control means.

30. The apparatus according to claim 28, wherein said adjustment means adjusts the relative positional relationship between the stereoscopic image and said stereoscopic vision control means by electronically controlling optical directivity control means included in said stereoscopic vision control means and constituted by spatial light modulation element which is electronically controlled.

31. The apparatus according to claim 18, further comprising detection means for detecting that a window in which a stereoscopic image is to be displayed is opened or moved, and

wherein said adjustment means is executed when said detection means detects that the window is opened or moved.

32. The apparatus according to claim 18, further comprising detection means for detecting movement of a window in which a stereoscopic image is displayed, and

wherein said adjustment means is executed at respective positions between movements of the window while the window is moved.

33. The apparatus according to claim 32, wherein an execution period of said adjustment means is shortened while the window is moved.

34. A method of controlling an information display system having stereoscopic vision control means (10, 21, 23, 103) for controlling directivity of a stereoscopic image obtained by arranging stripe parallax images corresponding to right and left eyes of an observer to allow the observer to observe stripe images of the stereoscopic image with right and left eyes, respectively, characterized by comprising:

the stereoscopic image display step (10, 21, 22, 101) of displaying a stereoscopic image obtained by arranging stripe parallax images corresponding to the right and left eyes;
the detection step of detecting a relative positional relationship between the stereoscopic image and said stereoscopic vision control means; and
the changing step (S11, S12, S21, S22, S31, S32, S42, S43) of, when the relative positional relationship detected in the detection step is not a proper relationship which allows a proper stereoscopic vision, changing the relative positional relationship to allow a proper stereoscopic vision.

35. A method of controlling an information processing apparatus which can be connected to an image display apparatus having stereoscopic vision control means (10, 21, 23, 103) for controlling directivity of a stereoscopic image obtained by arranging stripe parallax images corresponding to right and left eyes of an observer to allow the observer to observe stripe images of the stereoscopic image with right and left eyes, respectively, characterized by comprising:

the generation step (11) of generating image data including a window in which stripe parallax images corresponding to the right and left eyes are arranged;
the determination step (11, S11, S21, S31, S42) of determining whether a relative positional relationship between the window and said stereoscopic vision control means of said image display apparatus is a proper positional relationship which allows a proper stereoscopic vision; and
the adjustment step (11, S12, S22, S32, S43), when it is determined in the determination step that the relationship is not the proper relationship which allows a proper stereoscopic vision, adjusting the relative positional relationship to allow a proper stereoscopic vision.

36. A storage medium storing a computer program for performing image display by using an image display apparatus having stereoscopic vision control means (10, 21, 23, 103) for controlling directivity of a stereoscopic image obtained by arranging stripe parallax images corresponding to right and left eyes of an observer to allow the observer to observe stripe images of the stereoscopic image with right

Microsoft Exhibit 1002 - Page 896
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

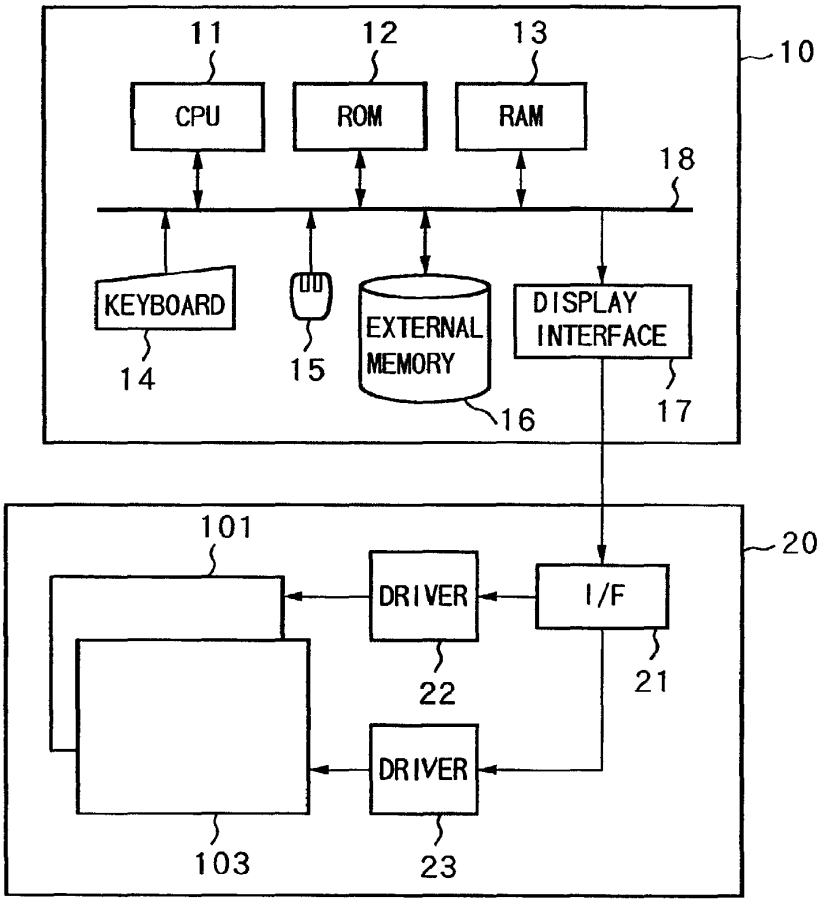
and left eyes, respectively, said computer program comprising:

a code of the determination step (11, S11, S21, S31, S42) of determining whether a relative positional relationship between a window in which stripe parallax images corresponding to the right and left eyes are arranged and said stereoscopic vision control means of said image display apparatus is a proper positional relationship which allows a proper stereoscopic vision; and

a code of the adjustment step (11, S12, S22, S32, S43) of, when it is determined in the determination step that the relationship is not the proper relationship which allows a proper stereoscopic vision, adjusting the relative positional relationship to allow a proper stereoscopic vision.

Microsoft Exhibit 1002 - Page 897
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.1



Microsoft Exhibit 1002 - Page 898
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.2

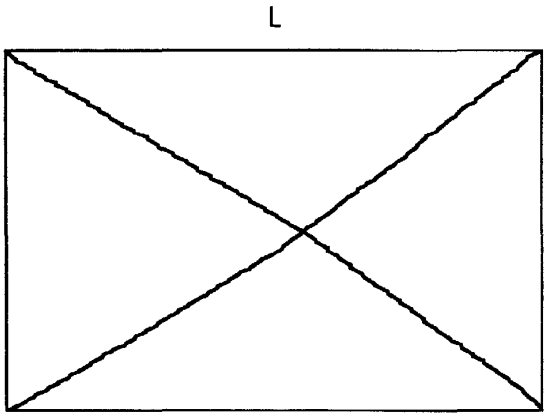
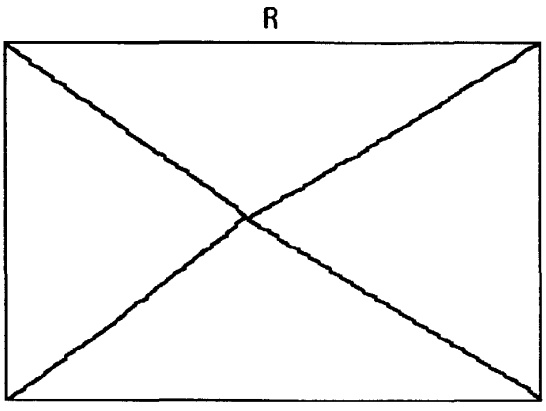


FIG.3



Microsoft Exhibit 1002 - Page 899
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.4

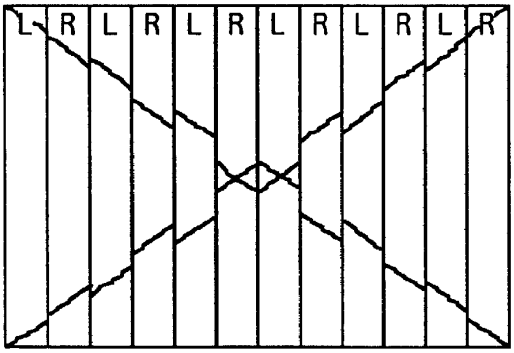
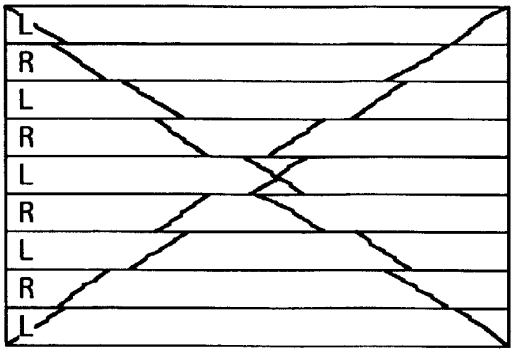
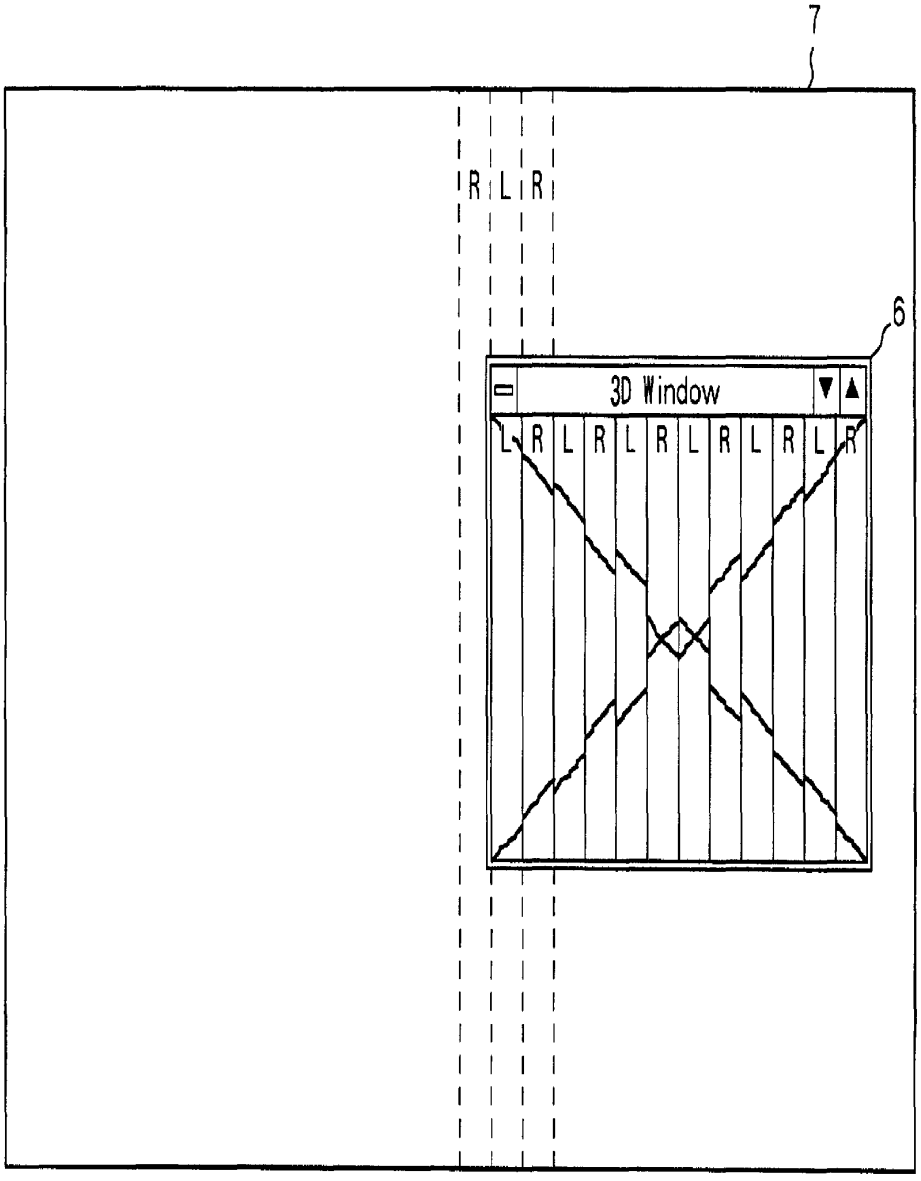


FIG.5



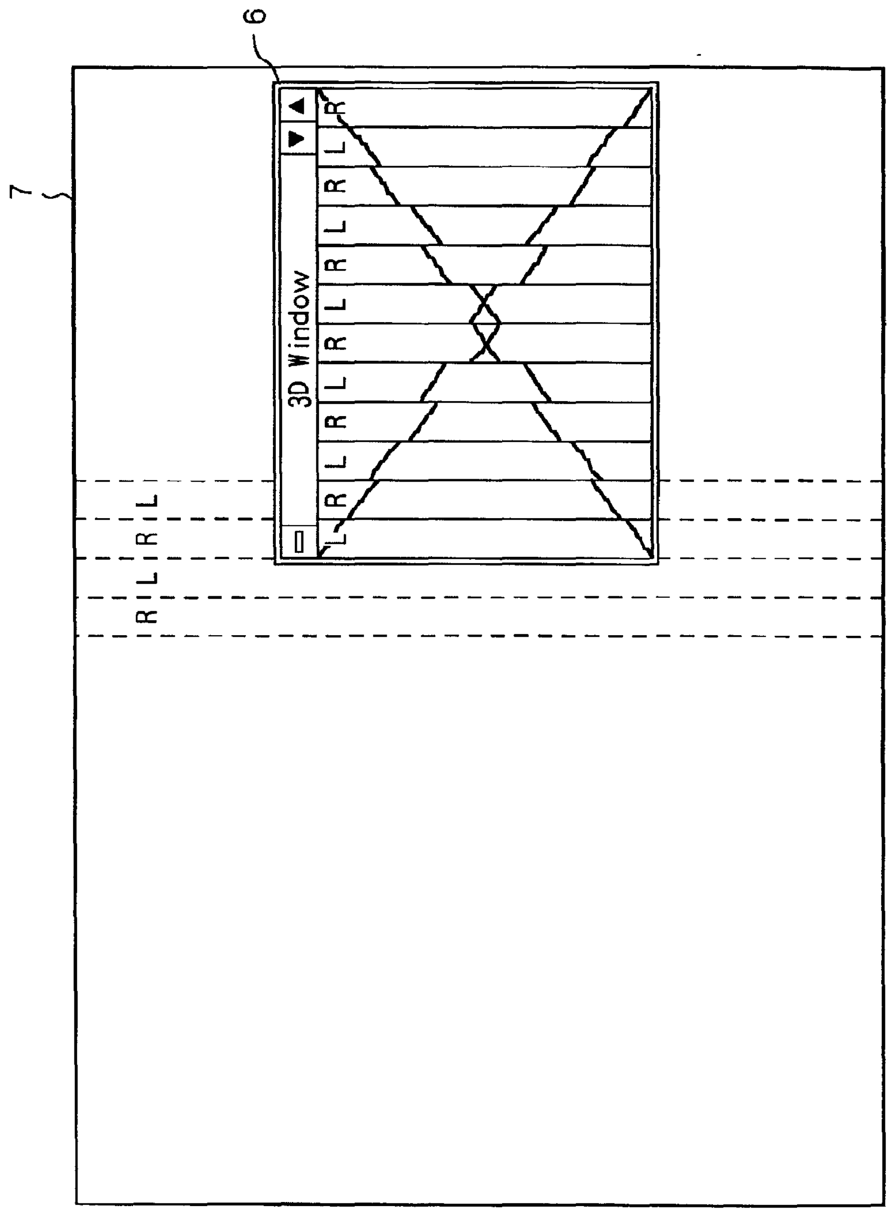
Microsoft Exhibit 1002 - Page 900
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.6



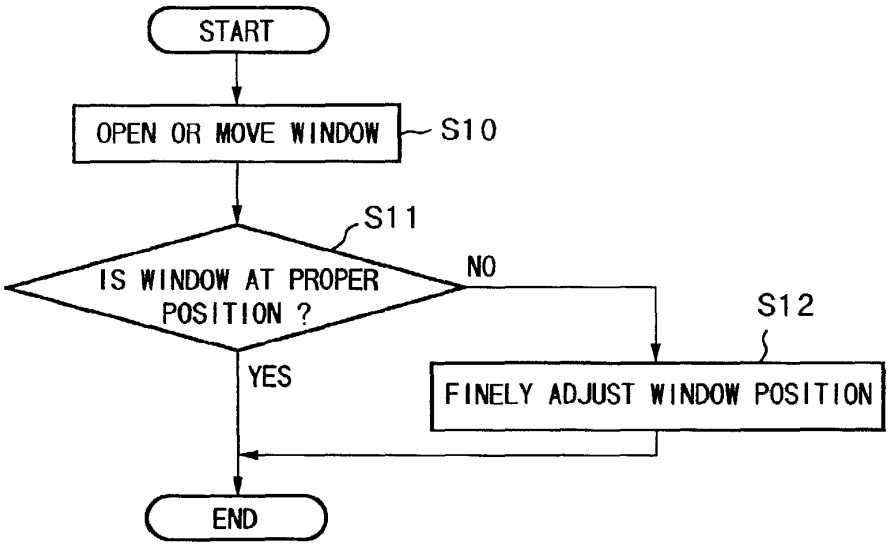
Microsoft Exhibit 1002 - Page 901
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.7



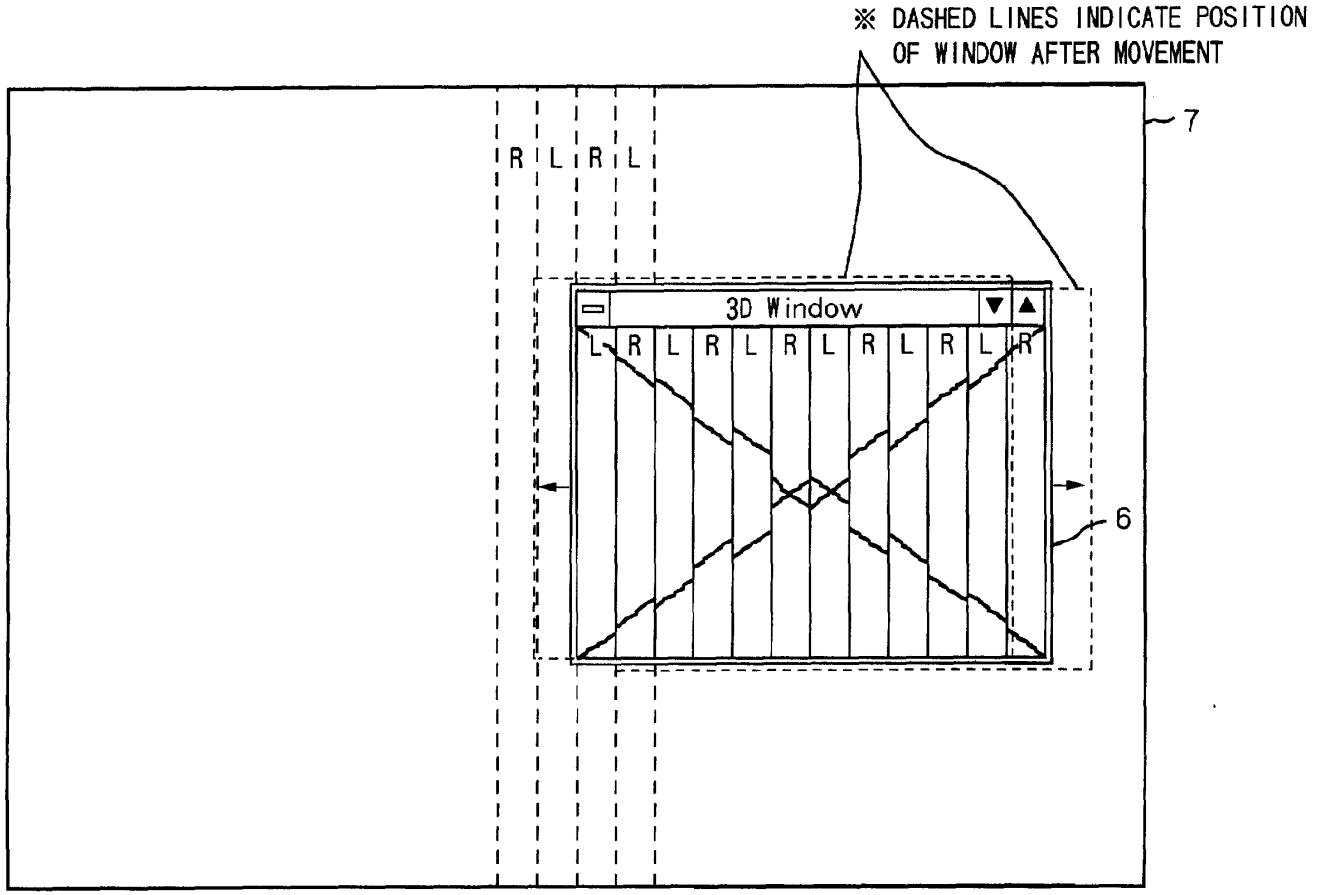
Microsoft Exhibit 1002 - Page 902
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.8



Microsoft Exhibit 1002 - Page 903
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

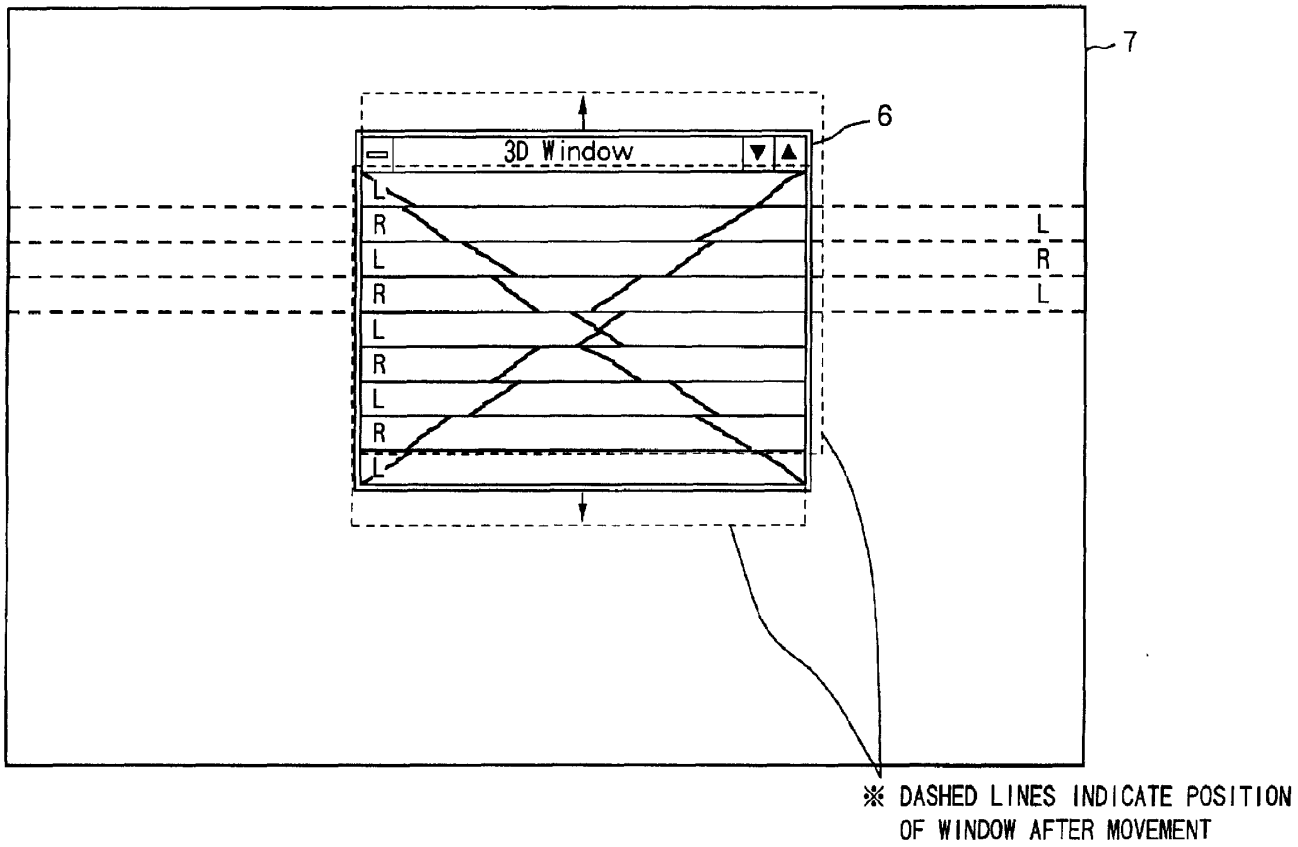
FIG.9



EP 0 860 729 A2

Microsoft Exhibit 1002 - Page 904
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

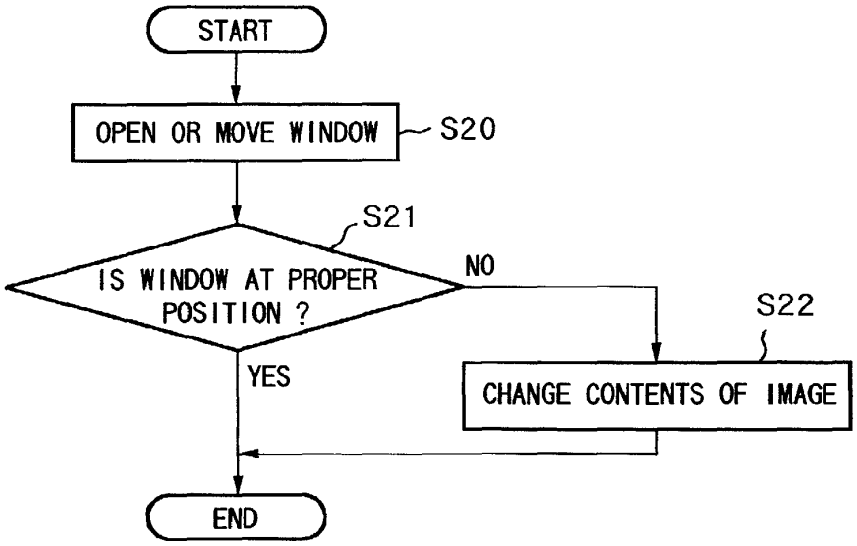
FIG.10



EP 0 860 729 A2

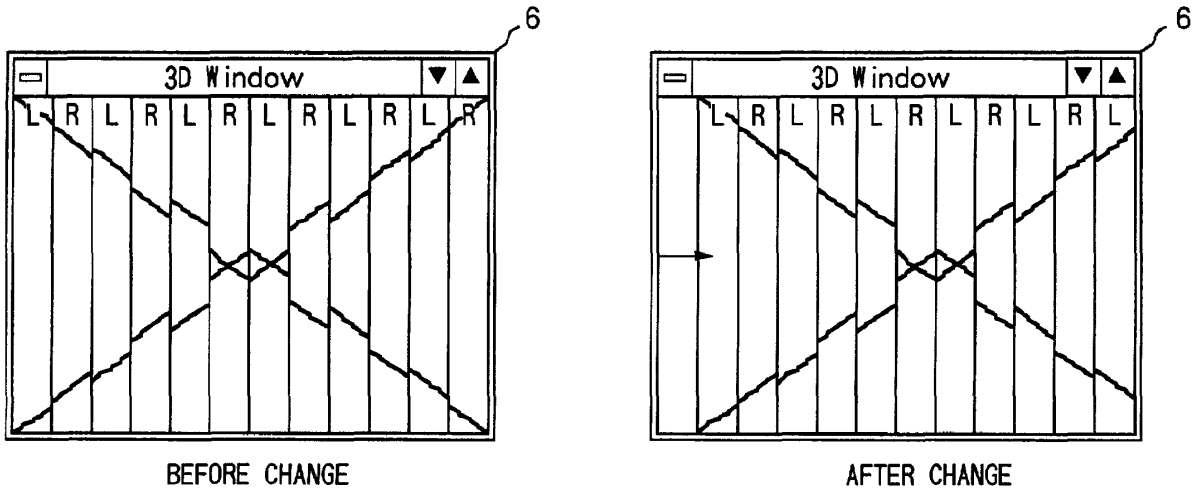
Microsoft Exhibit 1002 - Page 905
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.11



Microsoft Exhibit 1002 - Page 906
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.12



Microsoft Exhibit 1002 - Page 907
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.13

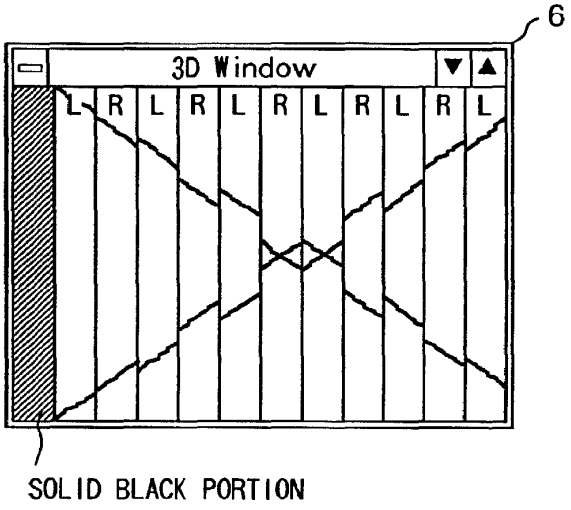
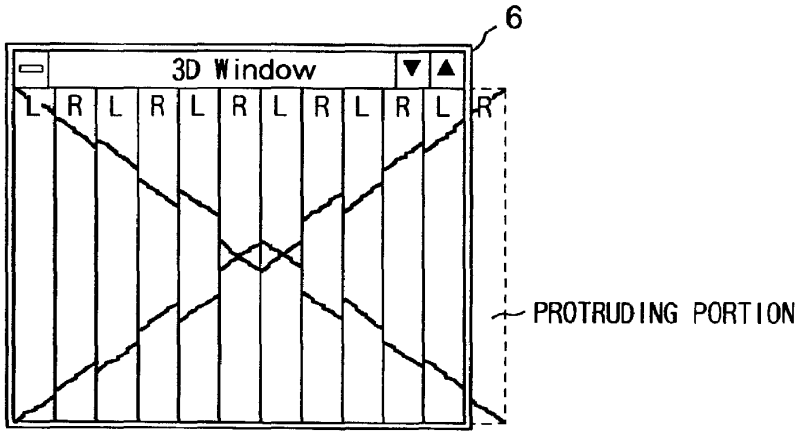
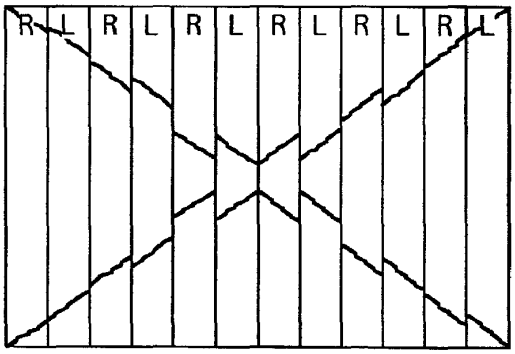


FIG.14



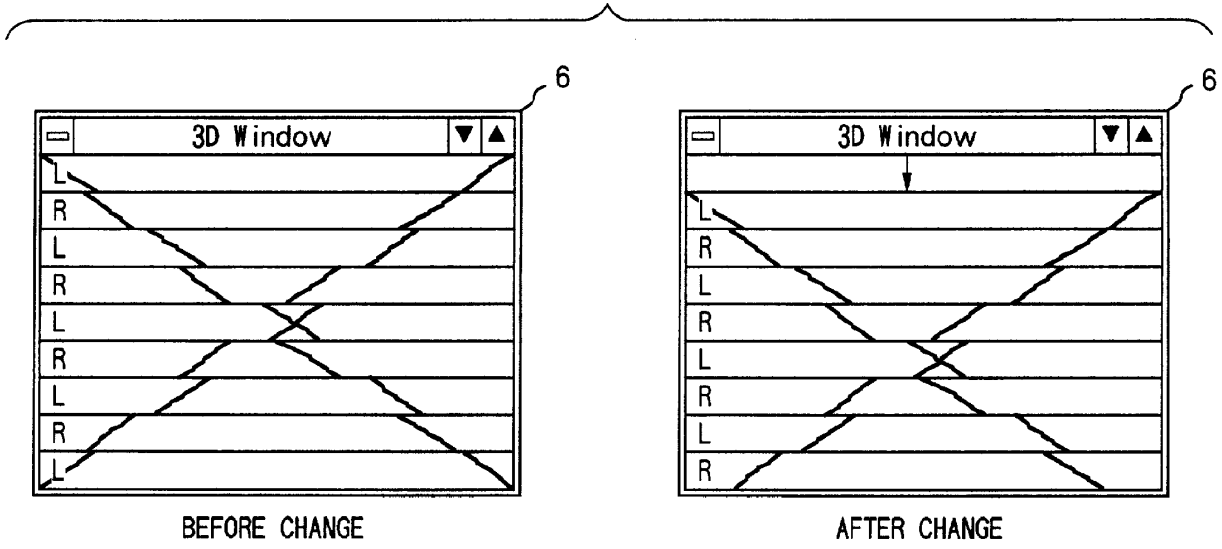
Microsoft Exhibit 1002 - Page 908
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.15



Microsoft Exhibit 1002 - Page 909
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.16



Microsoft Exhibit 1002 - Page 910
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.17

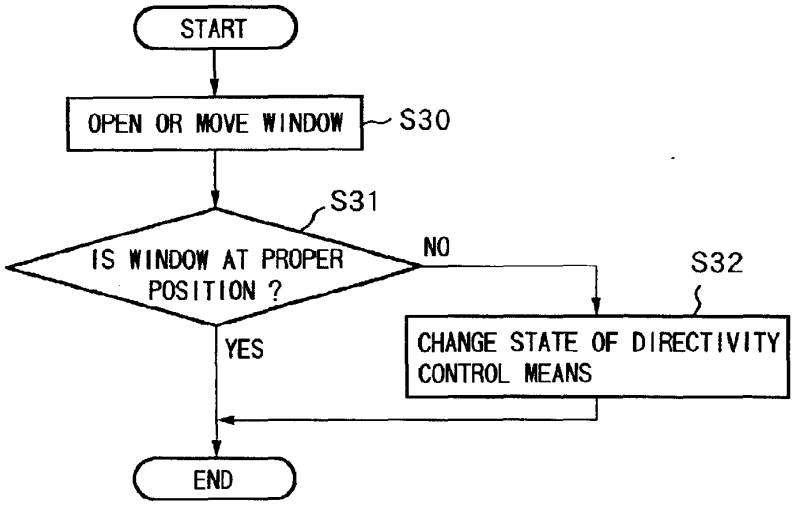
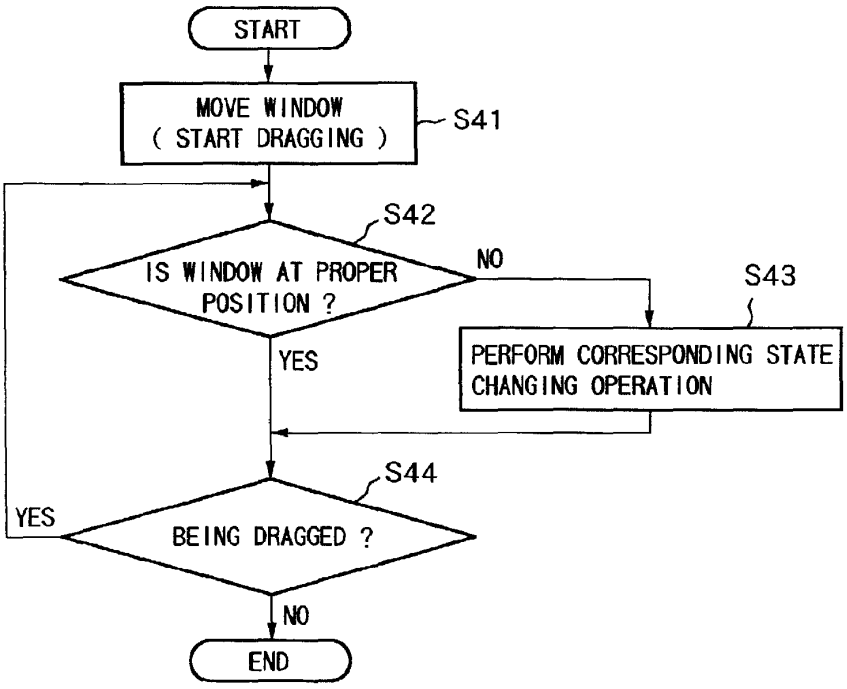


FIG.18



Microsoft Exhibit 1002 - Page 911
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.19

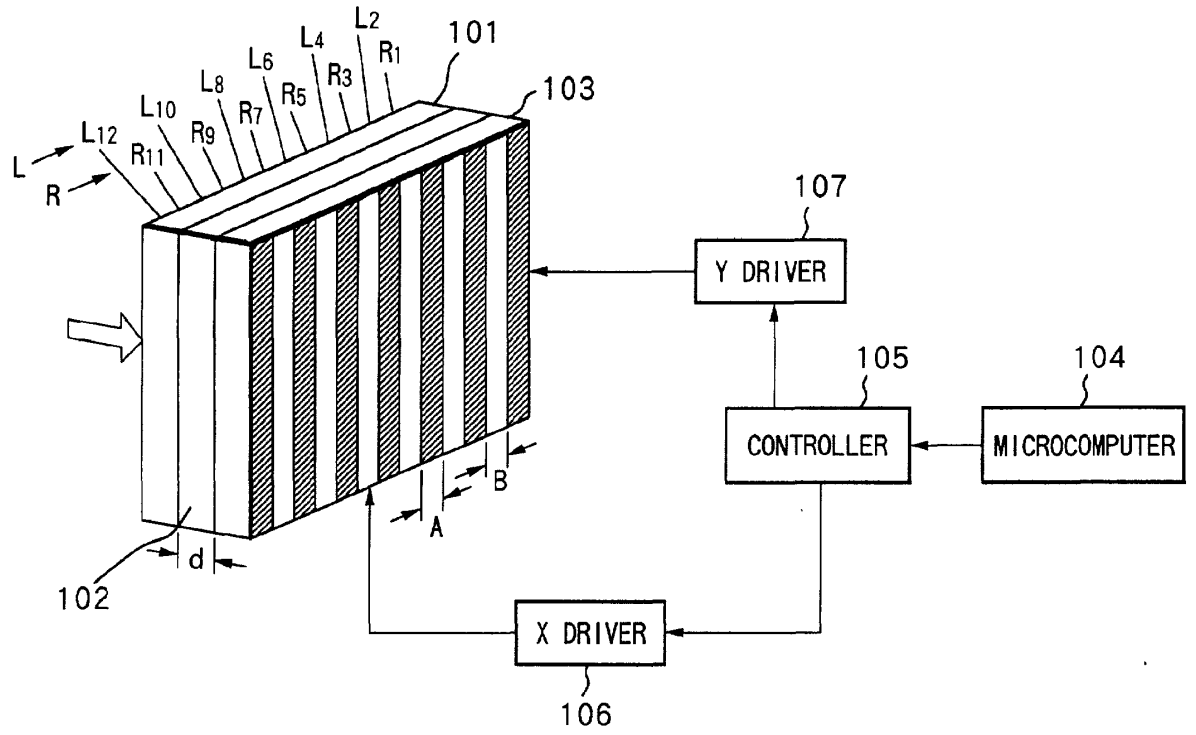

L
R
L12
R11
L10
R9
L8
R7
L6
R5
L4
R3
L2
R1
101
103
107
Y DRIVER
105
104
CONTROLLER
MICROCOMPUTER
B
A
d
102
X DRIVER
106

FIG.20A

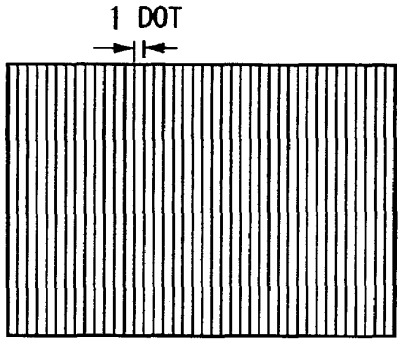
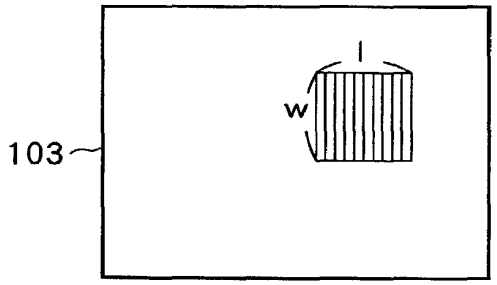
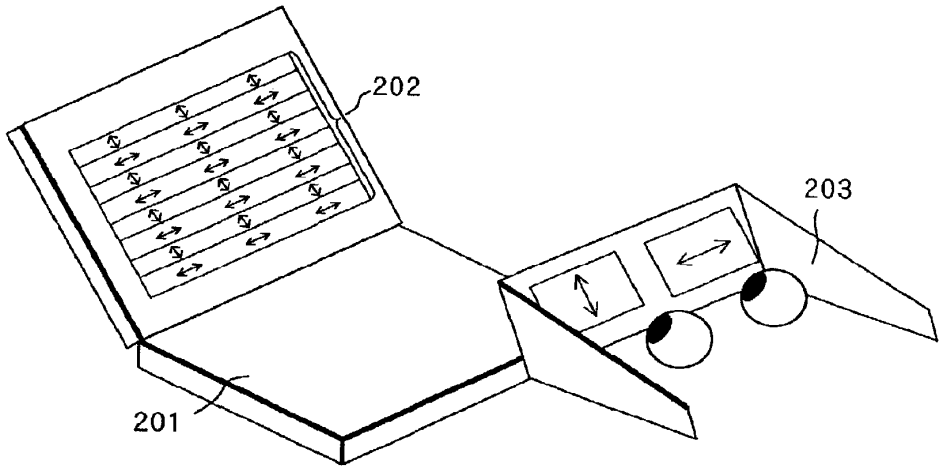


FIG.20B



Microsoft Exhibit 1002 - Page 913
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.21



Microsoft Exhibit 1002 - Page 914
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.22

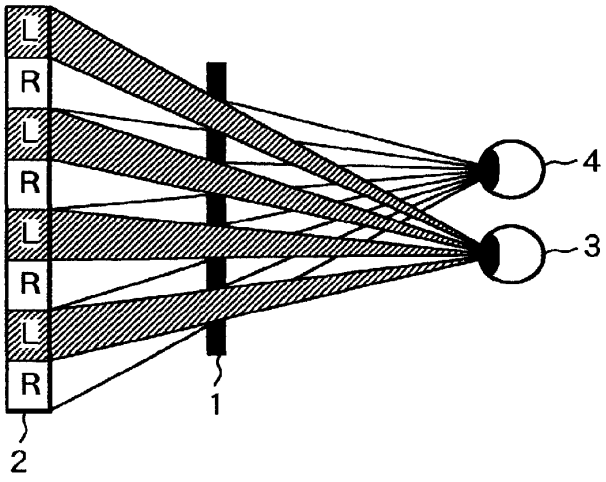
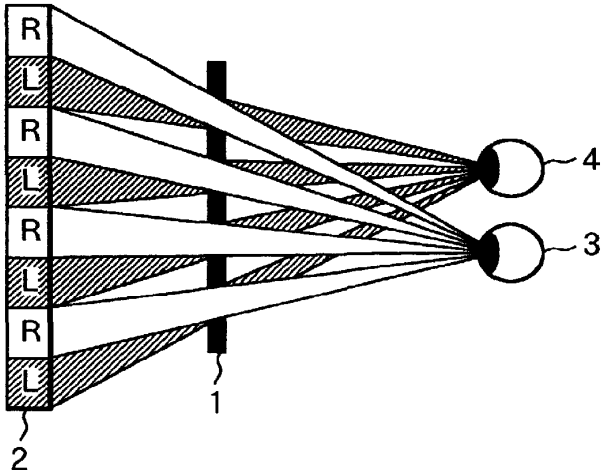


FIG.23



Microsoft Exhibit 1002 - Page 915
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 939 273 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
01.09.1999 Bulletin 1999/35

(51) Int Cl.[6]: **F21V 8/00**, G02F 1/1335

(21) Application number: **99103765.4**

(22) Date of filing: **26.02.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **26.02.1998 JP 6431198**

(71) Applicant: **NITTO DENKO CORPORATION**
Osaka (JP)

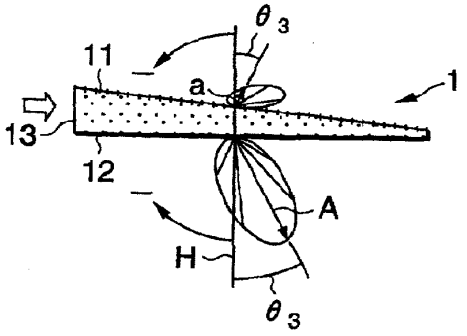
(72) Inventors:
- **Umemoto, Seiji**
  c/o NITTO DENKO CORPORATION
  Ibaraki-shi, Osaka (JP)
- **Yano, Shuji c/o NITTO DENKO CORPORATION**
  Ibaraki-shi, Osaka (JP)

(74) Representative: **Grünecker, Kinkeldey,**
Stockmair & Schwanhäusser Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

(54) Light guide plate, planar light source unit and reflection-type liquid-crystal display device

(57) A light guide plate (1) in which the light incident on an entrance end surface (13) is redirected to emerge from a bottom surface (12) via triangular prism structures formed on a top surface (11), with the direction of maximum intensity of the light emerging from the bottom surface (12) being within 30 degrees from the line normal to said bottom surface (12). The intensity of the light leaking from the top surface (11) at the same angle as the direction of said maximum intensity is no more than a tenth of said maximum intensity in order to give high contrast. A light source is arranged adjacent the entrance end surface of the light guide plate and a reflection-type liquid-crystal display device is provided beneath the bottom surface (12). Light emerging from the bottom surface (12) is reflected by the liquid crystal cell and is transmitted through the light guide plate (1) to be viewed from the top surface. The light guide plate (1) allows ambient light to also illuminate the display device.

FIG.4



EP 0 939 273 A1

Printed by Jouve, 75001 PARIS (FR)

Microsoft Exhibit 1002 - Page 916
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a light guide plate capable of forming a bright and high-contrast reflection-type liquid-crystal display device, and a planer light source unit that uses the light guide plate to permit efficient utilization of light.

[0002] The present application is based on Japanese Patent Application No. Hei. 10-64311, which is incorporated herein by reference.

2. Description of the Related Art

[0003] To meet the current need for illumination equipment that enabled the viewing of a reflection-type liquid-crystal display device in the dark or other situations, the present inventors attempted the application of a front light system in which the back light used in a transmission-type liquid-crystal display device was provided on the viewing side of the liquid-crystal cell. The back light uses a light guide plate that receives incident light cn a side and that allows it to emerge from either the top or the bottom surface through a light issuing means. The front light system allows the display to be viewed via the light guide plate.

[0004] However, the back light using the conventional light guide has involved difficulty in attempts for commercialization since it suffers from various problems such as low contrast in ON state, low brightness in OFF state and disturbed display.

[0005] It should also be mentioned that a back light using a light guide plate in which diffusing dots or fine asperities form a light issuing means provides only low contrast during viewing in On state and also provides low contrast and insufficient display brightness during viewing in OFF state with extraneous light such as indoor illumination; in addition, the display image that can be viewed through the light guide plate is so extensively disturbed that it lacks clarity.

[0006] A back light is known that uses a light guide plate in which a stepped prism structure consisting of inclined surfaces having a slope of 45 degrees and flat surfaces (zero degrees of inclination) form a light issuing means (as described in Japanese Patent Publication No. Sho. 62-73206). Even this back light has the disadvantage of giving low contrast and insufficient display brightness during viewing in ON state.

SUMMARY OF THE INVENTION

[0007] Accordingly, an object of the present invention is to develop a reflection-type liquid-crystal display device that gives high contrast during viewing in both OFF state and ON state, that provides a highly bright display and that creates a display image through a light guide plate that is less disturbed and features high clarity.

[0008] Another object of the invention is to develop a light guide plate and a planer light source unit that are capable of forming the reflection-type liquid-crystal display device.

[0009] The present invention provides a light guide plate in which the light incident on an entrance end surface is allowed to emerge from a bottom surface via a light issuing means formed on a top surface, with the direction of maximum intensity of the emerging light as measured in a plane perpendicular to the two reference planes defined by said entrance end surface and said bottom surface being within 30 degrees from the line normal to said bottom surface and wherein when the direction toward the entrance end surface away from said normal line taken as the reference is assumed to be negative, the intensity of the light leaking from the top surface at the same angle as the direction of said maximum intensity is no more than a tenth of said maximum intensity, with the incident light from the bottom surface being transmitted through the top surface.

[0010] The present invention also provides a planer light source unit having a light source adjacent the entrance end surface of said light guide plate, as well as a reflection-type liquid-crystal display device having a reflective layer furnished, light-crystal cell provided beneath the bottom surface of the planer light source unit.

[0011] According to the invention, one can produce a light guide plate in which the light emerging from the bottom surface has high directivity in a vertical direction and in which the leakage light from the top surface is less likely to overlap a display image. Using this light guide plate, one can produce a planer light source unit capable of efficient utilization of light and can hence provide a reflection-type liquid-crystal display device that gives high contrast during viewing in both OFF and ON states, that provides a highly bright display and that creates a display image through the light guide plate that is less disturbed and features high clarity and display quality.

[0012] These advantages of the invention are based on the characteristics imparted to the light guide plate. While making intensive studies in order to solve the aforementioned problems, the present inventors found the following facts

Microsoft Exhibit 1002 - Page 917
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

about light guide plates using the above-mentioned diffusing dots or fine asperities as light issuing means: as shown in Figs. 9 and 10, transmitted light incident on a side of the light guide plate 18 is divergent in almost all directions on account of the scattering by the light issuing means and due to its scattering characteristics, both the light α_1 emerging from the bottom surface and the leakage light β_3 from the top surface have maximum intensity (B or b) in a direction that forms an angle of about 60 degrees (θ_4) with the line H dropped normal to the bottom surface (looked into the front surface) and their maximum intensities are substantially the same; hence, the quantity of light in the directions effective for viewing, particularly, in the viewing angle range of from about 15 degrees up to about 30 degrees down in longitudinal direction with reference to said normal line and in the range of about 30 degrees both to the right and the left in a transverse direction, is small enough to provide an insufficiently bright display; in addition, the light α_2 emerging from the bottom surface to form the display image overlaps the leakage light β_4 from the top surface, thereby producing only low contrast; in OFF state, the scattered light γ_2 washes out the display image to reduce its contrast; what is more, due to the scattering caused by the light guide plate, rays of display light γ_1 and γ_3 mix together and the display image is extensively disturbed.

[0013] It has been found that the same problem occurs in the light guide plate having the prism-like light issuing means according to Japanese Patent Publication No. Sho. 62-73206. So much light leaks from the top surface of the light guide plate that it overlaps the display image forming light emerging from the bottom surface, thereby lowering the contrast of the image. In addition, more light emerges at great angles that the light issuing in the directions effective for viewing and, as a result, the brightness of the display decreases to deteriorate its quality.

[0014] Therefore, in order for the light guide plate to form a bright and clear display image, it is required that the light incident on a side emerge from the bottom surface with high directivity, particularly at an angle of θ_3 which is the nearest possible to the normal H to the bottom surface as illustrated by the arrow A in Fig. 4, preferably with a high degree of convergence within the above-stated viewing angle range. Reflection-type liquid-crystal display devices usually intend to produce uniform and clear displays via a roughened reflective layer having an average diffusing angle of about 5 to 15 degrees. Therefore, if more of the incident light (B in Fig. 9 and α_1 in Fig. 10) forms a large angle with the reflective layer, less of the light emerges in the directions effective for viewing and this introduces difficulty in providing a bright display. In addition, large-angle viewing increases the chance of display inversion and massive color charges tend to occur in displays of a field birefringence type.

[0015] For higher contrast, it is required that the leakage light from the top surface (as indicated by a in Fig. 4) make the least overlap with the display image forming light A emerging from the bottom surface, the overlap being preferably the smallest possible within the above-stated viewing angle range. Reflection-type liquid-crystal display devices usually have contrast ratios of 1:5 to 1:20, so the overlap between the leakage light and the display image has a substantial effect on the contrast ratio.

[0016] To prevent the formation of a disturbed display image, it is required that both the light being transmitted from the top to the bottom surface and the light being transmitted in opposite way should be the least scattered. The front light in a reflection-type liquid crystal display device is an auxiliary light source that enables viewing in the dark, inherently using extraneous light such as indoor illumination or other available light with a view to reducing power consumption. If, in its normal OFF state, the front light is prevented by the light guide plate from receiving extraneous light, a dark display is produced. If scattering occurs on the light guide plate, its surface is washed out to give a lower contrast or the display image becomes disturbed, mostly due to the mixing of rays of display light.

[0017] To further improve the display quality, it is desired to accomplish clear displays that do not have high proportions of unnaturalness or disturbances. The pitch of pixels in liquid-crystal display devices is generally 100 to 300 μm, so it is desired that information having a pitch of about 100 μm be clearly discernible with the effects of the light guide plate on light transmission being controlled to minimum. Also desired is satisfactory display quality that is controlled in moiré.

[0018] Features and advantages of the invention will be evident from the following detailed description of the preferred embodiments described in conjunction with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] In the accompanying drawings:

Fig. 1 is a perspective view illustrating a light guide plate;
Figs. 2A to 2C are side views illustrating three different types of light guide plate;
Figs. 3A and 3B are side views illustrating prismatic asperities;
Fig. 4 is a diagram illustrating the exit characteristics according to the present invention;
Fig. 5 is a side sectional view of a planer light source unit;
Fig. 6 is a side sectional view of a reflection-type liquid-crystal display device;
Fig. 7 is a side sectional view of another reflection-type liquid-crystal display device;

Microsoft Exhibit 1002 - Page 918
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Fig. 8 is an illustration of the display image according to the present invention;
Fig. 9 is a diagram illustrating the exit characteristics obtained in the related art; and
Fig. 10 is an illustration of the display image produced in the related art.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] The light guide plate according to the invention is such that the light incident on an entrance end surface is allowed to emerge from a bottom surface via a light issuing means formed on a top surface, with the direction of maximum intensity of the emerging light as measured in a plane perpendicular to the two reference planes defined by said entrance end surface and said bottom surface being within 30 degrees from the line normal to said bottom surface and also such that when the direction toward the entrance end surface away from said normal line taken as the reference is assumed to be negative, the intensity of the light leaking from the top surface at the same angle as the direction of said maximum intensity is no more than a tenth of said maximum intensity, with the incident light from the bottom surface being transmitted through the top surface.

[0021] Examples of the light guide plate according to the invention are shown in Figs. 1 and 2a to 2c. Indicated by 1 is the light guide which comprises of the top surface 11, 16 or 17 forming a light issuing means, the bottom surface 12 serving as an exit end, an entrance end surface 13, transverse side surfaces 14, and a far end 15 which is opposed to the entrance end surface.

[0022] The light guide plate according to the invention is such that the light incident on the entrance end surface is allowed to emerge from the bottom surface via the light issuing means formed on the top surface. Assuming a plate-like shape, it generally has a top surface, an opposed bottom surface, and an entrance end surface connecting the top and bottom surfaces. The plate may have the same thickness throughout but, preferably, the thickness of the far end 15 opposed to the entrance end surface 13 is smaller than that of the entrance end surface as in the illustrated case; the far end 15 is preferably at least less than half in thickness of the entrance end surface.

[0023] Making the opposed end 15 thinner than the entrance end surface 13 offers several advantages; first, the incident light on the entrance end surface (indicated by thick arrows in Figs. 3A and 3B, and 4) travels to the opposed end after being launched efficiently into the light issuing means formed on the top surface and emerging from the bottom surface after reflection and other phenomena, whereby the incident light is efficiently supplied to the target surface; second, the light guide plate can be reduced in weight. Take, for example, the case where the top surface forms a straight plane as shown in Fig. 2A; the weight of a light guide plate whose thickness decreases toward the far end 15 is about 75% of the weight of a light guide plate having a uniform thickness.

[0024] The light guide plate of the invention suffices to show the exit characteristics described above. Hence, the light issuing means to be provided on the top surface of the aforementioned plate-like shape may be formed of any suitable elements that show such characteristics. Mainly from the viewpoint of ease in attaining the stated characteristics, the light issuing means is preferably composed of prismatic asperities.

[0025] Such prismatic asperities may be formed of ridges or grooves bounded by planes of equal sides; however, mainly from the viewpoint of efficient utilization of light, the prismatic asperities are preferably formed of ridges or grooves each bounded by a plane of the shorter side and a plane of the longer side. An example of such prismatic asperities is shown in Figs. 3A and 3B, in which 2a refers to a ridge, 2b is a groove, 21 and 23 are planes of the shorter side, and 22 and 24 are planes of the longer side. The criterion for determining whether a certain shape is a ridge or groove is the line connecting, the point at which a plane of the shorter side crosses the plane on which it is formed and the point at which a plane of the longer side or the like crosses the plane on which it is formed. If the point at which the plane of the shorter side crosses the plane of the longer side or the like (this point may be referred to as "vertex") projects beyond the above-defined line, the shape is a ridge; if the crossing point is below that line, the shape is a groove.

[0026] Referring to the case illustrated in Figs. 3A and 3B, the criterion is a line 20 indicated by a phantom line connecting the point at which a plane of the shorter side 21 (or 23) that forms a certain shape crosses the plane on which it is formed and the point at which a plane of the longer side 22 (or 24) that forms the shape crosses the plane on which it is formed; the ridge 2a is so called since the point (vertex) at which the plane of the shorter side crosses the plane of the longer side length is above the line 20 whereas the groove 2b is so called since it is below the line 20.

[0027] Mainly from the viewpoint of improving the display quality such as brightness and contrast that can be attained with the light guide plate of the invention if it is assembled into a reflection-type liquid-crystal display device, a preferred light guide plate is of the type shown in Fig. 4, in which the direction θ_3 for maximum intensity A of the light emerging from the bottom surface 12 after the incident light (indicated by a thick arrow) was launched into the entrance end surface 13 is within 28 degrees, more preferably, 25 degrees, most preferably 20 degrees from the line H normal to said bottom surface 12 as measured in a plane (cross section on the paper) perpendicular to the two reference planes defined by the entrance end surface 13 and the bottom surface 12.

[0028] The light guide plate is preferably such that when the direction toward the entrance end surface 13 away from said normal line H taken as the reference is assumed to be negative, the intensity of the light a. leaking from the top

Microsoft Exhibit 1002 - Page 919
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

surface 11 at the same angle θ_3 as the direction of maximum intensity A is of the smallest possible value not more than a tenth of said maximum intensity A, more preferably no more than 1/15, most preferably no more than 1/20, of A. Said leakage light a overlaps the light of maximum intensity A when the latter is reflected in a positive direction; therefore, if the value of a/A is great, the relative intensity of the display image and hence the contrast is reduced.

[0029] Mainly from the viewpoint of improving the display quality such as contrast that can be attained with the light guide plate of the invention if it is assembled into a reflection-type liquid-crystal display device, a preferred light guide plate is such that the luminance of the light emerging from the bottom surface as measured in the direction of the line normal to the above-defined perpendicular plane is no more than 60%, more preferably no more than 50%, most preferably no more than 40%, of the luminance in said direction of maximum intensity. This is because liquid-crystal cells usually entail 4 to 5% surface reflection and due to this surface reflection, the light emerging in the direction of said normal line is brought back near to the vertical direction which is a typical viewing angle for liquid-crystal display devices and the resulting overlap with the display light lowers the contrast and other elements of the display quality.

[0030] In addition, mainly from the viewpoint of improving the display quality such as display's sharpness that can be attained with the light guide plate of the invention if it is assembled into a reflection-type liquid-crystal display device, a preferred light guide plate is such that the quantity of light leaking from the top surface within 30 degrees of a solid angle about the above-defined normal line H is no more than 1/8, more preferably no more than 1/10, most preferably no more than 1/20, of the quantity of light emerging from the bottom surface. Such leakage light also lowers the contrast and other elements of the display quality by overlapping the display light during viewing near the vertical direction. If such leakage light is controlled, any unwanted light that deteriorates the display quality is eliminated to produce a sharper display.

[0031] Mainly from the viewpoint of satisfying the aforementioned condition for the direction of maximum intensity and for attaining chateristics such as the ratio of maximum intensity to the intensity of leakage light, the luminance ratio between the normal direction and the direction of maximum intensity and the ratio of the quantity of the leakage light from the top surface within a specified solid angle to the quantity of the light emerging from the bottom surface, a preferred light issuing means is as illustrated in Figs. 3A and 3B and has as its structure a repetition of prismatic asperities (ridge 2a or groove 2b) each comprising a plane of the shorter side inclined at an angle (θ_1) of 30 to 45 degrees with the reference plane defined by the bottom surface 12 and a plane of the longer side inclined at an angle (θ_2) greater than zero degrees up to 10 degrees.

[0032] In the structure described above, the plane of the shorter side 21 or 23 that is formed as an inclined surface sloping downward from the entrance side 13 to the opposed side 15 functions in such a way that those rays of the incident light from a side which are launched into said plane are reflected to be supplied to the bottom surface (from which the light emerges). If the angle of inclination, θ_1, of the plane of the shorter side is adjusted to lie within the range of 30 to 45 degrees, the transmitted light is reflected at an angle of high perpendicularity to the bottom surface as indicated by a kinked arrow in Figs. 3A and 3B, thus ensuring efficient emergence of light from the bottom surface that has maximum intensity A in the direction θ_3 within 30 degrees from the line H normal to the bottom surface (see Fig. 4).

[0033] If the light guide plate is assumed to have a refractive index of 1.5, Snell's law dictates that the transmitted light is within the range of ±41.8 degrees and travels to the opposed end as it repeats total reflection along the way. Therefore, if the angle of inclination θ_1 of the plane of the shorter side is adjusted to lie within the stated range (30 to 45 degrees), said plane reflects the transmitted light such that it emerges from the bottom surface with high degree of perpendicularity. Of course, a portion of the transmitted light fails to satisfy the condition for total reflection simply passes through the plane of the shorter side; however, such leakage light emerges from the bottom surface at a large angle in excess of 60 degrees with the normal line and has no significant effects on viewing at angles near the vertical direction.

[0034] Mainly from the viewpoint of ensuring the aforementioned performance including the control of leakage light and the resulting interference with viewing, the angle of inclination θ_1 of the plane of the shorter side is preferably in the range of 32 to 44 degrees, more preferably 33 to 43 degrees, most preferably 35 to 42 degrees. If θ_1 is less than 30 degrees, the direction of maximum intensity of the light emerging from the bottom surface forms such a great angle with the normal line that less light is available for effective viewing and the brightness tends to decrease. If θ_1 exceeds 45 degrees, more light tends to leak from the top surface.

[0035] The function of the plane of the longer side is twofold. First, it reflects the incident light being transmitted to be supplied to the plane of the shorter side. Second, it transmits the display image from the liquid-crystal cell of a reflection-type liquid-crystal display device into which the light guide plate of the invention is assembled. From this viewpoint, the angle of inclination θ_2 of the plane of the longer side with respect to the reference plane defined by the bottom surface 12 must be greater than zero degrees and up to 10 degrees. If this condition is met, transmitted light incident on the plane of the longer side 22 (or 24) at an angle greater than θ_2 is reflected as indicated by a kinked arrow in Figs. 3A and 3B; due to the inclination of the plane of the longer side, the light is reflected in a direction having a great degree of parallelism with respect to the bottom surface 12 and incident on the adjacent plane of the shorter side 21 (or 23), from which it is reflected and emerges from the bottom surface 12 with the high degree of convergence

Microsoft Exhibit 1002 - Page 920
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

attained by the above-described collimating effect.

[0036] Thus, in addition to the transmitted light that is directly incident on the plane of the shorter side, the transmitted light that is first incident on the plane of the longer side from which it is reflected to be incident on the adjacent plane of the shorter side is also reflected by that plane of the shorter side and supplied to the bottom surface, thereby achieving a corresponding improvement in the efficient utilization of the incident light. As a further advantage, the incident angle of the light that falls upon the plane of the shorter side after reflection from the plane of the longer side can be made uniform enough to suppress the variation in the angle of reflection, thereby ensuring the emergence of collimated and convergent light. Thus, by adjusting the angle of inclination of the plane of the shorter side and that of the plane of the longer side to lie within the stated ranges, high degree of directivity can be imparted to the emergence of light and light can be allowed to emerge from the bottom surface in directions that are either perpendicular to the bottom surface or at angles near the normal line.

[0037] If the angle of inclination of the plane of the longer side is zero degrees (if it is not inclined at all), it is less effective in collimating the transmitted light. If the angle of inclination of the plane of the longer side exceeds 10 degrees, less light is incident on the plane of the longer side and the supply of light toward the opposed end becomes insufficient to achieve uniform light emission. A problem also arises to the cross-sectional shape of the light guide plate and difficulty is encountered is reducing the thickness of the opposed end of the plate; less light is incident on the prismatic asperities and the efficiency of light emission tends to decrease. Mainly from the viewpoint of attaining the stated performance including the production of convergent exit light by collimating the transmitted light and for the control of leakage light, the angle of inclination θ_2 of the plane of the longer side is preferably not greater than 8 degrees, more preferably not greater than 5 degrees.

[0038] Mainly from the viewpoint of ensuring visibility of the display image via planes of the longer side on the light guide plate, preferred planes of the longer side are such that the variation in the angle of inclination θ_2 as measured throughout the light guide plate is within 5 degrees, more preferably within 4 degrees, most preferably within 3 degrees and that the difference in θ_2 between a plane of the longer side and the nearest plane of the longer side is within 1 degree, more preferably within 0.3 degrees, most preferably within 0.1 degree. If these conditions are met, it is possible to suppress the effects that may be caused on the display image by the difference in the angle of inclination θ_2 between planes of the longer side through which light is transmitted. If the deviation in the angle of light transmission through planes of the longer side differs greatly from one place to another, an unnatural display image will be produced and particularly in the case where a significant difference occurs in the deviation of the transmitted image near neighboring pixels, the display image tends to become quite unnatural.

[0039] The above-stated condition for the difference in the angle of inclination presupposes that θ_2 which represents the angle of inclination of the plane of the longer side is in excess of zero degrees and up to 10 degrees. In other words, θ_2 must be sufficiently small that the deviation of the display image due to refraction that occurs when light passes through the plane of the longer side is controlled not to exceed a permissible value; this is to ensure that there will be no change in the optimal viewing direction of the liquid-crystal display device of which the point of observation has been optimized by setting it near the vertical direction. If the display image is deflected, the optimal viewing direction is offset from angles near the vertical direction; in addition to that, if the deviation of the display image is great, the viewing angle comes closer to the direction in which the leakage light emerges from the top surface of the light guide plate, often causing adverse effects such as lower contrast. Note that the condition that θ_2 or the angle of inclination of the plane of the longer side be in excess of zero degrees and up to 10 degrees also includes other requirements such as the need to reduce any adverse effects such as the dispersion of transmitted light to a negligible level.

[0040] From the viewpoint of producing a bright display image, it is preferred that extraneous light is incident with high efficiency and that the display image from the liquid-crystal cell can be transmitted or allowed to emerge with high efficiency. Considering this point, preferred prismatic asperities are such that the area of the plane of the longer side as projected onto the reference plane defined by the bottom surface is at least 5 times, more preferably at least 10 times, most preferably at least 15 times, the projected area of the plane of the shorter side. If this condition is met, most of the display image from the liquid-crystal cell can be transmitted via the planes of the longer side.

[0041] Further referring to the transmission of the display image from the liquid-crystal cell, the display image incident on the plane of the shorter side is reflected toward the entrance end surface and does not emerge from the top surface or if it does emerge, it is deflected at such a great angle away from the display image transmitted through the plane of the longer side with reference to the normal to the bottom surface that it hardly affects the display image transmitted via the plane of the longer side. From this viewpoint, therefore, the planes of the shorter side are preferably not localized with respect to the pixels in the liquid-crystal cell. If, in an extreme case, the planes of the shorter side overlap the pixels throughout the liquid-crystal cell, the display image via the planes of the longer side is hardly visible at angles near the vertical direction.

[0042] Therefore, mainly from the viewpoint of preventing the formation of an unnatural display due to insufficient transmission of the display light, the area over which the pixels overlap the planes of the shorter side is preferably reduced to ensure adequate transmission of light via the planes of the longer side. Considering that the pitch of the

Microsoft Exhibit 1002 - Page 921
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

pixels in a liquid-crystal cell is typically 100 to 300 μm, the stated viewpoint dictates that each plane of the shorter side is preferably formed to be no more than 40 μm, more preferably 1 to 20 μm, most preferably 5 to 15 μm, in size as calculated for the width of projection onto the reference plane defined by the bottom surface.

[0043] The above-stated viewpoint also dictates that the spacing between planes of the shorter side is preferably large. On the other hand, it should be remembered that the plane of the shorter side is in effect a functional element that allows for emergence of the light incident on a side of the light guide plate; if the spacing between planes of the shorter side is excessive, only limited illumination is produced from the light guide plate in ON state and the resulting display also looks unnatural. Considering these facts, the repeating pitch P of the prismatic asperities (ridges 2a or grooves 2b) shown in Figs. 3A and 3B is preferably adjusted to lie in the range of 50 μm to 1.5 mm. The pitch may be constant or irregular as exemplified by a random pitch or random or regular combinations of a specified number of pitch units.

[0044] Ideally, the vertexes of the prismatic asperities, or the points at which the planes of the shorter side cross the planes of the longer side, are each formed as the crossing point of two planes. In practice, however, neither the planes of the shorter side nor those of the longer side can be formed as planes that have no surface roughness in the strict sense of the term and, for the same reason, the vertexes cannot be formed as the crossing points of planes but are formed to a certain degree of radius. However, the roundness of vertexes is a potential cause of increasing the angle of travel of the transmitted light or producing more leakage light.

[0045] Possible effects of these phenomena include, for example, the decrease in directivity in the aforementioned direction effective for viewing the light emerging from the bottom surface and the decrease in contrast due to the leakage light. The light guide plate is desirably protected from these effects. As regards the planes of the shorter side and those of the longer side, the effects can be suppressed by forming them as planes whose surface roughness has been reduced to achieve the highest possible degree of smoothness. As regards the effects of the roundness of vertexes, the roundness of two vertexes in the prismatic asperities formed by a plane of the shorter side and two planes of the longer side that are adjacent to the shorter plane is approximated by an arc of a circle and the sum of the radii of the two arcs of a circle is adjusted to be no more than a half, preferably no more than a third, of the side length of the plane of the shorter side in order to control the aforementioned effects of vertex roundness.

[0046] If the above-stated condition of the sum of radii is satisfied, the area of planes which are inclined at angles no more than 30 degrees to have the disadvantage of being likely to increase the angle of travel and the leakage light by causing scattering similar to that occurred by the aforementioned diffusing dots or the like and abnormal reflections such as one at large angle, can be made sufficiently smaller than the area of the planes of the shorter side to suppress their adverse effects. The above-mentioned scattering and abnormal reflections also have something to do with the disturbance and other problems with the display image and by satisfying the above-stated condition of the sum of radii, such problems can also be prevented to improve the clarity and other elements of the display image.

[0047] Mainly from the viewpoint of preventing the disturbance of the display image due to the overall scattering characteristics of the light guide plate including the scattering due to the aforementioned roundness of vertexes and for producing a clear display image, a preferred light guide plate is such that normal incident light from the bottom surface passes through the top surface at a total ray transmission of at least 90% and with a haze of no more than 15%.

[0048] The light issuing means made up of prismatic asperities sometimes interfere with the pixels in the liquid-crystal cell to produce moiré. To prevent moiré, the pitch of the prismatic asperities need be adjusted; however, as already mentioned, the prismatic asperities have a preferred pitch range. The problem therefore is how to deal with the formation of moiré that occurs with the preferred pitch range.

[0049] For the purposes of the prevent invention, it is preferred to prevent moiré by forming the prismatic asperities at an angle with the reference plane defined by the entrance end surface such that they can be arranged in a crossed pattern with respect to the pixels. When adopting this approach, if the angle of inclination of the prismatic asperities is excessive, the reflection via the planes of the shorter side deviates to cause a substantial offset in the direction of emerging light and the intensity of light emission from the light guide plate in the direction of light travel becomes so much anisotropic that the efficiency of light utilization decreases to deteriorate the quality of the display.

[0050] From this viewpoint, the angle at which the direction of arrangement of the prismatic asperities is inclined with respect to the reference plane defined by the entrance side surface is preferably adjusted to lie within ±35 degrees, more preferably within ±30 degrees, most preferably ±25 degrees. The positive or negative sign represents the direction of inclination with reference to the entrance end surface. If moiré is negligible, the prismatic asperities are preferably arranged in directions that have the highest degree of parallelism to the entrance end surface.

[0051] As already mentioned, the light guide plate may assume any suitable shapes. If it is shaped like a wedge, any appropriate shapes may be adopted, with the top surface being appropriately shaped, as exemplified by a straight surface indicated by 11 in Fig. 2A or curved surfaces indicated by 16 and 17 in Figs. 2B and 2C, respectively.

[0052] The prismatic asperities forming the light issuing means also need not be formed of straight surfaces 21, 22 23 and 24 illustrated in Figs. 3A and 3B but may be formed in any appropriate shapes including bent surfaces, curved surfaces and so forth. The prismatic asperities may comprise combinations of ridges and grooves that differ not only

Microsoft Exhibit 1002 - Page 922
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

in pitch but also in other factors including shape.

[0053] Mainly from the viewpoint of preventing the production of a disturbed display image, the bottom surface of the light guide plate is preferably shaped to be flat enough to have the highest degree of smoothness but this is not the sole case of the invention. The shape of the entrance end surface also is not limited in any particular way and may be determined as appropriate. Generally, it is shaped as a plane perpendicular to the bottom surface but, if desired, it may assume an inwardly curved shape or any other shape that conforms to the perimeter or other factor of the light source, thereby improving the efficiency of light incidence. It is also possible for the entrance end surface to adopt a structure such as one having an introducing part that immediately follows the light source. The introducing part may assume any shape depending on the light source and others.

[0054] The light guide plate may be formed of any suitable materials that are transparent to the specific wavelength range of the light source used. With a light source emitting in the visible range, transparent resins typified by acrylic resins, polycarbonate resins, epoxy resins, etc., as well as glass may be mentioned as exemplary materials. The light guide plate formed of materials that show little or no birefringence is used with preference.

[0055] The light guide plate can be formed by any suitable methods including cutting. Methods of production that are preferred mainly from the viewpoint of allowing for mass production include: transferring a specified shape to a thermoplastic resin by pressing it under heating to a mold capable of forming that shape; heat melting a thermoplastic resin or fluidizing a resin either with heat or in the presence of a solvent and filling such resin into a mold capable of providing a specified shape; and preparing a liquid resin that can be polymerized with heat, ultraviolet radiation or other radiations, filling or casting the resin into a mold capable of forming a specified shape, and polymerizing the resin.

[0056] In the present invention, the light guide plate may typically be formed as a lamination of parts made of similar or dissimilar materials, as exemplified by a light guiding element that is responsible for optical transmission and to which is bonded a sheet having prismatic asperities or other light issuing means formed thereon. The light guide plate need not be formed as a unitary single layer made of one kind of material.

[0057] The thickness of the light guide plate can be determined at an appropriate value depending on the purpose of its use considering various factors including the size of the light guide plate and that of the light source. A typical thickness of the light guide plate for the case where it is used as a part of a reflection-type liquid-crystal display device and the like is no more than 5 mm, preferably 0.1 to 3 mm, more preferably 0.5 to 2 mm, in terms of the thickness at the entrance end surface.

[0058] Using the light guide plate of the invention, one can form various devices including a planer light source unit that allows precisely collimated light to emerge in a direction having high degree of perpendicularity that is advantageous for viewing, thereby achieving efficient utilization of the light from the light source to produce high brightness, as well as a reflection-type liquid-crystal display device that is bright, that features high contrast and that consumes less power.

[0059] Fig. 5 illustrates a planer light source unit 3 having a light guide plate 1 according to the invention. As shown, the planer light source unit 3 can be formed by positioning a light source 31 adjacent the entrance end surface of the light guide plate 1 and it is preferably used typically as a front light of sidelight type.

[0060] Any appropriate light source may be positioned adjacent the entrance end surface of the light guide plate. Typical examples that can be used with preference include linear light sources such as (cold or hot) cathode-ray tubes, point light sources such as a light-emitting diode, linear or planar arrays of such point light sources, and light sources that use a device for converting point light sources such that they are capable of linear emission at constant or varying intervals. Mainly from the viewpoint of lower power consumption and high durability, cold cathode-ray tubes are particularly preferred.

[0061] If necessary, the planer light source unit may be formed as an assembly with an appropriate auxiliary means such as a light source holder which is indicated by 32 in Fig. 5 and which surrounds the light source 31 so as to ensure that the divergent light from the light source is directed to the entrance end surface of the light guide plate 1 or a diffusing layer which is indicated by 4 in Fig. 6 and which is placed underneath the bottom surface of the light guide plate so as to produce uniform surface emission.

[0062] The light source holder is typically formed of a resin sheet furnished with a high-reflectance thin metal film, a metal foil or the like. If the light source holder is to be bonded to an end of the light guide plate via an adhesive or the like, it is not absolutely necessary to form a light issuing means at the joint.

[0063] The diffusing layer is an optional element that is preliminarily positioned beneath the light exit face of the planer light source unit, namely the bottom surface 12 of the light guide plate 1 for various purposes such as preventing the unevenness in light and dark areas so as to provide uniform brightness and reducing the moiré due to the intermingling of adjacent rays of light. In the present invention, a diffusing layer permitting a narrow range of diffusion is preferably used mainly from the viewpoint of maintaining the directivity of the light emerging from the light guide plate and achieving efficient utilization of light.

[0064] The diffusing layer can be formed by any appropriate methods and examples include: dispersing clear particles of high refractive index within a clear resin of low refractive index, applying a coating of the resin and curing the same;

Microsoft Exhibit 1002 - Page 923
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

dispersing air bubbles within a clear resin, applying a coating of the resin and curing the same; swelling a substrate surface in the presence of a solvent so as to produce crazes; forming a clear resin layer having irregular surface asperities; and using a diffusing sheet formed by any of the methods described above. In short, there is no particular limitation on the method of forming the diffusing layer.

[0065] The above-mentioned irregular surface asperities may be formed by any appropriate methods including mechanical and/or chemical methods by which the surface texture of a roll, a mold or the like that have been grained on the surface is transferred to the surface of a substrate or an overlying coated layer of a clear resin. The aforementioned clear particles may be selected from appropriate materials including, for example, optionally conductive, inorganic particles with an average size of 0.5 to 100 μm as exemplified by those of silica, alumina, titania, zirconia, tin oxide, indium oxide, cadmium oxide and antimony oxide, and organic particles as exemplified by those of crosslinked or uncrosslinked polymers.

[0066] As described above, the planer light source unit according to the invention features highly efficient light utilization, is bright and provides light that has high degree of perpendicularity, with an additional advantage that it can be formed in a large area. Hence, it can be applied with preference to various devices, typically as a front light system in a reflection-type liquid-crystal display device and the like; using this planer light source unit, one can produce a bright, high-contrast and low-power-consumption reflection-type liquid-crystal display device and the like.

[0067] Figs. 6 and 7 illustrate two examples of a reflection-type liquid-crystal display device using the planer light source unit 3 of the invention as a front light system. Indicated by 5 and 51 is a polarizer plate, 6 is a liquid-crystal cell, 61 and 63 are each a cell substrate, 62 is a liquid-crystal layer, and 7 and 64 are each a reflective layer. As shown, the liquid-crystal cell 6 furnished with the reflective layer 7 or 64 is positioned beneath the light exit side of the planer light source unit, namely, beneath of the bottom surface of the light guide plat 1 in the planer light source unit and this is how the reflection-type liquid-crystal display device is formed.

[0068] The reflection-type liquid-crystal display device is typically formed by assembling in an appropriate manner various components such as a liquid-crystal cell furnished with transparent electrodes serving as liquid-crystal switches, ancillary drive units, polarizer plates, a front light, a reflective layer and an optional compensating phase-difference plate. The present invention is not limited in any particular way except for the use of the above-described planer light source unit and the desired reflection-type liquid-crystal display device can be formed in the conventional manner as shown in Figs. 6 and 7. It should be noted that transparent electrodes are not shown in these drawings.

[0069] As will be understood from the above, the liquid-crystal cell to be used is not limited to any particular type and, in terms of the mode of molecular orientation in liquid crystals, any appropriate twisted, non-twisted, guest-host and ferroelectric liquid-crystal cells may be used, as exemplified by TN liquid-crystal cell, STN liquid-crystal cell, normal oriented cell, HAN cell and OCB cell. The method of driving liquid crystals also is not limited in any particular way and any appropriate drive systems may be employed, as exemplified by an active matrix system and a passive matrix system.

[0070] The reflection-type liquid-crystal display device requires the reflective layer 7 or 64 as an essential component and it may be provided outside the liquid-crystal cell 6 as illustrated in Fig. 6 or inside it as shown in Fig. 7. Any appropriate reflective layer may be formed as in the conventional art and examples include: a coating layer having the particles of high-reflectance metals such as aluminum, silver, gold, copper and chromium incorporated in a binder resin; a deposited layer of a thin metal film typically formed by evaporation; a reflective sheet having the above-described coating layer or deposited layer supported on a substrate; and a metal foil.

[0071] If the reflective layer is to be provided inside the liquid-crystal cell 6 as indicated by 64 in Fig. 7, it is preferably a highly conductive material as exemplified by the aforementioned high-reflectance metals rather than a transparent conductive film or the like that may be made of a conventional transparent electrode forming material.

[0072] The polarizer plates may also be of any appropriate types; however, mainly from the viewpoint of producing a display of satisfactory contrast ratio by assuring the incidence of highly linearly polarized light, plates capable of high degree of polarization as exemplified by iodine- or dye-based absorptive linear polrizers are preferably used.

[0073] When forming the reflection-type liquid-crystal display device, any appropriate optical elements may be provided in appropriate positions, as exemplified by a diffusing plate, an anti-glare layer, an anti-reflection layer and a protective layer that are provided on the polarizer plate on the viewing side, or a compensating phase-difference plate that is provided between the liquid-crystal cell and the polarizer plate.

[0074] The compensating phase-difference plate is typically intended to assure better visibility by compensating the wavelength dependency of birefringence and the like. In the present invention, this plate is optionally provided as between the polarizer plate either on the viewing side or on the back side and the liquid-crystal cell. If necessary, the plate may be provided both between the polarizer plate on the viewing side and the liquid-crystal cell and between the polarizer plate on the back side and the liquid-crystal cell. Any appropriate compensating phase-difference plate may be used depending on the wavelength range and the like and it may be formed as a single phase-difference layer or as an assembly of two or more superposed phase-difference layers.

[0075] The reflection-type liquid-crystal display device according to the invention is viewed via the light from the

Microsoft Exhibit 1002 - Page 924
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

planer light source unit, particularly via the light transmitted through the planes of the longer side on the light guide plate. Fig. 8 illustrates how the device is viewed in the case where the reflective layer 64 is provided within the liquid-crystal cell. As shown, when the planer light source unit is ON, the light α emerging from the bottom surface of the light guide plate 1 passes through the polarizer plate 5, liquid-crystal layer 62 and so forth to be reflected by the reflective layer 64; the reflected light travels back in the path including the liquid-crystal layer, the polarizer plate and so forth until it reaches the light guide plate 1, where it is transmitted through the planes of the longer side 22 to allow for the viewing of the display image (α).

[0076] In the case just described above, according to the present invention, intense leakage light β_1 emerges in a direction offset by a substantial angle from the front direction normal to the liquid-crystal cell. On the other hand, only weak leakage light β_2 emerges in the front direction. Therefore, one can view a display image of high display quality via the planes of the longer side at angles near the front direction.

[0077] When the planer light source unit is OFF and uses extraneous light, the light γ incident on the planes of the longer side 22 on the light guide plate travels forward and backward in the path including the polarizer plate, liquid-crystal layer, reflective layer and so forth in the same manner described above until it reaches the light guide plate 1 and a display image (γ) that has passed through the planes of the longer side can be viewed at angles near the front direction as one of high display quality that is less affected by disturbances and other adverse effects of the light guide plate.

[0078] In the present invention, the light guide plate and optical elements or parts such as a diffusing layer, a liquid-crystal cell and polarizer plates that compose the planer light source unit and the liquid-crystal display device may be secured one to another either entirely or partly as an integral assembly of superposed layers; alternatively, the individual components may be positioned in an easily separable state. Mainly from the viewpoint of preventing the decrease in contrast by controlling interfacial reflection, the components are preferably secured one to another and it is more preferred that at least the bottom surface of the light guide plate in the planer light source unit and the top surface of the liquid-crystal cell are secured to have intimate contact with each other.

[0079] To secure individual components to have an intimate contact with each other, an appropriate clear adhesive such as self-adhesives may be used and the resulting clear adhesive layer may incorporate the aforementioned clear particles and the like to form an adhesive layer or the like that exhibits a diffusing capability.

Examples

Example 1:

[0080] A clear polymethyl methacrylate (PMMA) plate is cut on one side with a diamond cutting tool to form a light guide plate of the following specifications: width, 80 mm; depth, 130 mm; thickness at the entrance end surface, 2 mm; thickness at the opposed end, 0.8 mm; bottom surface (exit face), flat; top surface, a curved surface projecting upward but substantially flat in the area extending from the entrance end surface to the opposed end (see Fig. 2B), with prismatic asperities formed parallel to the entrance end surface on a pitch of 390 μm; planes of the shorter side, inclined at angles varying within the range of 36.5 to 39 degrees; planes of the longer side, inclined at angles varying within the range of 1.1 to 1.5 degrees; the variation in the angle of inclination between a plane of the longer side and the nearest plane of the longer side, within 0.1 degree; the width of a plane of the shorter side as projected onto the bottom surface, 10 to 21 μm; and the ratio between the area of a plane of the shorter side as projected onto the bottom surface and the similar projected area of a plane of the longer side, no more than 1/17. The prismatic asperities were not formed immediately adjacent the entrance end surface but starting in a position 2 mm away from it.

[0081] A cold cathode-ray tube 2.4 mm in diameter was positioned adjacent the entrance end surface of the thus prepared light guide plate and a light source holder made of a polyester film having an evaporated silver coating was placed around the cathode-ray tube, with the edges being secured to the top and bottom end faces of the light guide plate. An inverter and a dc power source were connected to the cathode-ray tube to construct a planer light source unit. On the light exit side of the planer light source unit was provided a monochromatic reflection-type TN liquid-crystal cell having on the back side a reflective sheet prepared in the same manner as the light source holder. Thus fabricated was a reflection-type liquid-crystal display device. The planer light source unit could be set in either ON or OFF state by turning the power source on or off, respectively. In the liquid-crystal display device, all pixels could be turned on or off by manipulating the drive source.

Example 2:

[0082] A wedge-shaped light guide plate having the following specifications was formed in accordance with Example 1: width, 80 mm; depth, 130 mm; thickness at the entrance end surface, 1.5 mm; thickness at the opposed end, 1.0 mm; bottom surface, flat; top surface, flat and having prismatic asperities formed parallel to the entrance end surface

Microsoft Exhibit 1002 - Page 925
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

on a pitch of 500 μm; planes of the shorter side, inclined at angles varying within the range of 37.7 to 38.9 degrees; planes of the longer side, inclined at angles varying within the range of 0.6 to 1.1 degrees; the variation in the angle of inclination between a plane of the longer side and the nearest plane of the longer side, within 0.1 degree; the width of a plane of the shorter side as projected onto the bottom surface, 10 to 14 μm; and the ratio between the area of plane of the shorter side as projected onto the bottom surface and the similar projected area of a plane of the longer side, no more than 1/35. Using this light guide plate, a planer light source unit and a reflection-type liquid-crystal display device were fabricated. The prismatic asperities were not formed immediately adjacent the entrance end surface but starting in a position 2 mm away from it.

Example 3:

[0083] A light guideplate was formed in accordance with Example 2, except for the following points; the pitch of the prismatic asperities was 500 μm; the angle of inclination of the planes of the shorter side was 38.3 degrees; the angle of inclination of the planes of the longer side was 0.7 degrees (the variation in the angle of inclination between a plane of the longer side and the nearest plane of the longer side was substantially zero and within 0.1 degree); the width of a plane of the shorter side as projected onto the bottom surface was 10 μm; and the ratio between the area of a plane of the shorter side as projected onto the bottom surface and the similar projected area of a plane of the longer side was 1/49. Using this light guide plate, a planer light source unit and a reflection-type liquid-crystal display device were fabricated.

Example 4:

[0084] In accordance with Example 1, a light guide plate was formed from a flat plate of uniform thickness that was 80 mm wide, 130 mm deep and 1.5 mm thick at both the entrance end surface and the opposed end. On one of its sides, the plate had prismatic asperities that were formed parallel to the entrance end surface on a pitch of 500 μm. The angle of inclination of the planes of the shorter side was 38.3 degrees; the angle of inclination of the planes of the longer side was 0.9 degrees (the variation in the angle of inclination between a plane of the longer side and the nearest plane of the longer side was substantially zero and within 0.1 degree); the width of a plane of the shorter side as projected onto the bottom surface was 10 μm; and the ratio between the area of a plane of the shorter side as projected onto the bottom surface and the similar projected area of a plane of the longer side was 1/49. Using this light guide plate, a planer light source and a reflection-type liquid-crystal display device were fabricated. The prismatic asperities were not formed immediately adjacent the entrance end surface but starting in a position 2 mm away from it.

Example 5:

[0085] A light guide plate having the following specifications was formed in accordance with Example 1: width, 80 mm; depth, 63 mm; thickness at the entrance end surface, 2 mm; thickness at the opposed end, 0.8 mm; bottom surface, flat; top surface, a curved surface projecting upward but substantially flat in the area extending from the entrance end surface to the opposed end, with prismatic asperities formed parallel to the entrance end surface on a pitch of 160 μm; planes of the shorter side, inclined at angles varying within the range of 40.5 to 43.5 degrees; planes of the longer side, inclined at angles varying within the range of 1.8 to 4.9 degrees; the variation in the angle of inclination between a plane of the longer side and the nearest plane of the longer side, within 0.1 degree; the width of a plane of the shorter side as projected onto the bottom surface, 10.7 to 21.1 μm; and the ratio between the area of a plane of the shorter side as projected onto the bottom surface and the similar projected area of a plane of the longer side, no more than 1/6. Using this light guide plate, a planer light source unit and a reflection-type liquid-crystal display device were fabricated. The prismatic asperities were not formed immediately adjacent the entrance end surface but starting in a position 3 mm away from it.

Example 6:

[0086] A light guide plate having the following specifications was formed in accordance with Example 1: width, 80 mm; depth, 63 mm; thickness at the entrance end surface, 2 mm; thickness at the opposed end, 0.8 mm; bottom surface, flat; top surface, a curved surface projecting upward but substantially flat in the area extending from the entrance end surface to the opposed end; with prismatic asperities formed parallel to the entrance end surface on a pitch of 200 μm; planes of the shorter side, inclined at angles varying within the range of 39.1 to 41.9 degrees; planes of the longer side, inclined at angles varying within the range of 2.5 to 3.6 degrees; the variation in the angle of inclination between a plane of the longer side and the nearest plane of the longer side, within 0.1 degree; the width of a plane of the shorter side as projected onto the bottom surface, 10 to 22.3 μm; and the ratio between the area of a plane of the

Microsoft Exhibit 1002 - Page 926
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

shorter side as projected onto the bottom surface and the similar projected area of a plane of the longer side, no more than 1/7. Using this light guide plate, a planer light source unit and a reflection-type liquid-crystal display device were fabricated. The prismatic asperities were not formed immediately adjacent the entrance end surface but starting in a position 3 mm away from it.

Example 7:

[0087] A mold was prepared such that it could form a light guide plate of the same shape and dimensions as the plate formed in Example 5. The mold was heated to 100°C and filled with a heat melted mass of PMMA, thereby forming a light guide plate. Using this light guide plate, a planer light source unit and a reflection-type liquid-crystal display device were fabricated.

Example 8:

[0088] By a mold-using technique in accordance with Example 7, a molded plate having the following specifications was formed: width, 230 mm; depth, 190 mm; thickness at the entrance end surface; 2.6 mm; thickness at the opposed end, 0.8 mm; bottom surface, flat; and top surface, a curved surface projecting upward but substantially flat in the area extending from the entrance end surface to the opposed end, with prismatic asperities formed parallel to the entrance end surface. The molded plate was then cut to have the prismatic asperities crossing the entrance end surface, thereby forming a light guide plate having the following specifications: width, 80 mm; depth, 63 mm; thickness at the entrance end surface, 2 mm; thickness at the opposed end, 1 mm; top surface, having prismatic asperities formed on a pitch of 300 μm and arranged at a cross angle of 25 degrees with the entrance end surface; planes of the shorter side, inclined at angles varying within the range of 40.6 to 41.6 degrees; planes of the longer side, inclined at angles varying within the range of 0.9 to 1.6 degrees; the variation in the angle of inclination between a plane of the longer side and the nearest plane of the longer side, within 0.1 degree; the width of a plane of the shorter side as projected onto the bottom surface, 12.5 to 14.5 μm; and the ratio between the area of a plane of the shorter side as projected onto the bottom surface and the similar projected area of a plane of the longer side, no more than 1/20. Using this light guide plate, a planer light source unit and a reflection-type liquid-crystal display device were fabricated in accordance with Example 1. The prismatic asperities were not formed immediately adjacent the entrance end surface but starting in a position 2 mm away from it.

Comparative Example 1:

[0089] Using a commercial light guide plate, a planer light source unit and a reflection-type liquid-crystal display device were fabricated. The light guide plate was wedge-shaped and had a thickness of 155 mm, a depth of 60 mm, a thickness of 2 mm at the entrance end surface, and a thickness of 1 mm at the opposed end. It had a circular dot pattern on one side that was made up of randomly distributed ridges and grooves formed by embossing.

Comparative Example 2:

[0090] Using another commercial light guide plate, a planer light source unit and a reflection-type liquid-crystal display device were fabricated in accordance with Example 1. The light guide plate was wedge-shaped and had a thickness of 238 mm, a depth of 178 m, a thickness of 3 mm at the entrance end surface, and a thickness of 1.5 mm at the opposed end. It had white dots printed on one side in such a way that they were generally square on the side closer to the entrance end surface but changed to rectangles in the area closer to the opposed end than to the center, with the dot area increasing toward the opposed end.

Comparative Example 3:

[0091] A light guide plate having the following specifications was formed in accordance with Example 1: width, 80 mm; depth, 63 mm; thickness at the entrance end surface, 2 mm; thickness at the opposed end, 0.8 mm; bottom surface, flat; top surface, a curved surface projecting upward but substantially flat in the area extending from the entrance end surface to the opposed end, with prismatic asperities formed parallel to the entrance end surface on a pitch of 160 μm; planes of the shorter side, inclined at angles varying within the range of 40.1 to 43.2 degrees; planes of the longer side, inclined at angles varying within the range of 9.5 to 12.8 degrees; the variation in the angle of inclination between a plane of the longer side and the nearest plane of the longer side, within 0.2 degree; the width of a plane of the shorter side as projected onto the bottom surface, 30 to 43 μm; and the ratio between the area of a plane of the shorter side as projected onto the bottom surface and the similar projected area of a plane of the longer side, 1/2.9 to

Microsoft Exhibit 1002 - Page 927
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

1/4.3. Using the light guide plate, a planer light source unit and a reflection-type liquid-crystal display device were fabricated. The prismatic asperities were not formed immediately adjacent the entrance end surface but starting in a position 3 mm away from it.

Comparative Example 4:

[0092] A light guide plate having the following specifications was formed in accordance with Example 1: width, 80 mm; depth, 63 mm; thickness at the entrance end surface, 2 mm; thickness at the opposed end, 0.8 mm; bottom surface, flat; top surface, a curved surface projecting upward but substantially flat in the area extending from the entrance end surface to the opposed end, with prismatic asperities formed parallel to the entrance end surface on a pitch of 160 μm; planes of the shorter side, inclined at angles varying within the range of 28.8 to 29.3 degrees; planes of the longer side, inclined at angles varying within the range of 0.1 to 3.6 degrees; the variation in the angle of inclination between a plane of the longer side and the nearest plane of the longer side, within 0.1 degree; the width of a plane of the shorter side as projected onto the bottom surface, 10.7 to 21.1 μm; and the ratio between the area of a plane of the shorter side as projected onto the bottom surface and the similar projected area of a plane of the longer side, no more than 1/6. Using this light guide plate, a planer light source unit and a reflection-type liquid-crystal display device were fabricated. The prismatic asperities were not formed immediately adjacent the entrance end surface but starting in a position 3 mm away from it.

Comparative Example 5:

[0093] A light guide plate having the following specifications was formed in accordance with Example 1: width, 80 mm; depth, 63 mm; thickness at the entrance end surface, 2 mm; thickness at the opposed end, 0.8 mm; bottom surface, flat; top surface, a curved surface projecting upward but substantially flat in the area extending from the entrance end surface to the opposed end, with prismatic asperities formed parallel to the entrance end surface on a pitch of 160 μm; planes of the shorter side, inclined at angles varying within the range from about 40 to about 42 degrees; planes of the longer side, inclined at angles varying within the range from about 1 to about 10 degrees; the variation in the angle of inclination between a plane of the longer side and the nearest plane of the longer side, at least 1 degree in terms of the changes in the length and height of a plane of the shorter side; the width of a plane of the shorter side as projected onto the bottom surface, from about 10 to about 40 μm; and the ratio between the area of a plane of the shorter side as projected onto the bottom surface and the similar projected area of a plane of the longer side, about 1/4. Using this light guide plate, a planer light source unit and a reflection-type liquid-crystal display device were fabricated. The prismatic asperities were not formed immediately adjacent the entrance end surface but starting in a position 3 mm away from it.

Comparative Example 6:

[0094] A light guide plate having the following specifications was formed in accordance with Example 1: width, 80 mm; depth, 130 mm; thickness at the entrance end surface, 1.5 mm; thickness at the opposed end, 1 mm; bottom surface, flat; top surface, flat and having prismatic asperities formed parallel to the entrance end surface on a pitch of 2 mm; planes of the shorter side, inclined at an angle of 38.7 degrees; planes of the longer side, inclined at an angle of zero degrees; the variation in the angle of inclination between a plane of the longer side and the nearest plane of the longer side, within 0.1 degree; the width of a plane of the shorter side as projected onto the bottom surface, 10 μm; and the ratio between the area of a plane of the shorter side as projected onto the bottom surface and the similar projected area of a plane of the longer side, 1/199. Using the light guide plate, a planer light source unit and a reflection-type liquid-crystal display device were fabricated. The prismatic asperities were not formed immediately adjacent the entrance end surface but starting in a position 2 mm away from it.

Comparative Example 7:

[0095] Using a mold heated at 90°C, the technique of Example 7 was employed to form a light guide plate having the following specifications: width, 80 mm; depth, 63 mm; thickness at the entrance end surface, 2.0 mm; thickness at the opposed end, 0.8 mm; bottom surface flat; top surface, a curved surface projecting upward but substantially flat in the area extending from the entrance end surface to the opposed end, with prismatic asperities formed parallel to the entrance end surface on a pitch of 160 μm; planes of the shorter side, inclined at angles varying within the range of 40.6 to 43.5 degrees; planes of the longer side, inclined at angles varying within the range of 1.8 to 4.9 degrees; the variation in the angle of inclination between a plane of the longer side and the nearest plane of the longer side, within 0.1 degree; the width of a plane of the shorter side as projected onto the bottom surface, 10.7 to 21.1 μm; and the ratio

Microsoft Exhibit 1002 - Page 928
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

between the area of a plane of the shorter side as projected onto the bottom surface and the similar projected area of a plane of the longer side, no more than 1/6. Using the light guide plate, a planer light source unit and a reflection-type liquid-crystal display device were fabricated in accordance with Example 1. The prismatic asperities were not formed immediately adjacent the entrance end surface but starting in a position 3 mm away from it.

Comparative Example 8:

[0096] A light guide plate was formed in accordance with Example 8, except that the prismatic asperities were arranged at a cross angle of 40 degrees with the entrance end surface. Using the light guide plate, a planer light source unit and a reflection-type liquid-crystal display device were fabricated.

Evaluation Tests

[0097] The light guide plates, planer light source units and reflection-type liquid-crystal display devices fabricated in Examples 1 to 8 and Comparative Examples 1 to 8 were checked for the following characteristics.

Intensity of emerging light, or exit intensity:

[0098] With the planer light source unit turned on, the angular characteristics of the intensity of the light emerging from the top and bottom surfaces in the central area of the light guide plate were investigated with a brightness meter (BM7 of Thompson). The measurement was performed with the angle being varied from the line normal to the bottom surface in a plane perpendicular to both the bottom surface and the entrance end surface. To assure a constant area of measurement, each of the measurements was multiplied by the cosine of the angle of measurement θ and the intensity of the emerging light at θ was determined. The direction in which a maximum intensity of light emergence occurred was also determined.

[0099] The thus obtained data on the maximum intensity on the bottom surface, its direction, as well as the intensity of emerging light from the top surface in a direction of mirror symmetry with the direction of maximum intensity on the bottom surface with respect to the normal line and the bottom surface (said intensity is hereinafter called "corresponding exit intensity") are shown in Tables 1 and 2. The data on the front (normal direction) exit intensity on the top and bottom surfaces, as well as the front/maximum intensity ratio on the bottom surface are also shown in Tables 3 and 4.

Quantity of light within a solid angle of 30°:

[0100] A cylindrical body having a hole 10 mm in diameter and which was painted black on the inner surfaces to give a matte finish was installed in a face-to-face relationship with an illuminometer such that the solid angle formed between the hole and the light-receiving plane of the illuminometer was 30 degrees. Using the assembly, the quantity of light emerging from the top and bottom surfaces of the planer light source unit in ON state at solid angles within 30 degrees was measured. The result is shown in Tables 5 and 6, which also show the percent total ray transmission through the light guide plate and the haze.

Front luminance:

[0101] With the reflection-type liquid-crystal display device in a driven state, the front luminances in both a white state and a black state were measured with the planer light source unit held in On state. The result is shown in Tables 7 and 8. Front luminances were also measured without providing the planer light source unit and the result is shown as "Reference Example", in Table 8.

Vertex characteristics:

[0102] For the prismatic asperities on the light guide plates formed in Example 7 and Comparative Example 7, the side length of a plane of the shorter side, as well as the roundness of the vertexes of a ridge and a groove formed by a plane of the shorter side and an adjacent plane of the longer side were measured. In Example 7, the side length of a plane of the shorter side was 12.6 μm; the approximated radius of the vertex formed by a plane of the shorter side and an adjacent plane of the longer side was 3 μm at a ridge and 1 μm at a groove; hence, the ratio of the sum of two radii to the side length was 0.317.

[0103] In Comparative Example 7, the side length of a plane of the shorter side was 12.4 μm; the approximated radius of the vertex formed by a plane of the shorter side and an adjacent plane of the longer side was 5.5 μm at a ridge and 1.5 μm at a groove; hence, the ratio of the sum of two radii to the side length was 0.565.

Microsoft Exhibit 1002 - Page 929
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Table 1

	Angle of maximum intensity on bottom surface (deg)	Maximum intensity on bottom surface = M (cd/m^2)	Corresponding exit intensity on top surface = C (cd/m^2)	C/M
Example 1	16	680	34	0.050
Example 2	19	475	22	0.046
Example 3	18	460	19	0.041
Example 4	18	443	15	0.034
Example 5	8	1230	59	0.048
Example 6	15	1180	52	0.044
Example 7	12	1120	92	0.082
Example 8	18	810	87	0.107
Comparative Example 1	70	540	470	0.870
Comparative Example 2	45	250	220	0.880

Table 2

	Angle of maximum intensity on bottom surface (deg)	Maximum intensity on bottom surface = M (cd/m^2)	Corresponding exit intensity on top surface = C (cd/m^2)	C/M
Comparative Example 3	8	410	37	0.090
Comparative Example 4	50	1190	430	0.361
Comparative Example 5	9	1040	48	0.047
Comparative Example 6	16	138	16	0.116
Comparative Example 7	19	710	150	0.211
Comparative Example 8	22	600	73	0.122

Table 3

	Front exit intensity (cd/m^2)		Front/maximum intensity ratio on bottom surface
	on bottom surface	on top surface	
Example 1	104	18	0.153
Example 2	68	15	0.143
Example 3	67	11	0.146
Example 4	62	12	0.14
Example 5	560	34	0.455
Example 6	225	29	0.191
Example 7	545	46	0.487
Example 8	235	41	0.29
Comparative Example 1	21	16	0.039
Comparative Example 2	155	90	0.62

Microsoft Exhibit 1002 - Page 930
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Table 4

	Front exit intensity (cd/m^2)		Front/maximum intensity ratio on bottom surface
	on bottom surface	on top surface	
Comparative Example 3	220	29	0.537
Comparative Example 4	58	20	0.049
Comparative Example 5	470	28	0.452
Comparative Example 6	23	12	0.167
Comparative Example 7	360	58	0.507
Comparative Example 8	180	39	0.3

Table 5

	Quantity of light within a solid angle of 30° (LX)		Ratio of light on top surface to light on bottom surface	Total ray transmission (%)	Haze (%)
	on bottom surface	on top surface			
Example 1	14.5	1.3	0.09	92.4	7.4
Example 2	9.9	0.9	0.091	92.5	6.2
Example 3	9.7	0.8	0.082	92.7	6.5
Example 4	9.7	0.9	0.093	92.6	6.4
Example 5	28.5	2.7	0.095	92.5	10.1
Example 6	29.8	3.0	0.101	92.4	9.9
Example 7	26.4	3.1	0.117	92.3	11.3
Example 8	18.3	2.2	0.12	92.5	8.7
Comparative Example 1	0.9	0.9	1.0	92.1	16.0
Comparative Example 2	2.5	2.1	0.84	85.1	48.4

Table 6

	Quantity of light within a solid angle of 30° (LX)		Ratio of light on top surface to light on bottom surface	Total ray transmission (%)	Haze (%)
	on bottom surface	on top surface			
Comparative Example 3	13.6	1.8	0.132	88.9	24.3
Comparative Example 4	11.4	1.3	0.114	92.5	8.7
Comparative Example 5	23.7	2.8	0.118	92.2	11.2
Comparative Example 6	3.0	0.7	0.233	92.7	3.5

Microsoft Exhibit 1002 - Page 931
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Table 6 (continued)

	Quantity of light within a solid angle of 30° (LX)		Ratio of light on top surface to light on bottom surface	Total ray transmission (%)	Haze (%)
	on bottom surface	on top surface			
Comparative Example 7	17.4	2.2	0.126	92.4	11.7
Comparative Example 8	14.3	1.3	0.091	92.5	8.9

Table 7

	Front Luminance (cd/m^2)		
	in white state	in black state	white/black ratio
Example 1	170	22	7.7
Example 2	137	16	8.6
Example 3	129	13	9.9
Example 4	121	12	10.1
Example 5	305	37	8.2
Example 6	335	34	9.9
Example 7	274	43	6.4
Example 8	205	40	5.1
Comparative Example 1	74	19	2.9
Comparative Example 2	115	85	1.4
Comparative Example 3	102	30	3.4

Table 8

	Front luminance (cd/m^2)		
	in ON state		
	in white state	in black state	white/black ratio
Comparative Example 4	101	27	3.7
Comparative Example 5	265	32	8.3
Comparative Example 6	48	13	2.7
Comparative Example 7	210	65	3.2
Comparative Example 8	175	43	4.1
Reference Example	28	1.6	17.5

[0104] A comparison between Example 5 and Comparative Example 3 shows that when the light guide plate was assembled into a reflection-type liquid-crystal display device, the display was bright near the entrance end surface of the light guide plate of Comparative Example 3 but its brightness decreased sharply toward the opposed end. On the other hand, the light guide plate of Example 5 was substantially free from the change in luminance and featured high uniformity in brightness. In the light guide plate of Example 5, the planes of the shorter side in the light issuing means were hardly recognizable; however, in the light guide plate of Comparative Example 3, the planes of the shorter side were clearly visible.

Microsoft Exhibit 1002 - Page 932
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

[0105] A comparison between Example 5 and Comparative Example 4 shows that due to the difference in the angle of inclination of the planes of the shorter side, intense light emerged from the light guide plate of Comparative Example 4 in a direction offset by a substantial angle from the front direction and a marked drop occurred in luminance when the light guide plate was assembled into a reflection-type liquid-crystal display device. This caused a corresponding drop in contrast ratio compared to the value attained in Example 5.

[0106] A comparison between Example 3 and Comparative Example 6 shows that in Comparative Example 6 in which the angle of inclination of the planes of the longer side was set at zero degrees, the pitch of the prismatic asperities had to be increased to 2 mm; as a result, the bright-line emission from the light guide plate was clearly visible even by the reflection that occurred when it was assembled into a reflection type liquid-crystal display device; hence, the display quality decreased markedly, so did luminance.

[0107] A comparison between Example 7 and Comparative Example 7 shows that the difference that developed in their optical characteristics was due to the roundness of vertexes since the two light guide plates that were formed with the same mold did not have any differences in their basic shape and dimensions. As stated above, the light guide plate of Example 7 satisfied the condition of the present invention for the roundness of vertexes. However, the light guide plate of Comparative Example 7 did not satisfy the condition and the reflection-type liquid-crystal display device incorporating that light guide plate was dark and projected only low contrast.

[0108] Speaking of the viewing OFF state with the light guide plate positioned on the liquid-crystal cell, the linear pattern displayed on the liquid-crystal cell was clearly visible in Examples 1 to 8 and comparative Examples 4, 6, 7 and 8. On the other hand, the intended linear pattern was hardly recognizable due to scattering in Comparative Examples 1 and 2. In Comparative Example 3, the image was greatly displaced downward and looked darker than in Example 5. In Comparative Example 5, the line did not come out continuous but looked quite unnatural; this effect was particularly noticeable in viewing at an angle. Referring now to the viewing in ON state, the image had an obvious anisotropy in the horizontal direction and looked unnatural in Comparative Example 8. On the other hand, the deviation of the emerging light was small in Example 8.

[0109] When the light guide plate of Example 1 was brought into intimate contact with the liquid-crystal cell by means of a gel-based self-adhesive layer, a marked improvement was achieved in contrast, producing a clear display in both ON state and during illumination with extraneous light in OFF state. From the above-described facts, it can be seen that using the light guide plate and the planer light source unit according to the present invention, one can fabricate a bright and high-contrast reflection-type liquid-crystal display device.

[0110] Although the invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form can be changed in the details of construction and in the combination and arrangement of parts without departing from the spirit and the scope of the invention as hereinafter claimed.

Claims

1. A light guide plate comprising:

   an entrance end surface on which light is incident;
   a top surface having light issuing means; and
   a bottom surface from which the light emerge via said light issuing means,
   wherein, a direction of maximum intensity of the emerging light as measured in a plane perpendicular to the two reference planes defined by said entrance end surface and said bottom surface is within 30 degrees from a line normal to said bottom surface,
   when a direction toward said entrance end surface away from the normal line taken as the reference is assumed to be negative, intensity of light leaking from said top surface at the same angle as the direction of the maximum intensity is no more than a tenth of said maximum intensity, and
   incident light from the bottom surface is transmitted through said top surface.

2. A light guide plate according to claim 1, wherein luminance of the emerging light from said bottom surface as measured in the direction of the normal line to said perpendicular plane is no more than 60% of luminance in the direction of said maximum intensity.

3. A light guide plate according to claim 1, wherein quantity of the light leaking at solid angles within 30 degrees with reference to the normal line is no more than 1/8 of quantity of the light emerging from said bottom surface.

4. A light guide plate according to claim 1, wherein said light issuing means comprises a repetition of prismatic as-

Microsoft Exhibit 1002 - Page 933
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

perities each having a shorter side plane and a longer side plane and being arranged on a pitch of 50 μm to 1.5 mm,

wherein said shorter side plane is an inclined surface which slopes downward from said entrance end surface to an opposed end to said entrance end surface at angles of inclination of 30 to 45 degrees with respect to the reference plane defined by said bottom surface,
wherein said longer side plane is inclined at angles in excess of zero degrees and up to 10 degrees with respect to the reference plane defined by said bottom surface, with the variation in the angle of inclination of all the longer side planes as measured throughout the light guide plate being within 5 degrees, and difference in the angle of inclination between one longer side plane and a nearest longer side plane being within 1 degree, and
wherein area of said longer side plane as projected onto the reference plane defined by said bottom surface is at least 5 times of projected area of said shorter side plane.

5. A light guide plate according to claim 4, wherein a width of each plane of the shorter side as projected onto the reference plane defined by said bottom surface is no more than 40 μm.

6. A light guide plate according to claim 4, wherein roundness of two vertexes in the prismatic asperities formed by said shorter side plane and two longer planes which are adjacent to said shorter plane is approximated by an arc of a circle, and sum of radii of the two arcs of a circle is no more than a half of a side length of said shorter side plane.

7. A light guide plate according to claim 4, wherein the prismatic asperities are arranged either parallel to or at an incline angle within ±35 degrees with the reference plane defined by said entrance end surface.

8. A light guide plate according to claim 1, wherein normal incident light from said bottom surface passes through said top surface at a total ray transmission of at least 90% and with a haze of no more than 15%.

9. A planer light source unit comprising:

(A) a light guide plate comprising:

an entrance end surface on which light is incident;
a top surface having light issuing means; and
a bottom surface from which the light emerge via said light issuing means,
wherein, a direction of maximum intensity of the emerging light as measured in a plane perpendicular to the two reference planes defined by said entrance end surface and said bottom surface is within 30 degrees from a line normal to said bottom surface,
when a direction toward said entrance end surface away from the normal line taken as the reference is assumed to be negative, intensity of light leaking from said top surface at the same angle as the direction of the maximum intensity is no more than a tenth of said maximum intensity, and
incident light from the bottom surface is transmitted through said top surface; and

(B) a light source disposed adjacent to said entrance end surface.

10. A planer light source unit according to claim 9, wherein luminance of the emerging light from said bottom surface as measured in the direction of the normal line to said perpendicular plane is no more than 60% of luminance in the direction of said maximum intensity.

11. A planer light source unit according to claim 9, wherein quantity of the light leaking at solid angles within 30 degrees with reference to the normal line is no more than 1/8 of quantity of the light emerging from said bottom surface.

12. A planer light source unit according to claim 9, wherein said light issuing means comprises a repetition of prismatic asperities each having a shorter side plane and a longer side plane and being arranged on a pitch of 50 μm to 1.5 mm,

wherein said shorter side plane is an inclined surface which slopes downward from said entrance end surface to an opposed end to said entrance end surface at angles of inclination of 30 to 45 degrees with respect to the reference plane defined by said bottom surface,
wherein said longer side plane is inclined at angles in excess of zero degrees and up to 10 degrees with

Microsoft Exhibit 1002 - Page 934
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

respect to the reference plane defined by said bottom surface, with the variation in the angle of inclination of all the longer side planes as measured throughout the light guide plate being within 5 degrees, and difference in the angle of inclination between one longer side plane and a nearest longer side plane being within 1 degree, and

wherein area of said longer side plane as projected onto the reference plane defined by said bottom surface is at least 5 times of projected area of said shorter side plane.

13. A planer light source unit according to claim 12, wherein a width of each plane of the shorter side as projected onto the reference plane defined by said bottom surface is no more than 40 μm.

14. A planer light source unit according to claim 12, wherein roundness of two vertexes in the prismatic asperities formed by said shorter side plane and two longer planes which are adjacent to said shorter plane is approximated by an arc of a circle, and sum of radii of the two arcs of a circle is no more than a half of a side length of said shorter side plane.

15. A planer light source unit according to claim 12, wherein the prismatic asperities are arranged either parallel to or at an incline angle within +35 degrees with the reference plane defined by said entrance end surface.

16. A planer light source unit according to claim 9, wherein normal incident light from said bottom surface passes through said top surface at a total ray transmission of at least 90% and with a haze of no more than 15%.

17. A reflection-type liquid-crystal display device comprising:

(A) a light guide plate comprising:

an entrance end surface on which light is incident;
a top surface having light issuing means; and
a bottom surface from which the light emerge via said light issuing means,
wherein, a direction of maximum intensity of the emerging light as measured in a plane perpendicular to the two reference planes defined by said entrance end surface and said bottom surface is within 30 degrees from a line normal to said bottom surface,
when a direction toward said entrance end surface away from the normal line taken as the reference is assumed to be negative, intensity of light leaking from said top surface at the same angle as the direction of the maximum intensity is no more than a tenth of said maximum intensity, and
incident light from the bottom surface is transmitted through said top surface;

(B) a light source disposed adjacent to said entrance end surface; and
(C) a reflective layer having a liquid-crystal cell and provided beneath said bottom surface.

18. A reflection-type liquid-crystal display device according to claim 17, wherein luminance of the emerging light from said bottom surface as measured in the direction of the normal line to said perpendicular plane is no more than 60% of luminance in the direction of said maximum intensity.

19. A reflection-type liquid-crystal display device according to claim 17, wherein quantity of the light leaking at solid angles within 30 degrees with reference to the normal line is no more than 1/8 of quantity of the light emerging from said bottom surface.

20. A reflection-type liquid-crystal display device according to claim 17, wherein said light issuing means comprises a repetition of prismatic asperities each having a shorter side plane and a longer side plane and being arranged on a pitch of 50 μm to 1.5 mm,

wherein said shorter side plane is an inclined surface which slopes downward from said entrance end surface to an opposed end to said entrance end surface at angles of inclination of 30 to 45 degrees with respect to the reference plane defined by said bottom surface,
wherein said longer side plane is inclined at angles in excess of zero degrees and up to 10 degrees with respect to the reference plane defined by said bottom surface, with the variation in the angle of inclination of all the longer side planes as measured throughout the light guide plate being within 5 degrees, and difference in the angle of inclination between one longer side plane and a nearest longer side plane being within 1 degree,

Microsoft Exhibit 1002 - Page 935
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

and
wherein area of said longer side plane as projected onto the reference plane defined by said bottom surface is at least 5 times of projected area of said shorter side plane.

21. A reflection-type liquid-crystal display device according to claim 20, wherein a width of each plane of the shorter side as projected onto the reference plane defined by said bottom surface is no more than 40 μm.

22. A reflection-type liquid-crystal display device according to claim 20, wherein roundness of two vertexes in the prismatic asperities formed by said shorter side plane and two longer planes which are adjacent to said shorter plane is approximated by an arc of a circle, and sum of radii of the two arcs of a circle is no more than a half of a side length of said shorter side plane.

23. A reflection-type liquid-crystal display device according to claim 20, wherein the prismatic asperities are arranged either parallel to or at an incline angle within ±35 degrees with the reference plane defined by said entrance end surface.

24. A reflection-type liquid-crystal display device according to claim 17, wherein normal incident light from said bottom surface passes through said top surface at a total ray transmission of at least 90% and with a haze of no more than 15%.

25. A reflection-type liquid-crystal display device according to claim 17, wherein said bottom surface of said light guide plate is brought into contact with a top surface of said liquid-crystal cell.

Microsoft Exhibit 1002 - Page 936
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.1

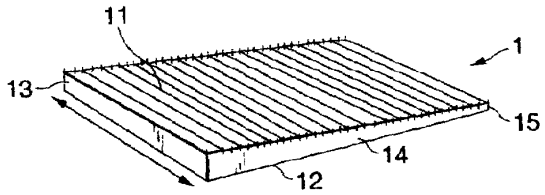


FIG.2A

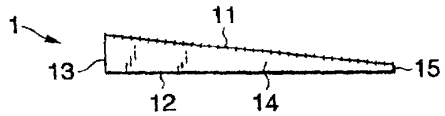


FIG.2B

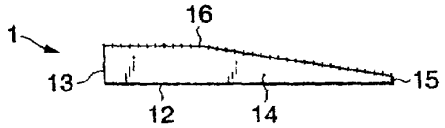
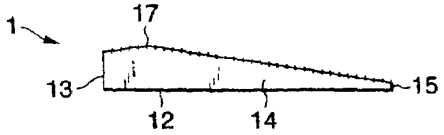


FIG.2C



Microsoft Exhibit 1002 - Page 937
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.3A

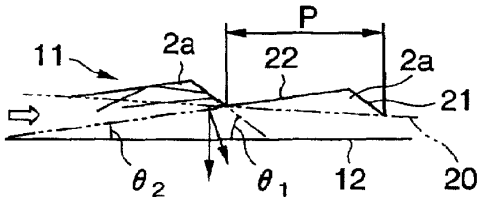


FIG.3B

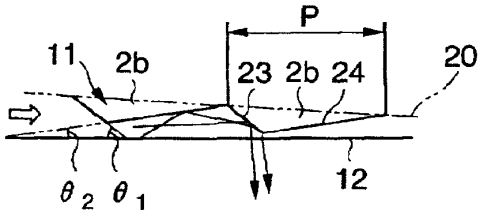


FIG.4

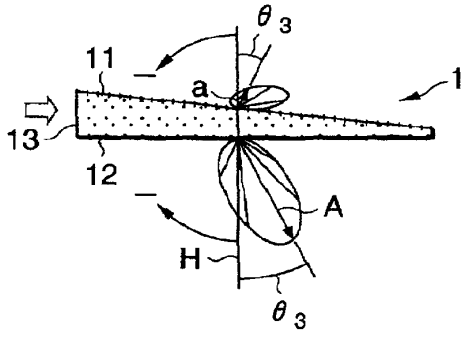


FIG.5



Microsoft Exhibit 1002 - Page 938
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.6

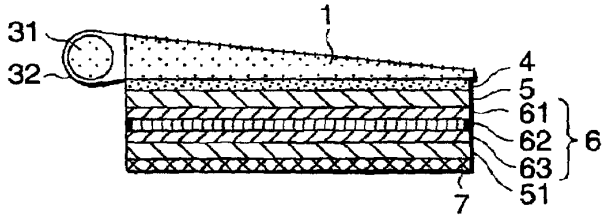


FIG.7

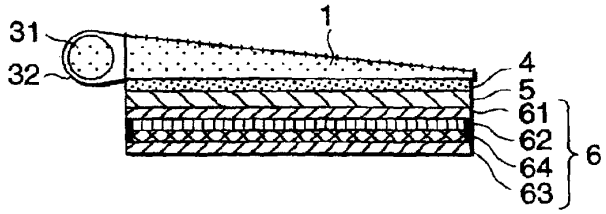
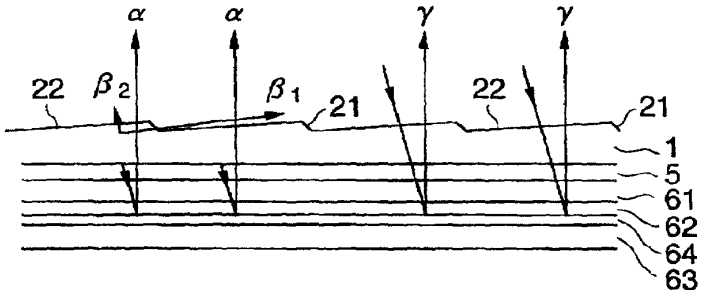


FIG.8



Microsoft Exhibit 1002 - Page 939
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.9

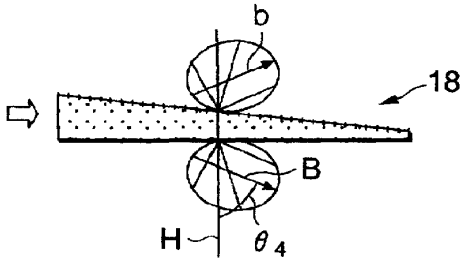
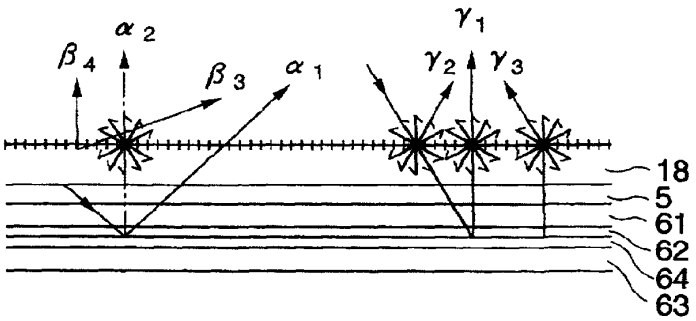


FIG.10



Microsoft Exhibit 1002 - Page 940
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 10 3785

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 545 705 A (SHARP KABUSHIKI KAISHA) 9 June 1993 * page 17, line 53 - page 18, line 51; figures 10,12 *	1-3,7, 9-11,15, 17-19, 23,25	F21V8/00 G02F1/1335
P,X	EP 0 867 747 A (SONY CORP) 30 September 1998 * figure 1 * * column 10, line 23 - line 50; figures 3A,B * * column 13, line 57 - column 14, line 36; figures 10,11 * * column 17, last line - column 18, line 52; figures 19-21 *	1,2,4,5, 7,9,10, 12,13, 15,17, 18,20, 21,23,25	
X	WO 95 34009 A (CLIO TECH INC ;ZOU HAN (US); TAI PING KAUNG (US)) 14 December 1995 * page 6, paragraph 2; figure 1 * * page 8; figure 3 * * page 14, paragraph 3 - page 15, paragraph 1; figure 12 *	1,7,9,15	TECHNICAL FIELDS SEARCHED (Int.Cl.6) F21V G02F
X	PATENT ABSTRACTS OF JAPAN vol. 096, no. 008, 30 August 1996 -& JP 08 094844 A (FUJITSU LTD), 12 April 1996	1,9,17	
A	* abstract; figure 7 *	4,7,12, 15,20,23	

-/--

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	1 June 1999	Ciarrocca, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

Microsoft Exhibit 1002 - Page 941
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 10 3785

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X A	EP 0 787 942 A (NITTO DENKO CORP) 6 August 1997 * page 13, line 57 - page 14, line 11 * * table 6 * * figures 1-14 *	1,4,5,7, 9,12,13, 15 17,20, 21,23	
P,X	EP 0 879 991 A (MATSUSHITA ELECTRIC IND CO LTD) 25 November 1998 * page 13, line 9 - page 17, line 36; figures 19,32 * * page 21, line 25 - line 31; figure 36 * * page 23, line 1 - line 23; figure 42 *	1,2,4, 7-10,12, 15-18, 20,24	
A	WO 93 16410 A (RAYCHEM CORP) 19 August 1993 * page 5, line 35 - page 6, line 30; figure 3 * * page 10, line 24 - line 29 *	1,4,9, 12,17,20	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	1 June 1999	Ciarrocca, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

Microsoft Exhibit 1002 - Page 942
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 10 3785

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

01-06-1999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 545705 A	09-06-1993	JP 5158033 A	25-06-1993
		JP 5158034 A	25-06-1993
		KR 9708351 B	23-05-1997
		US 5341231 A	23-08-1994
EP 0867747 A	30-09-1998	NONE	
WO 9534009 A	14-12-1995	US 5671994 A	30-09-1997
		US 5860722 A	19-01-1999
EP 0787942 A	06-08-1997	JP 9102209 A	15-04-1997
		US 5727107 A	10-03-1998
EP 0879991 A	25-11-1998	JP 10311915 A	24-11-1998
		JP 11064641 A	05-03-1999
WO 9316410 A	19-08-1993	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

Microsoft Exhibit 1002 - Page 943
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 394 593 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
03.03.2004 Bulletin 2004/10

(51) Int Cl.[7]: **G02B 27/22**, H04N 13/00

(21) Application number: **03019284.3**

(22) Date of filing: **26.08.2003**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(30) Priority: **27.08.2002 JP 2002247208**

(71) Applicant: **NEC CORPORATION**
Tokyo (JP)

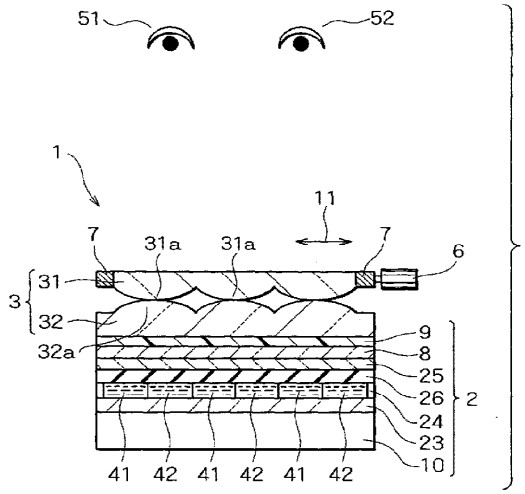
(72) Inventors:
- **Uehara, Shin-ichi**
  Tokyo (JP)
- **Takanashi, Nobuaki**
  Tokyo (JP)
- **Hayama, Hiroshi**
  Tokyo (JP)

(74) Representative: **Glawe, Delfs, Moll & Partner**
Patentanwälte
Postfach 26 01 62
80058 München (DE)

(54) 3D image / 2D image switching display apparatus and portable terminal device

(57) A 3D image/2D image switching display apparatus (1) is provided with a liquid crystal display unit (2) and first and second lenticular lenses (32, 31). To display a 3D image, the first lenticular lens (32) is arranged in such a way that the optical axis of the first lenticular lens (32) coincides with the optical axis of the second lenticular lens (31) so that pixels for a left eye (41) display an image for a left eye (51) and pixels for a right eye (42) display an image for a right eye (52). To display a 2D image, the first lenticular lens (32) is arranged in such a way that the optical axis of the first lenticular lens (32) is shifted from the optical axis of the second lenticular lens (31) by half a lens pitch so that the pixels for the left eye (41) and the pixels for the right eye (42) display the same image independently.

FIG. 4



Printed by Jouve, 75001 PARIS (FR)

EP 1 394 593 A1

Microsoft Exhibit 1002 - Page 944
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Description

[0001] The present invention relates to a three-dimensional (3D) image/two-dimensional (2D) image switching display apparatus which can display a 3D image and a 2D image, switching them from one to the other, and a portable terminal device incorporating the 3D image/2D image switching display apparatus.

[0002] Display apparatuses capable of displaying 3D images have been developed. 3D image display systems that have been studied so far can be classified into a type which uses glasses and a type which does not. With the use of the glasses-using type which includes an anaglyph type and a polarization glass type using polarization, a user cannot substantially avoid wearing glasses. In this respect, recently active studies have been made on glass-less 3D image display apparatuses which do not use glasses.

[0003] Glass-less 3D image display apparatuses include a parallax barrier type and a lenticular lens type. The parallax barrier type was conceived by Berthier in 1896 and verified by Ives in 1903. The parallax barrier has multiple thin vertical openings or slits formed therein. In the vicinity of the parallax barrier are laid out pixels for a right eye (hereinafter referred to as "right-eye pixels") and pixels for a left eye (hereinafter referred to as "left-eye pixels") in a direction perpendicular to the lengthwise direction of the slits. Lights from the pixels are partly shielded when passing the parallax barrier. Specifically, the pixels are laid out in such a way that while lights from the left-eye pixels reach the left eye but are shielded from going toward the right-eye pixels, lights from the right-eye pixels reach the right eye but do not reach the left eye. Accordingly, the lights from the left-eye pixels and the lights from the right-eye pixels respectively reach the left and right eyes, thus allowing the user to identify the image as a 3D image. At the time the parallax barrier was devised, the parallax barrier was arranged between the pixels and eyes and was therefore eyesore and provided a low visibility. The recent achievement of liquid crystal displays has made it possible to arrange the parallax barrier at the back of each display, improving the visibility. This has resulted in active studies on parallax barrier type display apparatuses at present.

[0004] The lenticular lens type display apparatus was invented in around 1910 by Ives et al. mentioned above, as described in, for example, "3D Display by Chihiro Masuda from Sangyo Tosho Publishing Co., Ltd. Fig. 1 is a perspective view showing the shape of a lenticular lens. As shown in Fig. 1, a lenticular lens 100 has two sides, one being flat and the other having a plurality of semicylindrical projections (cylindrical lenses) formed thereon extending in one direction. Right-eye pixels which display an image for the right eye and left-eye pixels which display an image for the left eye are alternately laid out on the focal plane of the lens. Therefore, light from each pixel is distributed by the lenticular lens 100 to directions respectively going to the right and left eyes. This can allow the right and left eyes to identify different images so that the observer can recognize a 3D image. This lenticular lens type is widely adapted to stereoscopic TVs or the like at present.

[0005] Recently have active studies also been made to permit a 3D image display apparatus to display a 2D image. The easiest scheme is to make the aforementioned images for the right eye and for the right eye match with each other and display the same image. In this case, the same information should be displayed over two pixels, thus reducing the resolution to a half. This particularly raises a significantly problem that the visibility of texts characters which are used most frequently at the time of displaying a 2D image drops significantly.

[0006] Studies have so far been made on schemes of displaying a 3D image and a 2D image, switching them from one to the other, without reducing the resolution. For example, Japanese Patent Publication Laid-Open No. 068961/1996 and Japanese Patent Publication Laid-Open No. 112273/1992 describe a 3D image display apparatus using a lenticular lens, which is designed in such a way that between the lenticular lens and a transparent plate so arranged as to face the irregular side of the lenticular lens, a substance having the same refractive index as the material for the lenticular lens is injected to nullify the lens effect. Fig. 2 is a perspective view showing the conventional 3D image display apparatus. As shown in Fig. 2, a transparent plate 103 is laid on the upheaval side of a lenticular lens 102 of this conventional 3D image display apparatus 101 and a clearance 104 is made between the lenticular lens 102 and the transparent plate 103. At the time of displaying a 2D image, a liquid substance (not shown) having the same refractive index as the lens is injected into the clearance 104 by a pump 105 or the like. This disables the lens effect and can thus ensure 2D display. In case of displaying a 3D image, the injected substance is discharged from the clearance 104 to make the lens effect available, thereby ensuring 3D display.

[0007] Japanese Patent Publication Laid-Open No. 197343/1997 describes a 3D image display apparatus which switches between the display of a 3D image and the display of a 2D image by changing the distance between the image display surface of a pixel and the lenticular lens. Fig. 3 is a cross-sectional view showing this conventional 3D image display apparatus. In the conventional 3D image display apparatus 111, as shown in Fig. 3, the distance between a lenticular lens 112 and an image display unit 113 is variable. Right-eye pixels 114 and left-eye pixels 115 are alternately laid out on the image display unit 113. When the distance between the lenticular lens 112 and the image display unit 113 is set to the focal distance of the lenticular lens, the lens effect of the lenticular lens 112 becomes effective with respect to lights from the pixels 114 and 115, thereby ensuring the display of a 3D image. When the distance between the lenticular lens 112 and the image display unit 113 is set to approximately zero on the other hand, the lens effect of

Microsoft Exhibit 1002 - Page 945
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

the lenticular lens 112 is disabled so that a 2D image can be displayed. In case where an electronic display, such as a liquid crystal device, is used as the image display unit 113, the thickness of the glass substrate limits the distance to be variable, thus making it difficult to set the distance between the lenticular lens 112 and the image display unit 113 is set to approximately zero. To cope with this difficulty, image transfer means, such as a fiber face plate 116, is provided on the lenticular-lens side surface of the image display unit 113 to equivalently cause the lenticular lens 112 to come close to the vicinity of the image display unit 113.

[0008] The prior art however has the following problems. The conventional 3D image/2D image switching display apparatus is provided with a lenticular lens and displays a 3D image by enabling the lens effect of the lenticular lens and displays a 2D image by disabling the lens effect of the lenticular lens. As switching means to switch between enabling and disabling of the lens effect of the lenticular lens is large in scale, the 3D image/2D image switching display apparatus disadvantageously becomes thicker and larger. The existence of the switching means reduces the display quality. Further, the operation of the switching means takes times, resulting in a longer time needed to switch between the display of a 3D image and the display of a 2D image. Furthermore, the provision of the switching means increases the cost for the 3D image/2D image switching display apparatus.

[0009] Those problems will be discussed more specifically. According to the prior art described in Japanese Patent Publication Laid-Open No. 068961/1996 and Japanese Patent Publication Laid-Open No. 112273/1992 as shown in Fig. 2, a mechanism which injects and discharges a liquid substance having the same refractive index as the material for the lenticular lens 102 into and from the clearance 104 by means of the pump 105 is provided as the switching means to enable/disable the lens effect of the lenticular lens. This method however requires the pump 105 to inject and discharge the liquid substance and a tank to store the discharged liquid substance. The requirements inevitably enlarge the apparatus and increase the cost. If the injection and discharge of the liquid substance are not done completely, bubbles or the like are produced, thereby reducing the display quality. In addition, the injection and discharge of the liquid substance take time, resulting in a longer time to switch the display of 2D and 3D images from one to another.

[0010] According to the prior art described in Japanese Patent Publication Laid-Open No. 197343/1997 as shown in Fig. 3, a mechanism which changes the distance between the lenticular lens 112 and the image display unit 113 is provided as the switching means to enable/disable the lens effect of the lenticular lens. This structure needs space for changing the distance and thus increases the thickness of the 3D image/2D image switching display apparatus. The need to use the expensive fiber face plate 116 or the like leads to a cost increase. Further, as light from the image display unit 113 passes through the fiber face plate 116, the display quality becomes lower as compared with the case where the fiber face plate 116 is not provided. There is another problem that the movement of the lenticular lens 112 takes time.

[0011] Accordingly, it is an object of the invention to provide a thin, small and low-cost 3D image/2D image switching display apparatus which ensures fast switching between the display of a 3D image and the display of a 2D image, provides a high display quality and is particularly suitable for mobile usages such as in a portable telephone and PDA (Personal Digital Assistant), and a portable terminal device which uses this 3D image/2D image switching display apparatus.

[0012] A three-dimensional (3D) image/two-dimensional (2D) image switching display apparatus according to the invention comprises: display unit having a plural of pixel groups cyclically laid out each comprised of first to n-th pixels (n being an integer equal to or greater than 2); first optical unit which has first optical elements cyclically laid out in association with the individual pixel groups and refracts lights output from the pixels; and second optical unit which has second optical elements cyclically laid out in association with the individual pixel groups and refracts lights output from the first optical unit, wherein when images displayed by the first to n-th pixels differ from one another, the second optical unit is placed in relative to the first optical unit at a first position where the first and second optical unit output lights, output from the first to n-th pixels, in first to n-th directions different from one another, and when the first to n-th pixels display a same image independently, the second optical unit is placed in relative to the first optical unit at a second position which is set apart from the first position in a layout direction of the second optical elements by half a distance of a layout cycle of the second optical elements or by a distance equal to an integer multiple of the layout cycle of the second optical elements added to the half the distance and where the first and second optical unit output lights, output from the first to n-th pixels, in a same direction.

[0013] According to the invention, it is possible to select between whether to output lights output from the first to n-th pixels in the first to n-th directions different from one another or to output the lights in the same direction by changing the relative positions of the first optical unit and the second optical unit. If images displayed by the first to n-th pixels differ from one another and the first and second optical unit output lights output from the first to n-th pixels in the first to n-th directions different from one another, an observer can observe different images by changing the viewpoint. This can permit the observer to recognize a 3D image. If the first to n-th pixels independently display the same image and the first and second optical unit output lights output from the first to n-th pixels in the same direction, a 2D image can be displayed at a high resolution. The first to n-th pixels independently displaying the same image means that those pixels together display the same image. This can increase the resolution of the same image to n times higher as

Microsoft Exhibit 1002 - Page 946
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

compared with the resolution of each image in case where images to be displayed by the first to n-th pixels differ from one another.

[0014] According to the invention, it is possible to realize selection between whether to output lights output from the first to n-th pixels in the first to n-th directions different from one another or to output the lights in the same direction by moving the second optical unit by half the distance of the layout cycle of the second optical elements or a distance equal to an integer multiple of the layout cycle of the second optical elements added to the former half the distance with respect to the first optical unit. This can realize a thin, small and low-cost 3D image/2D image switching display apparatus which ensures fast switching from one image display to another. Further, because there are no structural elements through which lights output from the pixels pass besides the first and second optical unit, the display quality is excellent. The use of the first and second optical unit can reduce aberration and can thus achieve high-quality image display.

[0015] The display unit may have two kinds of pixels, right-eye pixels for a right eye and left-eye pixels for a left eye, and at a time of displaying a 3D image, the right-eye pixels may display images for the right eye, the left-eye pixels may display images for the left eye and the first and second optical unit may output lights output from the right-eye pixels in a first direction and output lights output from the left-eye pixels in a second direction, and at a time of displaying a 2D image, the right-eye pixels and the left-eye pixels together may display a same 2D image and the first and second optical unit may output lights output from the right-eye pixels and the left-eye pixels in a same direction. This is the case where the aforementioned n is 2. As the observer shifts the right eye ahead in the first direction and shifts the left eye ahead in the second direction, the observer can observe an image for the right eye with the right eye and observe an image for the left eye with the left eye. As a result, the observer can recognize a 3D image. At the time of displaying a 2D image, the observer can observe the same image with the right and left eyes.

[0016] Further, the first optical unit may be a first lenticular lens portion which comprises one or plural convex type lenticular lenses and where the first optical elements are lens elements, the second optical unit may be a second lenticular lens portion which comprises one or plural convex type lenticular lenses and where the second optical elements are lens elements, at a time of displaying a 3D image, an optical axis of that lens element which is located at a center of the second lenticular lens portion may substantially coincide with an optical axis of one lens element of the first lenticular lens portion, and at a time of displaying a 2D image, the optical axis of the lens element located at the center of the second lenticular lens portion may be shifted from an optical axis of that lens element which is located at a center of the first lenticular lens portion, by half a length of a layout cycle of the lens elements of the second lenticular lens portion or a length equal to an integer multiple of the layout cycle of the lens elements of the second lenticular lens portion added to the half the length.

[0017] As the optical axis of the lens element of the first lenticular lens is matched with the optical axis of the lens element of the second lenticular lens, the first and second lenticular lenses become equivalent to a single virtual lenticular lens whose curvature is twice the curvature of the first and second lenticular lenses and whose layout cycle is equal to that of the first and second lenticular lenses. This can allow an image for the right eye to be output in the first direction and an image for the left eye to be output in the second direction. Further, as the optical axis of the lens element of the first lenticular lens is shifted from the optical axis of the lens element of the second lenticular lens by half the layout cycle, the first and second lenticular lenses become equivalent to a single virtual lenticular lens whose curvature is twice the curvature of the first and second lenticular lenses and whose layout cycle is about half the layout cycle of the first and second lenticular lenses. This can permit the lens elements to correspond to the individual images respectively, so that lights from the individual images are projected in magnification in the same direction.

[0018] Further, at least one of the first and second lenticular lens portions may comprise two or more lenticular lenses stacked one on another. In this case, the 3D image/2D image switching display apparatus has three or more lenticular lenses. This structure further reduces aberration.

[0019] Furthermore, it is preferable that a curvature of the lens elements of the first lenticular lens portion should be equal to a curvature of the lens elements of the second lenticular lens portion and in case where the first and second lenticular lens portions are considered as a single virtual lenticular lens, a clearance between the first and second lenticular lens portions should be equal to or less than 20% of a focal distance of lens elements of the virtual lenticular lens. This can achieve better 3D image display.

[0020] It is also preferable that at a time of displaying a 3D image, an amount of deviation between the optical axis of the lens element which is located at the center of the first lenticular lens portion and the optical axis of the lens element which is located at the center of the second lenticular lens portion should be equal to or less than 12% of a layout cycle of the lens elements of the first lenticular lens portion. This can achieve better 3D image display.

[0021] Further, the first and second lenticular lens portions may be provided respectively movable in relative to the display unit, at a time of displaying a 3D image, the optical axes of the lens elements which are located at the centers of the first and second lenticular lens portions may pass through a center of that pixel group, consisting of the right-eye pixels and the left-eye pixels which is located at a center of the display unit, and at a time of displaying a 2D image, the optical axis of the lens element which is located at the center of the first lenticular lens portion may pass through

Microsoft Exhibit 1002 - Page 947
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

a position shifted from the center of the pixel group by a length of 1/4 times a layout cycle of the lens elements of the first lenticular lens portion or a length equal to an integer multiple of the layout cycle of the lens elements of the first lenticular lens portion added to the length of 1/4 times the layout cycle and the optical axis of the lens element which is located at the center of the second lenticular lens portion may pass through a position shifted, in an opposite direction to a direction of shifting done with respect to the display unit, from the center of the pixel group by a length of 1/4 times the layout cycle or a length equal to an integer multiple of the layout cycle of the lens elements of the second lenticular lens portion added to the length of 1/4 times the layout cycle. This can allow the 3D visible range and the 2D visible range to match with each other so that it is unnecessary to shift the viewpoint at the time of switching between the display of a 3D image and the display of a 2D image.

[0022] It is further preferable that at a time of displaying a 2D image, a width of a 2D visible range over which a light emitting section of a pixel is projected in magnification should be set greater than a distance between both eyes of an observer, and that at a time of displaying a 3D image, a width of a 3D visible range over which light output from a pixel is projected in magnification via that lens element which is closest to that pixel should be set twice a distance between both eyes of an observer. This can maximize the area in which the 3D visible range and the 2D visible range overlap each other. While the distance between both eyes differs from one observer from another, the average distance between both eyes of users who are expected to be the users of the 3D image/2D image switching display apparatus of the invention. In general, the value of 65 mm, for example, is frequently used as the distance between both eyes.

[0023] One of the first and second optical unit may be a convex lenticular lens portion which comprises one or plural convex type lenticular lenses, the other one of the first and second optical unit may be a concave lenticular lens portion which comprises one or plural concave type lenticular lenses, at a time the first to n-th pixels respectively display first to n-th images, an optical axis of that lens element which is located at a center of the convex lenticular lens portion may be shifted from an optical axis of that lens element which is located at a center of the concave lenticular lens portion, by half a length of a layout cycle of the lens elements of the convex lenticular lens portion or a length equal to an integer multiple of the layout cycle of the lens elements of the convex lenticular lens portion added to the half the length, and at a time the first to n-th pixels respectively together display a same image, the optical axis of the lens element located at the center of the convex lenticular lens portion may substantially coincide with an optical axis of one lens element of the concave lenticular lens portion.

[0024] In case where the optical axis of the convex lenticular lens is shifted from the optical axis of the concave lenticular lens by half the length of the layout cycle, the convex and concave lenticular lenses become equivalent to a single virtual prism plate on which prism elements corresponding to the individual pixels are laid out. The virtual prism plate allows lights output from the first to n-th pixels to be output in the first to n-th directions. When the optical axis of the convex lenticular lens matches with the optical axis of the concave lenticular lens, the functions of the lenses are canceled out and lights output from the first to n-th pixels are output in the same direction.

[0025] Furthermore, the first optical unit may be a first fly-eye lens portion which comprises one or plural fly-eye lenses, the second optical unit may be a second fly-eye lens portion which comprises one or plural fly-eye lenses, and the second fly-eye lens portion may be movable in all directions in which the pixels of the display unit are laid out in relative to the first fly-eye lens portion. This can permit light to be irradiated in every direction in which the pixels are laid out. As a result, different images can be output in, for example, the up and down direction besides the right and left direction of the screen. Even when the direction of the screen is switched to the right and left direction and the up and down direction, for example, therefore, 3D display can be ensured in each direction. It is also possible to realize three-dimensional feeling in the up and down direction.

[0026] The first optical unit may be a first prism plate on which prism elements are laid out, the second optical unit may be a second prism plate on which prism elements are laid out, at a time of displaying a 3D image, a vertex of that prism element which is located at a center of the second prism plate, as seen from a direction perpendicular to a display surface of the display unit, may substantially coincide with a trough portion between one prism element of the first prism plate and those prism elements which adjoin that one prism element, and at a time of displaying a 2D image, the vertex of the prism element which is located at the center of the second prism plate, as seen from the direction perpendicular to the display surface of the display unit, may substantially coincide with a vertex of one prism element of the first prism plate. The use of a prism plate as optical unit can make the cost lower as compared with the case where a lenticular lens is used.

[0027] It is preferable that the display unit should have a color filter which colors lights output from the pixels and should have a plurality of stripe portions colored to plural kinds of colors and cyclically laid out in parallel to one another and a lengthwise direction of the stripe portions should be parallel to layout directions of the first and second optical elements. This can prevent the generation of color moire and ensure high-quality image display.

[0028] Alternatively, the display unit should display an image by color field sequential display method. This eliminates the need for a color filter and can reduce the influence of division of the color space, thereby improving the image display quality. It is also possible to reduce the quantity of pixels to 1/3 of the ordinary quantity. Further, there is not light absorption by a color filter, thus improving the emission efficiency, which can contribute to power saving.

Microsoft Exhibit 1002 - Page 948
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

[0029] The 3D image/2D image switching display apparatus may further comprise a casing which houses the display unit and the first and second optical unit and to which the second optical unit is fixed. In this case, the second optical unit may have a capability of a protection plate, a touch panel or a front-light for the display unit. This eliminates the need to particularly provide a protection plate, a touch panel or a front-light, thus making it possible to enhance the capabilities of the apparatus and/or make the apparatus thinner.

[0030] At least one part of the first optical unit may be formed integral with a member which constitutes a display surface of the display unit. This can make the 3D image/2D image switching display apparatus thinner. Provided that the thickness of the 3D image/2D image switching display apparatus is set unchanged, the thickness of other optical unit can be increased, thereby suppressing the warping and deformation of the optical unit. This can allow the 3D image/2D image switching display apparatuses with a good display quality to be manufactured at a high yield.

[0031] At least one of the first and second optical unit may be divided into a plurality of portions as seen from a direction perpendicular to a display surface of the display unit and the plurality of portions may be movable independently of one another. This can ensure simultaneous display of a 2D image and a high-resolution 2D image.

[0032] It is preferable that at least one of the first and second optical unit should be provided with a frame. This can suppress transformation of the optical unit, such as warping and deformation.

[0033] It is also preferable that an antireflection coating should be formed on a surface of at least one of the first and second optical unit. This can suppress reflection of light by the optical unit, further improving the display quality.

[0034] The 3D image/2D image switching display apparatus can further comprise an actuator, attached to at least one of the first and second optical unit, for moving the one of the first and second optical unit in relative to the other optical unit.

[0035] The 3D image/2D image switching display apparatus may further comprise a casing for housing the display unit and the first and second optical unit, and one pair or plural pairs of non-linear springs which are located between the casing and at least one of the first and second optical unit in such a way as to be stretched and contracted in a layout direction of the first optical elements and whose reaction force is discontinuously reduced when an amount of displacement exceeds a threshold value, and which are provided in such a way that an amount of displacement of one of each pair of non-linear springs is greater than the threshold value while an amount of displacement of the other non-linear spring becomes smaller than the threshold value. Accordingly, the optical unit can be held stably at the first position or the second position due to the difference in the reaction forces of the non-linear springs.

[0036] The actuator may be a linear member made of a shape memory alloy and connected to a power supply. Accordingly, the actuator which operates on an electric signal can be realized with a simple structure.

[0037] A portable terminal device according to the invention has the above-described 3D image/2D image switching display apparatus. The portable terminal device may be a portable telephone, a portable terminal, PDA, a game machine, a digital camera or a digital video.

[0038] According to the invention, as elaborated above, as the first optical unit having the first optical elements laid out thereon and the second optical unit having the second optical elements laid out thereon are provided and the second optical unit is moved in relative to the second optical unit in the layout direction of the first and second optical elements to change the relative positions of the first optical unit and the second optical unit, the display of a 3D image and the display of a 2D image can be switched from one to the other. This can realize a thin, small and low-cost 3D image/2D image switching display apparatus which executes fast switching between the display of a 3D image and the display of a 2D image, and provides a high display quality.

Fig. 1 is a perspective view showing the shape of a lenticular lens;
Fig. 2 is a perspective view showing one conventional 3D image display apparatus;
Fig. 3 is a cross-sectional view showing another conventional 3D image display apparatus;
Fig. 4 is a cross-sectional view showing a 3D image/2D image switching display apparatus according to a first embodiment of the invention;
Fig. 5 is a perspective view showing a portable terminal device according to the embodiment;
Figs. 6A and 6B are cross-sectional views illustrating the operation of the switching display apparatus, Fig. 6A showing the case of displaying a 3D image while Fig. 6B shows the case of displaying a 2D image;
Fig. 7 is a diagram showing an optical model in case where two lenticular lenses are regarded as a single lenticular lens at the time of displaying a 3D image;
Fig. 8 is a cross-sectional view showing a single lenticular lens equivalent to two lenticular lenses;
Fig. 9 is a diagram showing an optical model to be used in simulation in the embodiment and shows the layout at the time of displaying a 3D image;
Fig. 10 is a graph showing the results of the simulation with the observation position taken on the horizontal axis and the irradiance at the observation position taken on the vertical axis;
Fig. 11 is a graph showing the results of the simulation in case of displaying a 3D image using a single lenticular lens and in case of displaying a 2D image without using a lenticular lens with the observation position taken on

Microsoft Exhibit 1002 - Page 949
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

the horizontal axis and the irradiance at the observation position taken on the vertical axis;

Fig. 12 is a graph showing the results of the simulation with the observation position taken on the horizontal axis and the irradiance at the observation position taken on the vertical axis;

Fig. 13 is a graph showing the influence of the distance between lenticular lenses on the display quality of a 3D image with the horizontal axis showing the position of an observer on the Z axis of the lenticular lens and the vertical axis showing a contrast ratio CR;

Fig. 14 is a graph showing the results of the simulation with the observation position taken on the horizontal axis and the irradiance at the observation position taken on the vertical axis;

Fig. 15 is a graph showing the influence of the distance between lenticular lenses on the display quality of a 3D image with the horizontal axis showing the position of an observer on the X axis of the lenticular lens and the vertical axis showing a contrast ratio CR;

Fig. 16 is a cross-sectional view showing a 3D image/2D image switching display apparatus according to a second embodiment of the invention and shows a 2D-image display state;

Fig. 17 is a graph showing the results of the simulation on the apparatus shown in Fig. 16, with the observation position taken on the horizontal axis and the irradiance at the observation position taken on the vertical axis;

Fig. 18 is a cross-sectional view showing a 3D image/2D image switching display apparatus according to a third embodiment of the invention and shows a 3D-image display state;

Fig. 19 is a cross-sectional view showing a 3D image/2D image switching display apparatus according to a fourth embodiment of the invention and shows a 3D-image display state;

Figs. 20A and 20B are graphs showing the allowable ranges of a 3D visible range and a 2D visible range, with the observation position taken on the horizontal axis and the irradiance at the observation position taken on the vertical axis;

Figs. 21A and 21B are cross-sectional views showing a 3D image/2D image switching display apparatus according to a fifth embodiment of the invention, Fig. 21A showing a 2D-image display state while Fig. 21B shows a 3D-image display state;

Fig. 22 is a graph showing the shape of a lens with the position on the lens perpendicular to the optical axis taken on the horizontal axis and the height of the lens at the position taken on the vertical axis;

Fig. 23 is a diagram showing the path of light output from one end portion of one pixel;

Fig. 24 is a diagram showing the path of light output from the other end portion of this pixel;

Fig. 25 is a diagram showing the path of light output from the center portion of the pixel;

Fig. 26 is a graph showing the results of the simulation on the apparatus shown in Figs. 21A and 21B, with the observation position taken on the horizontal axis and the irradiance at the observation position taken on the vertical axis;

Figs. 27A and 27B are cross-sectional views showing a 3D image/2D image switching display apparatus according to a modification of the fifth embodiment, Fig. 27A showing a 2D-image display state while Fig. 27B shows a 3D-image display state;

Figs. 28A and 28B are cross-sectional views showing a 3D image/2D image switching display apparatus according to a sixth embodiment of the invention, Fig. 28A showing a 2D-image display state while Fig. 28B shows a 3D-image display state;

Fig. 29 is a graph showing the results of the simulation on the apparatus shown in Figs. 28A and 28B, with the observation position taken on the horizontal axis and the irradiance at the observation position taken on the vertical axis;

Figs. 30A and 30B are cross-sectional views showing a 3D image/2D image switching display apparatus according to a seventh embodiment of the invention, Fig. 30A showing a 3D-image display state while Fig. 30B shows a 2D-image display state;

Figs. 31A and 31B are top views showing the 3D image/2D image switching display apparatus, Fig. 31A showing a 3D-image display state while Fig. 31B shows a 2D-image display state;

Fig. 32 is a cross-sectional view showing a 3D image/2D image switching display apparatus according to an eighth embodiment of the invention and shows a 3D-image display state;

Fig. 33 is a diagram showing an optical model of this switching display apparatus;

Fig. 34 is a top view showing a 3D image/2D image switching display apparatus according to a ninth embodiment of the invention;

Fig. 35 is a cross-sectional view showing a 3D image/2D image switching display apparatus according to an tenth embodiment of the invention and shows a 3D-image display state;

Fig. 36 is a top view showing a 3D image/2D image switching display apparatus according to an eleventh embodiment of the invention;

Fig. 37 is a graph showing the characteristics of a non-linear spring with the position of displacement taken on the horizontal axis and the reaction force taken on the vertical axis; and

Microsoft Exhibit 1002 - Page 950
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Fig. 38 is a top view showing a 3D image/2D image switching display apparatus according to a twelfth embodiment of the invention.

[0039] Embodiments of the invention will be described specifically below with reference to the accompanying drawings. First, the first embodiment will be described. Fig. 4 is a cross-sectional view showing a 3D image/2D image switching display apparatus according to the embodiment and Fig. 5 is a perspective view showing a portable terminal device according to the embodiment. Fig. 4 also shows a right eye 51 and a left eye 52 of an observer.

[0040] As shown in Fig. 4, the 3D image/2D image switching display apparatus 1 according to the embodiment (hereinafter simply called "switching display apparatus 1" too) is provided with a liquid crystal display (LCD) unit 2 with an optical distributor 3 provided on that side of the LCD unit 2 from which light is output.

[0041] The LCD unit 2 is provided with a backlight 10 and a glass substrate 23, a liquid crystal (LC) layer 24, a color filter 26 and a glass substrate 25 are provided at that position of the LCD unit 2 where light from the backlight 10 is input and in parallel to one another in order from the backlight 10. Left-eye pixels 41 and right-eye pixels 42 are alternately laid out on the LC layer 24. An optical film 8, such as a polarizing plate or a compensator, is adhered to the glass substrate 25 as needed. The color filter 26 is of a stripe type and has, for example, red (R), green (G) and blue (B) stripes cyclically laid out in parallel to one another.

[0042] The optical distributor 3 is provided with a convex lenticular lens 31 as first optical unit and also a convex lenticular lens 32 as second optical unit. Like the lenticular lens 100 shown in Fig. 1, the lenticular lens 31 has two sides, one being flat and the other having a plurality of semicylindrical projections 31a (cylindrical lenses), as optical elements or lens elements, formed thereon extending in one direction. The lenticular lens 32 having the same shape as the lenticular lens 31 has two sides, one being flat and the other having a plurality of semicylindrical projections 32a (cylindrical lenses) formed thereon. As the lenticular lenses 31 and 32 are convex type lenses, they have positive focal distances. The lenticular lenses 31 and 32 are arranged in parallel to each other in such a way that the projections 31a face the projections 32a. The lenticular lens 32 is located closer to the LCD unit 2 than the lenticular lens 31. The string direction of the projections 31a and the string direction of the projections 32a are the same direction of 11. Further, the lens pitch of the lenticular lens corresponds to the length of a pair of a single left-eye pixel 41 and a right-eye pixel 42, laid out along the direction 11 and adjacent to each other, in the direction 11. That is, one projection 31a and one projection 32a correspond to pixel groups each consisting of a pair of pixels 41 and 42.

[0043] The lenticular lens 32 is adhered to the optical film 8 of the LCD unit 2 via a photo-curing adhesive layer 9. At this time, the lenticular lens 32 is fixed to the LCD unit 2 in such a way that the center of the lenticular lens 32 coincides with the center of the LCD unit 2. Further, the lengthwise direction of the stripes of the color filter 26 matches with the string direction 11 of the projections 31a and 32a. When the lengthwise direction of the stripes of the color filter 26 becomes perpendicular to the direction 11, the lenticular lens causes color separation which is observed as color moire, reducing the display quality. It is therefore preferable that the lengthwise direction of the stripes should match with the direction. In the switching display apparatus 1, therefore, the backlight 10, the glass substrate 23, the LC layer 24, the color filter 26, the glass substrate 25, the optical film 8, the photo-curing adhesive layer 9, the lenticular lens 32 and the lenticular lens 31 are laid out in the named order in parallel to one another.

[0044] A frame 7 for suppressing transformation of the lenticular lens 31, such as warping and deformation, is attached to the periphery of the lenticular lens 31. Attached to the frame 7 is an actuator 6 which can move the lenticular lens 31 in the direction 11 with respect to the lenticular lens 32. The lenticular lenses 31 and 32 are formed of polymethyl methacrylate (PMMA). Further, an antireflection coating (not shown) which is an antireflection coating to suppress the surface reflection is formed on the surfaces of the lenticular lenses 31 and 32. There is also provided a casing (not shown) which houses the LCD unit 2 and the optical distributor 3 and constitutes the outside plate of the switching display apparatus 1. The casing is provided with guide unit for guiding the movement of the lenticular lens 31. The guide unit is a groove, for example.

[0045] A portable terminal device according to the embodiment will be discussed next. Figs. 6A and 6B are cross-sectional views illustrating the operation of the switching display apparatus 1. Fig. 6A shows the case of displaying a 3D image and Fig. 6B shows the case of displaying a 2D image. Fig. 7 is a diagram showing an optical model in case where two lenticular lenses are regarded as a single lenticular lens at the time of displaying a 3D image, and Fig. 8 is a cross-sectional view showing a single lenticular lens equivalent to two lenticular lenses at the time of displaying a 2D image. It is to be noted that the backlight 10, the color filter 26, the optical film 8, the photo-curing adhesive layer 9, the frame 7 and the actuator 6 are not shown in Figs. 6A and 6B. The same is true of Figs. 16, 18, 19, 21A, 21B, 27A, 27B, 28A, 28B, 30A, 30B and 32.

[0046] To begin with, the case of displaying a 3D image will be discussed. To display a 3D image by the switching display apparatus 1, as shown in Fig. 6A, the position of the lenticular lens 31 is adjusted by the actuator 6 (see Fig. 4) in such a way that the optical axis of the projections 31a of the lenticular lens 31 (hereinafter also called "optical axis of the lenticular lens 31") coincides with the optical axis of the projections 32a of the lenticular lens 32 (hereinafter also called "optical axis of the lenticular lens 32"). That is, the projections 31a of the lenticular lens 31 are made to

Microsoft Exhibit 1002 - Page 951
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

face the projections 32a of the lenticular lens 32. Then, the left-eye pixels 41 display an image for the left eye and the right-eye pixels 42 display an image for the right eye.

[0047] As shown in Figs. 4 and 6A, light output from the backlight 10 passes the glass substrate 23, the LC layer 24 and the glass substrate 25 of the LCD unit 2 in the named order. At this time, images are formed by the pixels 41 and 42 of the LC layer 24. Then, the light that has passed the glass substrate 25 passes through the color filter 26, the optical film 8 and the photo-curing adhesive layer 9 and enters the optical distributor 3. The light incident to the optical distributor 3 is distributed to two directions, one directed toward the left eye 52 of the observer and the other directed toward the right eye 51. The distribution operation will be elaborated below.

[0048] In case where the lenticular lenses 31 and 32 are arranged in such a way that the projections 31a face the projections 32a, as shown in Fig. 6A, the heights of the projections 31a and the 32a of the lenticular lenses 31 and 32 are sufficiently low with respect to the focal distances of those lenses, so that the two lenticular lenses 31 and 32 can be regarded as equivalent to a single lenticular lens which has double the capability of those lenses. That is, the two lenticular lenses 31 and 32 shown in Fig. 6A are equivalent to a single lenticular lens 36 shown in Fig. 7 whose lens pitch is equal to the lens pitch of the lenticular lenses 31 and 32 and whose curvature is twice the curvature of the lenticular lenses 31 and 32.

[0049] As shown in Fig. 7, the lights that are output from the left-eye pixels 41 are refracted by the lenticular lens 36 and travel toward an area E_L. The lights that are output from the right-eye pixels 42 are refracted by the lenticular lens 36 and travel toward an area E_R. As the observer shifts the left eye 52 to the area E_L and shifts the right eye 51 to the area E_R, therefore, an image for the left eye is input to the left eye 52 and an image for the right eye is input to the right eye 51 so that the observer can recognize a 3D image.

[0050] The case of displaying a 2D image will be discussed next. To display a 2D image by the switching display apparatus 1, as shown in Fig. 6B, the position of the lenticular lens 31 is adjusted by the actuator 6 in such a way that the optical axis of the lenticular lens 31 is shifted from the optical axis of the lenticular lens 32 by half the lens pitch in the direction 11. That is, each projection 31a of the lenticular lens 31 are made to face a portion between the projections 32a of the lenticular lens 32. At the time of switching between the display of a 3D image and the display of a 2D image, the lenticular lens 31 has only to be moved in the direction 11 with respect to the lenticular lens 32 by a distance 0.5 times the lens pitch, but may also be shifted by a distance equal to an integer multiple of the lens pitch added to the former distance, e.g, a distance 1.5 times the lens pitch. Then, the pixels 41 and 42 are made to display a 2D image. At this time, the pixels 41 and 42 display the same image independently. That is, the pixels 41 and 42 are driven as independent pixels to display the same image together. The resolution of a 2D image therefore becomes twice the resolution of the aforementioned 3D image.

[0051] As shown in Figs. 4 and 6B, light output from the backlight 10 passes the glass substrate 23, the LC layer 24, the glass substrate 25, the color filter 26, the optical film 8 and the photo-curing adhesive layer 9 in the named order and enter the optical distributor 3. The light that has entered the optical distributor 3 is output in one direction by the lenticular lenses 32 and 31 of the optical distributor 3. As a result, the lights that have passed the pixels 41 and 42 are both input to the left eye 52 and the right eye 51 of the observer. This operation will be described in detail below.

[0052] In case where the optical axis of the lenticular lens 31 is shifted by half the lens pitch from the optical axis of the lenticular lens 32 in the direction 11, as shown in Fig. 6B, the lenticular lenses 31 and 32 become nearly equivalent to a single lenticular lens 37 whose lens pitch is half the lens pitch of the lenticular lenses 31 and 32 and whose curvature is twice the curvature of the lenticular lenses 31 and 32 as shown in Fig. 8.

[0053] The lights that are output from the pixels 41 and 42 are refracted by the lenticular lenses 31 and 32 and are output in the same direction. At this time, each pixel is magnified to an area in the observation plane which has a given width e and its cyclic pitch becomes e too. Therefore, the light output from the pixel 41 and the light output from the pixel 42 are both input to the left eye 52 and the right eye 51 of the observer. As a result, the same image is input to the left eye 52 and the right eye 51, so that the observer can recognize a 2D image.

[0054] The sizes of the individual sections of the switching display apparatus 1 will be discussed below. While the description will be given of the case where two lenticular lenses are used, the case of using a single lenticular lens will be discussed first using an optical model shown in Fig. 7. Let H be the thickness of the lenticular lens 36 and let n be its refractive index. Suppose that one side of the lenticular lens 36 is flat and the other side has multiple convex cylindrical lenses or semicylindrical projections 36a extending in one direction laid out along the direction 11. Let f be the focal distance of the lenticular lens and let L be the lens pitch. The pixels of the LCD unit 2 are laid out as sets each consisting of two pixels, a single left-eye pixel 41 and a single right-eye pixel 42. Let P be the width of each pixel. A set of two pixels, a single left-eye pixel 41 and a single right-eye pixel 42, corresponds to a single projection 36a. Let D be the distance between the lenticular lens 36 and the observer and let e be the lengths in the direction 11 of the area E_L and the area E_R which are 3D visible ranges, i.e., areas where the left eye 52 and the right eye 51 on a virtual plane apart from the lens by a distance D and parallel to the lens where the observer can recognize a 3D image. Further, let W_L be a distance from the center of that projection 36a which is located at the center of the lenticular lens 36 to the center of that projection 36a which is located at an end of the lenticular lens 36, and let W_P be a distance

Microsoft Exhibit 1002 - Page 952
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

from the center of a pair of the left-eye pixel 41 and right-eye pixel 42 that are located at the center of the LCD unit 2 to the center of the pixel pair that is located at an end of the LCD unit 2. In addition, let α and β be respectively the incident angle and output angle of light on the projection 36a that is positioned at the center of the lenticular lens 36, and let γ and δ be respectively the incident angle and output angle of light on the projection 36a that is positioned at the end of the lenticular lens 36. Let C be the difference between the distance W_L and the distance W_P and let 2m be the number of pixels included in the area of the distance W_P.

[0055] Normally, as the lenticular lens is often designed in accordance with a display unit, P is treated as a constant. Further, n is determined by selecting the material for the lenticular lens. The distance D between the lens and the observer and the 3D visible range e are set to desired values. Using those values, the distance H between the lens surface and the pixels and the lens pitch L are determined. The following equations 1 to 6 are derived from the Snell's law and geometrical relationship. So are the following equations 7 to 9.

[Equation 1]

$$n \times \sin \alpha = \sin \beta$$

[Equation 2]

$$D \times \tan \beta = e$$

[Equation 3]

$$H \times \tan\alpha = P$$

[Equation 4]

$$n \times \sin\gamma = \sin\delta$$

[Equation 5]

$$H \times \tan\gamma = C$$

[Equation 6]

$$D \times tan\delta = W_L$$

[Equation 7]

$$W_P\text{-}W_L = C$$

[Equation 8]

$$W_P = 2 \times m \times P$$

[Equation 9]

$$W_L = m \times L$$

[0056] The following equations 10, 11 and 12 are derived from the equations 2, 1 and 3, respectively.

Microsoft Exhibit 1002 - Page 953
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

[Equation 10]

$$\beta = \arctan\left(\frac{e}{D}\right)$$

[Equation 11]

$$\alpha = \arcsin\left(\frac{\sin\beta}{n}\right)$$

[Equation 12]

$$H = \frac{P}{\tan\alpha}$$

[0057] The following equation 13 is derived from the equations 6 and 9. The following equation 14 is derived from the equations 7 to 9. Further, an equation 15 given below is derived from the equation 5.

[Equation 13]

$$\delta = \arctan\left(\frac{m \times L}{D}\right)$$

[Equation 14]

$$C = 2 \times m \times P - m \times L$$

[Equation 15]

$$\gamma = \arctan\left(\frac{C}{H}\right)$$

[0058] If the thickness H of the lenticular lens is set equal the focal distance f as given in the following equation 16, the radius of curvature, r, of the lens is acquired from the following equation 17.

[Equation 16]

$$f = H$$

[Equation 17]

$$r = H \times \frac{n-1}{n}$$

Microsoft Exhibit 1002 - Page 954
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

[0059] The following will illustrate one example of the specific sizes of the switching display apparatus 1. The sizes given below are exemplified to make the understanding of the embodiment easier and are not restrictive. Provided that a display unit with a pixel pitch P of 0.24 mm is used, polymethyl methacrylate (PMMA) having the refractive index n of 1.49 is used as the material for the lenticular lens, the distance D between the lens and an observer is 280 mm, the length e of the 3D visible range is 65 mm and the value of m is set to 60, for example, it is understood from the equations given above that the distance between the lens surface and the pixels should be set to 1.57 mm, the lens pitch L should be set to 0.4782 mm and the radius of curvature r of the lens should be set to 0.5161 mm.

[0060] Based on the results, the optical system that has two lenticular lenses is then designed. Because the two lenticular lenses 31 and 32 are equivalent to the single lenticular lens 36 as mentioned earlier, the radius of curvature R of the two lenticular lenses 31 and 32 is designed to be double the radius of curvature r of the single lenticular lens 36. That is, the following equation 18 is satisfied. The radius of curvature R of the two lenticular lenses 31 and 32 is, for example, 1.032 mm. The lenticular lenses are processed into the aforementioned shapes by a well-known scheme. The thicknesses of the lenticular lenses 31 and 32 are, for example, 0.5 mm. The gap between the lenticular lenses 31 and 32 is, for example, 30 μm. Further, the thicknesses of the glass substrates 23 and 25 are, for example, 0.7 mm, and the thickness of the optical film 8 is, for example, 0.15 mm.

[Equation 18]

$$R = 2 \times r$$

[0061] To study the properness of this design, computer-aided simulation is carried out using a ray tracing simulator available on the market. Fig. 9 is a diagram showing an optical model which is used in this simulation and shows the layout at the time of displaying a 3D image. Fig. 10 is a graph showing the results of the simulation with the observation position taken on the horizontal axis and the irradiance at the observation position taken on the vertical axis, and Fig. 11 is a graph showing the results of the simulation in case of displaying a 3D image using a single lenticular lens and in case of displaying a 2D image without using a lenticular lens with the observation position taken on the horizontal axis and the irradiance at the observation position taken on the vertical axis.

[0062] As shown in Fig. 9, nine semicylindrical projections 32a with the radius of curvature R of 1.032 mm are laid out on the display-unit side lenticular lens 32, the layout pitch (lens pitch) L is set to 0.4782 mm and the thickness H is set to 1.57 mm. The center of the projection 32c that is positioned at the center of the nine projections is set as the origin of simulation, the Z axis is set in the direction of the thickness and the X axis is set in the string direction of the lenses. As the observer side lenticular lens 31, a lens which has the same pitch and same radius of curvature as the lenticular lens 32 is used and its thickness is set to 0.5 mm. The lenticular lens 31 has its lens surface directed toward the display unit and abutting on the display-unit side lenticular lens 32.

[0063] As a pixel, a single illuminant 43 which is a light emitting area with a width of 0.186 mm is laid with the position of (x, z) = (0.12 mm, -1.57 mm) in the coordinate system as the center in such a way as to abut on the flat side of the display-unit side lenticular lens 32. That is, this setting is to permit light from the illuminant 43 to enter the right eye but not to enter the left eye. A non-display area of 0.027 mm is provided on either side of the light emitting area. Accordingly, an area of $0 \leq x \leq 0.027$ mm and an area of $0.213 \leq x \leq 0.240$ mm become non-display areas and an area of $0.027 \leq x \leq 0.213$ mm becomes a light emitting area. The non-display areas are equivalent to light shielding portions that are arranged for the purpose of transferring a display signal to the pixels. A light receiving surface 53 equivalent to an observation position is set over an area of $-150 \leq x \leq +150$ mm. In case where the display of a 2D image is simulated, the observer side lenticular lens 31 is shifted in the + X direction by half the lens pitch (0.2391 mm).

[0064] To evaluate the uniformity of the display screen, computation is likewise executed for those pixels which are positioned at the ends of the display screen. To achieve uniform display, it is a prerequisite and also a sufficient condition that the simulation result for the center of the display screen should coincide with the simulation result for the end of the display screen. This is because the display quality of a pixel located between the center and end of the display screen takes an intermediate value between the display quality of a pixel located at the center and the display quality of a pixel located at the end of the display screen, the display quality of the entire display screen can be evaluated by evaluating the display qualities of the center pixel and the end pixel. In the simulation on a pixel located at the end of the display screen, the center of the lens that is positioned at the end of the screen is set as the origin and two lenticular lenses are set as done for the center of the display screen. As a pixel, an illuminant having a width 0.186 mm is set with the position of $x = 0.227$ mm as the center while an offset of $C = 0.107$ mm is set in consideration of the difference between the lens pitch and the pixel pitch. The light receiving surface is set over an area of ±150 mm in the X direction with the position of (x, z) = (-28.692 mm, 280 mm) as the center. Those simulation results are illustrated in Fig. 11.

[0065] For the purpose of comparison, simulation is performed in the case where a 3D image is displayed using a single lenticular lens whose curvature is twice the curvature of the lenticular lenses 31 and 32 and in the case where

Microsoft Exhibit 1002 - Page 955
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

a 2D image is displayed without using a lenticular lens. The simulation results are illustrated in Fig. 11.

[0066] In the simulation using the optical model shown in Fig. 9, the irradiance becomes higher in an area of $-60 \leq x \leq 0$ and becomes lower in the other area at the time of displaying a 3D image as shown in Fig. 10. Although a low peak is seen in an area of $-150 \leq x \leq -120$ mm, it is the light that has passed the projections 32b shown in Fig. 9. A peak seen in an area of $-60 \leq x \leq 0$ mm is the light that has passed the projection 32c in the nine projections which is located at the center. Further, a peak seen in an area of $60 \leq x \leq 120$ mm is the light that has passed the projection 32d shown in Fig. 9.

[0067] In case where the distance between both eyes of an observer is 65 mm and the center position of both eyes is $x = 0$ mm, for example, the position of the right eye becomes $x = -32.5$ mm and the position of the left eye becomes $x = +32.5$ mm. In case where display as shown in Fig. 10 is done, therefore, a sufficient amount of light enters the right eye but light hardly enters the left eye. This means that in case where the left-eye pixels are allowed to display an image for the left eye and the right-eye pixels are allowed to display an image for the right eye in the actual switching display apparatus 1 as shown in Fig. 4, the image for the left eye is input to the left eye and the image for the right eye is input to the right eye and the separation of both images is secured sufficiently, so that the observer can recognize a 3D image well.

[0068] In case where a 3D image is displayed using a single lenticular lens as shown in Fig. 11, approximately the same results as obtained in the case where two lenses shown in Fig. 10 are used are acquired, but the width of the image of a pixel projected in magnification becomes greater than that in the case where the two lenses shown in Fig. 10 are used. This is because the use of two lenses can reduce aberration as compared with the case of using a single lens equivalent to the two lenses, the blurriness of the projected image can be suppressed. That is, the use of two lenses can achieve the display of a high-quality 3D image which has lower aberration and is less likely to cause cross-talking as compared with the case of using a single lens.

[0069] At the time of displaying a 2D image, an area which reduces the irradiance in the period of about 60 mm appears. This is the area where the aforementioned non-display area is projected in magnification. Except for this area, the irradiance becomes approximately uniform over a wide area of $-90 \leq x \leq +150$ mm.

[0070] In case where a 2D image is displayed without using the lenticular lens as shown in Fig. 11, a nearly uniform irradiance distribution is acquired over the entire observation area. Although an area in which a non-display area is projected in magnification or a non-2D visible range can be identified in case where a 2D image is displayed using the two lenticular lenses as shown in Fig. 11, as compared with the case where a 2D image is displayed without using the lenticular lens as shown in Fig. 11, the similar results are acquired, except for the dark portion, in case where the lens is not used.

[0071] That is, if the aforementioned non-2D visible range is avoided, even in case where two lenses are used, lights with irradiances equal to each other are input to the right eye and the left eye. This means that even in case where both the left-eye pixels and the right-eye pixels in the actual switching display apparatus 1 shown in Fig. 4 are used as independent pixels and a high-resolution 2D image is displayed, the same image can be input to the left eye and the right eye by adequately selecting the observation position and observing from, for example, the position of A-A shown in Fig. 10 and the observer can recognize a 2D image well.

[0072] Further, as shown in Fig. 10, the simulation results on the center pixel of the display unit approximately coincide with the simulation results on the end pixel for both a 3D image and a 2D image. Therefore, uniform display is achieved over the entire display screen. At the time the display-unit side lenticular lens is fixed to the LCD unit when assembling the switching display apparatus that is imagined in this simulation from the results shown in Fig. 10, it is apparent that the display-unit side lenticular lens can be laid out accurately by setting the two lenticular lenses in the state for the display of a 2D image and adjusting the lenticular lenses to the position where the brightness of the LCD unit is minimized as observed from the front side of the observer whose distance between both eyes is 65 mm.

[0073] The following will describe the reason for limited values of the individual structural elements of the invention.

[0074] The clearance between the first lenticular lens portion and the second lenticular lens portion: 20% or less of the focal distance of the lens element of the virtual lenticular lens

[0075] In case of using two lenses, the pixels are positioned at a position closer than the focal distance of the first lens, so that light output from one projection of the first lens enters the second lens in a wide range. Therefore, an increase in the clearance between the lenses increases the amount of light incident to the projections of the second lens other than the projection of the second lens, arranged at the position facing the projection of the first lens from which light has been output, thereby degrading the characteristic. For example, most of the light output from the projection 32c shown in Fig. 9 is input to the projections 31b, 31d and so forth. It is therefore necessary to set the clearance between the lenses within a given range.

[0076] To study the error allowance in the Z-axis direction in case where two lenticular lenses are laid out, i.e., the distance between the two lenticular lenses, simulation is performed while changing the positions of the lenses in the Z-axis direction. Simulation similar to the above-described simulation is carried out in case where the position of the observer side lenticular lens is set to distances of 5 μm, 50 μm, 100 μm and 500 μm in the positive Z-axis direction.

Microsoft Exhibit 1002 - Page 956
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

The results are illustrated in Fig. 12.

[0077] Fig. 12 is a graph showing the results of the simulation with the observation position taken on the horizontal axis and the irradiance at the observation position taken on the vertical axis, and Fig. 13 is a graph showing the influence of the distance between lenticular lenses on the display quality of a 3D image with the horizontal axis showing the position of an observer on the Z axis of the lenticular lens and the vertical axis showing a contrast ratio CR. In the simulation results shown in Fig. 12, the result of computing the contrast ratio at the position of the center of both eyes x = 0 mm (i.e., the position of the right eye is x = -32.5 mm and the position of the left eye is x = 32.5 mm) and with the distance between both eyes set to 65 mm is what is seen at "0 mm" illustrated in Fig. 10. The result of computing the contrast ratio at the position of the center of both eyes x = 25.5 mm (i.e., the position of the right eye is x = -7 mm and the position of the left eye is x = 58 mm) and with the distance between both eyes set to 65 mm is what is seen at "25.5 mm" illustrated in Fig. 10.

[0078] Crosstalk is introduced as the index to quantitatively evaluate the display characteristic. The crosstalk is evaluated by the contrast ratio CR and the greater the absolute value of the value CR is, the less crosstalk occurs, thus realizing good 3D display. Given that i_R is the irradiance of light incident to the right eye and i_L is the irradiance of light incident to the left eye, the contrast ratio CR is defined by the following equation 19. According to the document titled "3D Display Without Multiple-eye glasses" by Haruo Isono, NHK STRL R&D, Vol. 2, p. 13-17, 1993), the contrast ratio CR should be less than about -7.8 dB or {(irradiance of an image for the right eye)/(irradiance of an image for the left eye)} < (1/6 in order to ensure good 3D display.

[Equation 19]

$$CR = 10 \times \log\left(\frac{i_R}{i_L}\right)$$

[0079] As shown in Fig. 12, with the position of the observer side lenticular lens being $z \leq 100$ μm, a large change in display characteristic is not seen even if the distance between lenses increases. With the position of the observer side lenticular lens becoming $z \leq 500$ μm, however, while nearly same results as obtained in the case of $z \leq 100$ μm are acquired when the observation position lies in an area of $-35 \leq x \leq 35$ mm, the display characteristic is degraded in the other area.

[0080] In case where the positions of the right and left eyes are set to the positions of x = ±32.5 mm, i.e., the position of the center of both eyes is x = 0 mm, as shown in Fig. 13, no significant deterioration of the characteristic occurs even if the lens position is 500 μm. In consideration of the case where the right and left eyes have been shifted within a range of ±60 mm, it is necessary to make evaluation in case where the position of the center of both eyes is x = 25.5 mm. In case where the position of the center of both eyes is x = 25.5 mm as shown in Fig. 13, as the lens clearance increases, the deterioration of the characteristic is seen and the characteristic becomes significantly degraded when the position of the observer side lenticular lens becomes z = 500 μm. As apparent from Fig. 13, it is preferable that the clearance between the lenticular lenses should be set within 320 μm to realize CR < -7.8 dB even at an end of the observation area of ±60 mm.

[0081] As this value is the allowable value set for the display unit and the lenses in this simulation, the allowable value is expressed by an ordinary index. In general, the focal distance is the quantity that becomes a reference for the length of the lens in the direction of the optical axis. In the simulation, the allowable value for the distance between both eyes is 320 μm and the lens's focal distance f, which is equal to the thickness H of the lens as apparent from the equation 16, is 1.57 mm. Therefore, the allowable value for the distance between both eyes is equivalent to 20% of the focal distance. In other words, it is preferable that the allowable value for the distance between both eyes should lie within 20% of the focal distance.

[0082] The amount of deviation between the optical axis of that lens element which is positioned at the center of the first lenticular lens portion and the optical axis of that lens element which is positioned at the center of the second lenticular lens portion: 12% or less of the layout cycle of the lens elements of the first lenticular lens portion

[0083] To study the error allowance in the X-axis direction in case where two lenticular lenses are laid out, i.e., the allowable value for the distance between optical axes of the two lenticular lenses in carrying out 3D display, simulation is performed while changing the positions of the lenses in the X-axis direction. Specifically, simulation is carried out while changing the position of the observer side lenticular lens in the X-axis direction to x = 0 μm, ±30 μm, ±50 μm and ±100 μm with respect to the display-unit side lenticular lens. It is to be noted that x = 0 indicates the case where the center of the observer side lenticular lens matches with the center of the display-unit side lenticular lens and the optical axes of both lenticular lenses coincide with each other, as seen from a direction parallel to the optical axis of

Microsoft Exhibit 1002 - Page 957
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

the lenticular lens.

[0084] Fig. 14 is a graph showing the results of the simulation with the observation position taken on the horizontal axis and the irradiance at the observation position taken on the vertical axis, and Fig. 15 is a graph showing the influence of the distance between lenticular lenses on the display quality of a 3D image with the horizontal axis showing the position of an observer on the X axis of the lenticular lens and the vertical axis showing the contrast ratio CR. Although Figs. 14 and 15 show the simulation results only in the range of $x \geq 0$, the simulation results in the range of $x < 0$ are the same as those in the range of $x \geq 0$.

[0085] It is apparent from Fig. 14 that as the positional deviation between the lenses gets larger, the characteristic is degraded from near the center of the observation area. This phenomenon seems to have occurred due to an increase in stray light traveling from one projection of the display-unit side lens to projections adjoining the projection of the observer side lens which faces the former projection. As shown in Fig. 15, to achieve the contrast ratio CR < -7.8 dB, the amount of deviation of the lenticular lenses should be set to ±60 μm or less.

[0086] Because this value is the allowable value set for the display unit and the lenses in this simulation as per the case of the Z-axis direction, the allowable value is expressed by an ordinary index. In general, the lens pitch is the quantity that becomes a reference for the length of the lenticular lens in a direction perpendicular to the optical axis of the lens. In the simulation, the allowable value for the amount of deviation between lenses is ±60 μm and the lens pitch L is 0.4782 mm. Therefore, the allowable value for the amount of deviation of the lenses in the X-axis direction is equivalent to 12% of the lens pitch. In other words, it is preferable that the amount of deviation between the optical axes of two lenses should be set within ±12% of the lens pitch.

[0087] As described above, the 3D image/2D image switching display apparatus according to the embodiment switches between the display of a 3D image and the display of a 2D image by combining two lenticular lenses are combined and moving one of the lenticular lenses by half the lens pitch in the direction perpendicular to the optical axis with respect to the other lenticular lens. The switching display apparatus does not therefore require large-scale switching means to switch image display. The short moving distance of the lens can contribute to making the switching display apparatus thinner, smaller and lighter and reducing the cost. The short moving distance of the lens can also ensure fast switching between the display of a 3D image and the display of a 2D image. In addition, as there is no switching means that intervenes the light passing area, the display quality does not get lower.

[0088] The embodiment requires neither a pump nor a tank or the like as compared with, for example, the prior art described in Japanese Patent Publication Laid-Open No. 068961/1996 and Japanese Patent Publication Laid-Open No. 112273/1992, which injects and discharges a liquid substance having the same refractive index as the material for the lenticular lens. This can reduce the size and cost of the apparatus. The requirement of neither injection nor discharge of a liquid substance can ensure fast switching of image display and does not raise the problem of incomplete injection and incomplete discharge, thus ensuring high-quality display. Further, as compared with the prior art described in Japanese Patent Publication Laid-Open No. 197343/1997, which makes the distance between the lenticular lens and the image display unit variable, the embodiment requires no space to make the distance variable and can thus make the apparatus thinner. Furthermore, as it is unnecessary to provide an expensive fiber face plate, the cost can be made lower. In short, the embodiment can provide a 3D image/2D image switching display apparatus which has features, such as thin in size, small in size and light in weight, fast switching, high-quality display and low cost.

[0089] The 3D image/2D image switching display apparatus according to the embodiment can therefore be suitably adapted to portable devices, such as a portable telephone, and can display both good 3D and 2D images. When the 3D image/2D image switching display apparatus according to the embodiment is adapted to a portable device, unlike in the case when the apparatus is adapted to a large display apparatus, an observer can arbitrarily adjust the positional relationship between his both eyes and the display screen so that the optimal visible range can be found promptly.

[0090] Although the switching display apparatus according to the embodiment has a backlight provided as a light source, a front-light may be provided in place of the backlight. In this case, in consideration of light rays incident to the LCD unit, it is preferable to provide a light source at an end portion of the display-unit side lenticular lens and cause light from the light source to be input to the display-unit side lenticular lens. At this time, the irregular surface of the display-unit side lenticular lens serves as grooves to scatter the incident light toward the LCD unit, thus making it unnecessary to particularly form grooves for the front-light.

[0091] The portable terminal device according to the embodiment can be adapted to a portable terminal device, such as a portable terminal, PDA, a game machine, a digital camera or a digital video, as well as a portable telephone. Further, beside a LCD unit, an organic electroluminescence display unit, a plasma display unit, a CRT display unit, a LED display unit, a field emission display unit, PALC (Plasma Address Liquid Crystal) or the like may be used as the display unit. Even in case of using a LCD unit, not only an ordinary transmission type LCD unit but also a reflection type LCD unit, a transflective type LCD unit, a visible everywhere transflective type LCD unit or the like can be used. The portable terminal device according to the embodiment can also be adapted to a still image like a print.

[0092] The second embodiment of the invention will be described below. Fig. 16 is a cross-sectional view showing a 3D image/2D image switching display apparatus according to the embodiment, and shows a 2D-image display state.

Microsoft Exhibit 1002 - Page 958
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Fig. 17 is a graph showing the results of the simulation on the apparatus shown in Fig. 16, with the observation position taken on the horizontal axis and the irradiance at the observation position taken on the vertical axis. The embodiment is characterized in that the positions of the lenticular lenses at the time of displaying a 2D image are shifted by a quarter (1/4) of the lens pitch, with respect to the pixels of the display unit, from the positions taken at the time of displaying a 3D image.

[0093] According to the first embodiment, because the non-display area of a pixel is magnified too at the time of displaying a 2D image as shown in Fig. 10, a non-2D visible range where a 2D image cannot be identified is produced in the 2D visible range. As this non-2D visible range overlaps a 3D visible range, the 2D visible range and the 3D visible range are deviated from each other. At the time of switching between the display of a 3D image and the display of a 2D image, therefore, the viewpoint should be shifted for observation which is troublesome.

[0094] To solve this problem, the non-2D visible range and the 3D visible range should not coincide with each other. There are two possible ways to achieve it. The first solution is to shift the lens position at the time of displaying a 2D image by 1/4 of the lens pitch with respect to the display unit. The second solution is to set the 3D visible range large. The first solution will be discussed in the following description of the second embodiment.

[0095] According to the first embodiment, the curved surface of the virtual lens that is obtained by arranging two lenticular lenses shifted by half a lens pitch from each other has half the pitch of the original lenticular lenses and its optical axis coincides with the center of each pixel. As a result, the pixel is projected in magnification with the center of the observation position as the center. According to the second embodiment, therefore, the positions of the two lenticular lenses and the positions of the pixels are shifted by 1/4 of the lens pitch along the direction 11 as shown in Fig. 16. As a result, the optical axis of the curved surface of the equivalent virtual lens is shifted by 1/4 of the lens pitch with respect to the center of each pixel. Therefore, the center of the magnified image is also shifted by 1/4 of the lens pitch of the magnified. This can allow the 2D visible range and the 3D visible range to coincide with each other.

[0096] As shown in Fig. 16, while the 3D image/2D image switching display apparatus according to the embodiment uses the same LCD unit 2 and lenticular lenses 31 and 32 as used in the first embodiment, the display-unit side lenticular lens 32 is not adhered to the LCD unit 2 but arranged with a clearance of, for example, about 20 μm from the LCD unit 2. In addition, an actuator 6 for moving the display-unit side lenticular lens 32 in the lens string direction 11 is also attached to the lenticular lens 32. The other structure of the switching display apparatus of the embodiment than is mentioned above is the same as that of the first embodiment.

[0097] The operation of the switching display apparatus according to the embodiment will be described next. At the time of displaying a 3D image, the actuators are operated in such a way that the optical axes of the two lenticular lenses match with the center of a pair of pixels at the center of the display screen. At the time of displaying a 2D image, the optical axis of the display-unit side lenticular lens 32 is shifted by 1/4 of the lens pitch in the direction 11 by actuating the associated actuator and the optical axis of the observer side lenticular lens 31 is shifted by 1/4 of the lens pitch in the direction opposite to the moving direction of the lenticular lens 32 by actuating the associated actuator. As a result, the optical axis of the lenticular lens 31 and the optical axis of the lenticular lens 32 are shifted by half the lens pitch and the optical axis of the single lens equivalent to the two lenses is shifted by 1/4 of the lens pitch with respect to each pixel.

[0098] The same results can be acquired, regardless of the moving direction of each lens, as long as the two lenses move in the opposite directions. The other operation of the switching display apparatus of the embodiment than is discussed above is the same as that of the first embodiment. The above-described operation can allow the 3D visible range at the time of displaying a 3D image to coincide with the 2D visible range at the time of displaying a 2D image, thus achieving excellent display of a 3D image and display of a 2D image.

[0099] Fig. 17 shows the results of the computed-aided simulation on the optical system shown in Fig. 16. The other conditions in the simulation than are mentioned above are the same as the simulation conditions in the first embodiment. As shown in Fig. 17, the simulation results of the second embodiment show that the 2D visible range match with the 3D visible range.

[0100] As the embodiment can apparently permit the 2D visible range to match with the 3D visible range, the viewpoint need not be shifted at the time of switching between the display of a 3D image and the display of a 2D image. The other effects of the switching display apparatus of the embodiment than are mentioned above are the same as those of the first embodiment.

[0101] The third embodiment of the invention will be described below. Fig. 18 is a cross-sectional view showing a 3D image/2D image switching display apparatus according to the embodiment and shows a 3D-image display state. As shown in Fig. 18, the switching display apparatus according to the embodiment differs from the switching display apparatus according to the second embodiment in that the actuators 6 are attached to the LCD unit 2 and the display-unit side lenticular lens 32. The other structure of the embodiment than that difference is the same as that of the second embodiment.

[0102] Accordingly, the switching display apparatus of the invention switches between the display of a 3D image and the display of a 2D image by moving the LCD unit 2 and the display-unit side lenticular lens 32, not moving the two

Microsoft Exhibit 1002 - Page 959
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

lenticular lenses 31 and 32 as done in the switching display apparatus of the second embodiment. Specifically, at the time of displaying a 3D image, the actuator 6 attached to the lenticular lens 32 and the actuator 6 attached to the LCD unit 2 are operated in such a way that the optical axes of the two lenticular lenses coincide with the portion between the pixels at the center of the display screen. At the time of displaying a 2D image, the actuator 6 attached to the lenticular lens 32 is operated to shift the optical axis of the lenticular lens 32 by half the lens pitch in the string direction 11 of the lens elements and the actuator 6 attached to the LCD unit 2 is operated to shift the position of the LCD unit 2 by 1/4 of the lens pitch in the direction opposite to the moving direction of the lenticular lens 32. As a result, the relative positional relationship between the lenticular lenses 31 and 32 and the LCD unit 2 becomes the same as the one obtained at the time of displaying a 2D image in the second embodiment. The other operation of the embodiment than is discussed above is the same as that of the second embodiment.

[0103] In case where the topmost surface of the apparatus is made movable, it is very likely that an operational failure occurs due to the influence of dust or the like. This therefore requires that a protection plate be provided further on the observer side to the observer side lenticular lens in which case the thickness of the protection plate increases the overall thickness of the apparatus. According to the embodiment, therefore, the observer side lenticular lens is fixed and the actuators are attached to the display-unit side lenticular lens and the LCD unit to make both movable. This can provide the observer side lenticular lens with the capability of the protection plate and thus make the overall apparatus thinner. The observer side lenticular lens can also be provided with the capability of a touch panel or a front-light. In case where the capability of a front-light is provided, particularly, grooves to scatter light toward the LCD unit may be provided in the observer side flat side of the observer side lenticular lens or light may be scattered toward the LCD unit by the irregular surface of the lenticular lens, thereby eliminating the need to form such grooves.

[0104] As apparent from the above, the embodiment can allow the 3D visible range at the time of displaying a 3D image to coincide with the 2D visible range at the time of displaying a 2D image and can thus realize a thin and highly-reliable 3D image/2D image switching display apparatus. The other effects of the embodiment than are mentioned above are the same as those of the second embodiment.

[0105] The fourth embodiment of the invention will be described below. Fig. 19 is a cross-sectional view showing a 3D image/2D image switching display apparatus according to the embodiment of the invention and shows a 3D-image display state. In the description of this embodiment, the second solution to make the 3D visible range coincide with the 2D visible range, which is mentioned in the foregoing description of the second embodiment, i.e., the scheme of setting the 3D visible range large will be discussed. As shown in Fig. 19, the focal distances of the lenticular lenses 31 and 32 in the switching display apparatus of the embodiment are made shorter than those of the switching display apparatus according to the first embodiment. The other structure of the embodiment than that difference is the same as that of the first embodiment.

[0106] The embodiment makes the 3D visible range larger than the one in the first embodiment. As the 3D visible range becomes larger, the 2D visible range inevitably becomes larger. The 3D visible range and 2D visible range are designed in such a way as to overlap each other at the positions of both eyes of the observer. The designing scheme will be discussed below. It is assumed that the left eye is positioned at, for example, $x = 32.5$ mm, and the right eye at, for example, $x = -32.5$ mm in Fig. 10. In this case, both eyes are positioned in the non-2D visible range where the non-display area in the 2D display is projected in magnification so that the observer cannot recognize a 2D image. As the 3D image and 2D image are magnified in the $\pm X$ direction with the position of $X = 0$ as the center, the 2D visible range at the position of $-20 \leq x \leq 20$ mm is magnified in the $\pm x$ direction in Fig. 10 and the ends of the 2D visible range reach the positions of the both eyes ($x = \pm 32.5$ mm) so that the observer can recognize a 2D image. When the images are further magnified, however, the 3D visible range at the position of $-50 \leq x \leq -10$ is shifted in the -x direction to come off the position of the right eye ($x = -32.5$ mm), so that the observer cannot recognize a 3D image.

[0107] Figs. 20A and 20B are exemplary graphs showing the allowable ranges of a 3D visible range and a 2D visible range, with the observation position taken on the horizontal axis and the irradiance at the observation position taken on the vertical axis. Given that W_{BM} is the total width of the non-display portions of two adjoining pixels and W_{eye} is the distance between both eyes, the allowable width, W_{3D}, of the 3D visible range shown in Fig. 20A is the distance from the positions of the eyes to the non-2D visible range and is given by the following equation 20. The allowable width, W_{2D}, of the 2D visible range is the distance from the eyes to the non-2D visible range and is given by the following equation 21.

[Equation 20]

$$W_{3D} = \frac{W_{eye}}{2} - \frac{e \times W_{BM}}{2 \times P}$$

Microsoft Exhibit 1002 - Page 960
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

[Equation 21]

$$W_{2D} = \frac{e}{2} - \frac{W_{eye}}{2} - \frac{e \times W_{BM}}{2 \times P}$$

[0108] The case where W_{3D} and W_{2D} match with each other is the case where a 3D image and a 2D image can be recognized within the largest range. At this time, the following equation 22 is satisfied. This is tantamount to setting the 3D visible range to twice the distance between both eyes.

[Equation 22]

$$e = 2 \times W_{eye}$$

[0109] One example of the sizes of the 3D image/2D image switching display apparatus according to the embodiment based on the above-described design will be described below. For example, the radius of curvature of the lenticular lens is 0.747 mm and the lens pitch is 0.4791 mm. Further, the thickness of the display-unit side lens plate is 0.3 mm. The sizes of the other portions of this switching display apparatus are the same as those of the first embodiment illustrated earlier. As the 3D image/2D image switching display apparatus is operated in the same way as done in the first embodiment and observation is made at a position 400 mm apart from the lenticular lens, an observation can be made both at the time of displaying a 3D image and at the time of displaying a 2D image without changing the viewpoint. The visible range in either case can be secured to ±18 mm from the center of the visible range, which would provide the 3D image/2D image switching display apparatus with a wider range for observation.

[0110] The fifth embodiment of the invention will be described next. Figs. 21A and 21B are cross-sectional views showing a 3D image/2D image switching display apparatus according to the embodiment of the invention. Fig. 21A shows a 2D-image display state and Fig. 21B shows a 3D-image display state. Fig. 22 is a graph showing the shape of a lens with the position on the lens perpendicular to the optical axis taken on the horizontal axis and the height of the lens at the position taken on the vertical axis. Fig. 23 is a diagram showing the path of light output from one end portion of one pixel, Fig. 24 is a diagram showing the path of light output from the other end portion of this pixel, and Fig. 25 is a diagram showing the path of light output from the center portion of the pixel. Further, Fig. 26 is a graph showing the results of the simulation on the apparatus shown in Figs. 21A and 21B, with the observation position taken on the horizontal axis and the irradiance at the observation position taken on the vertical axis.

[0111] As shown in Figs. 21A and 21B, the switching display apparatus according to the embodiment is characterized in that one of the two lenticular lenses is a concave lenticular lens. In the switching display apparatus according to the embodiment, the convex lenticular lens 32 is provided on the LCD unit side and a concave lenticular lens 33 is provided further on the observer side to the lenticular lens 32. An actuator is attached to the concave lenticular lens 33 so that the lenticular lens 33 is movable in the string direction of recessed portions as the lens elements. The absolute value of the focal distance of the convex lenticular lens 32 is approximately equal to the absolute value of the focal distance of the concave lenticular lens 33. The other structure of the embodiment than that difference is the same as that of the first embodiment.

[0112] The operation of the switching display apparatus according to the embodiment will be described next. To display a 2D image, as shown in Fig. 21A, the lenticular lenses 32 and 33 are arranged in such a way that the optical axis of the convex lenticular lens 32 matches with the optical axis of the concave lenticular lens 33. This arrangement causes the lens functions of the two lenticular lenses to cancel out each other to thereby realize 2D display. To display a 3D image, as shown in Fig. 21B, the lenticular lenses 32 and 33 are arranged in such a way that the optical axis of the convex lenticular lens 32 is shifted by half the lens pitch from the optical axis of the concave lenticular lens 33. This prevents the lens effects of both lenticular lenses from canceling out each other as done in the case of displaying a 2D image, and can thus ensure good 3D display.

[0113] A detailed description will now be given of how to design the lenticular lenses in the embodiment. The restriction on the lenses to realize good 2D display is as simple as making the absolute value of the focal distance of the concave lens coincides with the absolute value of the focal distance of the convex lens. Let us therefore consider the conditions to achieve good 3D display.

[0114] In case where the concave lenticular lens and the convex lenticular lens are so arranged as to be shifted by half the lens pitch from each other, a single virtual lens (hereinafter called "combined lens") equivalent to those two lenses has nearly a linear shape as shown in Fig. 22. At the time of displaying a 3D image, therefore, the combined lens has a capability similar to the capability of a prism plate which has multiple prisms laid out at the lens pitch. It is therefore suffice to design the angle of inclination (or the inclination angle) of the prism. In case of a prism, unlike a

Microsoft Exhibit 1002 - Page 961
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

lens, light from one point of a pixel is projected on the observation plane without being subjected to the focus action and thus becomes a bundle of lights, so that the irradiance distribution of the projected image is expected to have a mountain-like shape. To maximize the effect of 3D display, the position of the mountaintop should be set to the positions of the eyes. This is tantamount to the case where light coming from the center of a pixel is dispersed and the dispersed light is distributed over a range of a width e around the position of $x = \pm(e/2)$.

[0115] At this time, as shown in Fig. 23, light emitted from the end of that side (right-hand end in the diagram) of the right-eye pixel 42 which is located farther from the left-eye pixel (not shown) associated with this pixel 42 is projected on an area of $-3 \times e/2 \leq x \leq -e/2$ on the observation plane by a prism plate 34 or the combined lens when the boundary between the right-eye pixel and the left-eye pixel is $x = 0$. As shown in Fig. 24, light emitted from the end of that side (left-hand end in the diagram) of the right-eye pixel 42 which is located closer to the left-eye pixel associated with this pixel 42 is projected on an area of $-e/2 \leq x \leq e/2$ on the observation plane by the prism plate 34. As shown in Fig. 25, light emitted from the center of the right-eye pixel 42 is projected on an area of $-e \leq x \leq 0$ on the observation plane by the prism plate 34. Given that the angle of inclination of the prism is θ, the following equation 23 is satisfied according to the Snell's law.

[Equation 23]

$$n \times \sin\left(\theta - \frac{\alpha}{2}\right) = \sin\theta$$

[0116] The inclination angle 6 of the prism becomes 6 = 13.1° using the values in the first embodiment. A description will now be given of means which realizes the inclination angle θ with the optical axes of the concave lens and convex lens shifted by half the lens pitch from each other. In case where the lenses with the radius of curvature R are shifted from each other by half the lens pitch as shown in Fig. 22, the convex lens surface, f(x), in the cross section containing the optical axis is given by the following equation 24 and the concave lens surface, g(x), is given by the following equation 25. Therefore, the lens surface, h(x), of the combined lens is given by the following equation 26.

[Equation 24]

$$f(x) = -\sqrt{R^2 - \left(\frac{L}{2}\right)^2} + \sqrt{R^2 - x^2}$$

[Equation 25]

$$g(x) = \sqrt{R^2 - \left(\frac{L}{2}\right)^2} - \sqrt{R^2 - \left(x - \frac{L}{2}\right)^2}$$

[Equation 26]

$$h(x) = f(x) + g(x) = \sqrt{R^2 - x^2} - \sqrt{R^2 - \left(x - \frac{L}{2}\right)^2}$$

[0117] Equations 27 and 28 given below are derived from the equation 26. As a result, the inclination angle θ is expressed by the following equation 29. Solving the following equation 29 for the radius of curvature R yields the following equation 30.

[Equation 27]

Microsoft Exhibit 1002 - Page 962
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

$$h(0) = R - \sqrt{R^2 - \left(\frac{L}{2}\right)^2}$$

[Equation 28]

$$h\left(\frac{L}{2}\right) = -R + \sqrt{R^2 - \left(\frac{L}{2}\right)^2}$$

[Equation 29]

$$\tan\theta = \frac{4 \times \left(R - \sqrt{R^2 - \left(\frac{L}{2}\right)^2} \right)}{L}$$

[Equation 30]

$$R = \frac{L \times \left\{ 1 + \left(\frac{\tan\theta}{2} \right)^2 \right\}}{2\tan\theta}$$

[0118] Substituting, for example, the aforementioned values, the inclination angle $\theta = 13.1°$ and the lens pitch L = 0.4782 mm in the equation 30, the radius of curvature R becomes equal to 1.03 mm, which is equivalent to about twice the radius of curvature r = 0.5161 mm when a single lenticular lens is used.

[0119] To study the appropriateness of this design, computer-aided simulation is carried out. The optical model that is used in this simulation differs from the optical model used in the simulation in the first embodiment in that a concave lenticular lens is used as the observer side lenticular lens and 2D display is achieved by arranging the two lenticular lenses in such a way that their optical axes coincide with each other whereas 3D display is achieved by arranging the two lenticular lenses with their optical axes shifted from each other by half the lens pitch. The other conditions in the simulation than the mentioned ones are the same as those in the simulation in the first embodiment. The simulation results are illustrated in Fig. 26.

[0120] As shown in Fig. 26, the results of the simulation show that for both 2D display and 3D display, the display characteristic of the center of the display screen approximately matches with the display characteristic of the end of the display screen. The switching display apparatus can therefore achieve uniform display on the entire display screen. In case of 2D display, the magnified area of non-display area (see Fig. 10) which is observed in the first embodiment cannot be observed and the uniform irradiance distribution similar to the one obtained in the case where the lens is not used is acquired.

[0121] As apparent from the above, the embodiment can realize excellent 2D image display in which the non-display area of a pixel is not projected in magnification, as compared with the case where two convex lenticular lenses are used. The embodiment can also ensure 3D image display. It is therefore possible to realize a 3D image/2D image switching display apparatus.

[0122] Although the observer side lenticular lens or the concave lenticular lens 33 is movable in this embodiment as in the first embodiment, the LCD unit and the display-unit side lenticular lens or the convex lenticular lens 32 may be made movable as done in the second and third embodiments. What is important at this time is the relative layout of the right-eye pixels, the left-eye pixels and the projections of the convex lenticular lens at the time of displaying a 3D image and the boundary portion between the right-eye pixel and the left-eye pixel should match with the center of the associated projection. As long as this rule is kept, either one of the convex lenticular lens or the concave lenticular lens

Microsoft Exhibit 1002 - Page 963
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

may be arranged on the display-unit side or either lens may be made movable. In case where the convex lenticular lens is to be arranged on the display-unit side, accurate layout can be made by arranging the convex lenticular lens in such a way that a 3D image on, when displayed on the display unit, can be observed with a good quality.

[0123] A modification of the fifth embodiment of the invention will be described next. Figs. 27A and 27B are cross-sectional views showing a 3D image/2D image switching display apparatus according to the modification. Fig. 27A shows a 2D-image display state and Fig. 27B shows a 3D-image display state. In this modification, the above-described technique of the fifth embodiment is adapted to a multi-view type switching display apparatus. The "multi-view" type is the system in which one or more kinds of pixels are prepared in addition to the right-eye pixel and the left-eye pixel so that three pixels or more are associated with a single lens element of the lenticular lens.

[0124] As shown in Figs. 27A and 27B, four kinds of pixels 401 to 404, for example, are cyclically laid out, in the name order, on the LC layer 24 of the LCD unit 2 along the direction 11. One projection 32a of the lenticular lens 32 and one projection 33a of the lenticular lens 33 correspond to a pixel group consisting of the pixels 401 to 404 one each. The other structure of the modification than that particular layout is the same as that of the fifth embodiment.

[0125] The operation of the switching display apparatus according to this modification will be discussed next. To display a 2D image, as shown in Fig. 27A, the optical axis of the convex lenticular lens 32 is made coincident with the optical axis of the concave lenticular lens 33. Then, the same 2D image is displayed with the pixels 401 to 404 treated as independent pixels. Because the lens effects of the convex lenticular lens 32 and the concave lenticular lens 33 cancel out each other at this time, lights output from the pixels 401 to 404 travel in the same direction.

[0126] At the time of displaying a 3D image, by way of comparison, on the other hand, the optical axis of the convex lenticular lens 32 is shifted from the optical axis of the concave lenticular lens 33 by the half the lens pitch, as shown in Fig. 27B. Accordingly, the lenticular lenses 32 and 33 function as a prism as per the fifth embodiment. Then, the pixels 401 to 404 display four different kinds of images, respectively. At this time, the convex lenticular lens 32 and the concave lenticular lens 33 bring about the prism effect and output light from the pixel 401 in the first direction, light from the pixel 402 in the second direction, light from the pixel 403 in the third direction and light from the pixel 404 in the fourth direction. Accordingly, as the observer changes the viewpoint, the observer can recognize four kinds of images. As a result, at the time of displaying the image of a subject, for example, the display can be made in such a way that the image of the subject seen from the front can be recognized in the observation of the switching display apparatus from the front side and the image of the subject seen from the oblique direction can be recognized in the observation of the switching display apparatus from the oblique direction. The other operation and effect of the modification than what have been discussed above are the same as those of the fifth embodiment. The number of the kinds of pixels is not limited to four, but three kinds or five kinds or more may be used.

[0127] The sixth embodiment of the invention will be described below. Figs. 28A and 28B are cross-sectional views showing a 3D image/2D image switching display apparatus according to the embodiment. Fig. 28A shows a 2D-image display state and Fig. 28B shows a 3D-image display state. Fig. 29 is a graph showing the results of the simulation on the apparatus shown in Figs. 28A and 28B, with the observation position taken on the horizontal axis and the irradiance at the observation position taken on the vertical axis.

[0128] As shown in Figs. 28A and 28B, the embodiment is characterized in that two plate-like members in each of which prism-like optical elements extending in one direction are laid out in parallel to one another (hereinafter called "prism plate 35") are used instead of two lenticular lenses, as compared with the first embodiment. The two prism plates 35 have the identical shape. The one of the two prism plates 35 which is arranged on the display-unit side is fixed to the LCD unit 2 and an actuator (not shown) is attached to the other one arranged on the observer side so that the latter prism plate 35 is movable in the layout direction 11 of the prism-like optical elements. The inclination angle of each prism plate 35 is half the inclination angle ($\theta = 13.1°$) of the virtual prism in the fifth embodiment. The other structure of the embodiment than that structure mentioned above is the same as that of the first embodiment.

[0129] The operation of the switching display apparatus according to the embodiment will be described next. In case where the switching display apparatus displays a 2D image, as shown in Fig. 28A, the two prism plates 35 are laid out in such a way that the vertex of the display-unit side prism plate 35 matches with the trough of the observer side prism plate 35. This allows the two prism plates 35 to cancel out their prism functions each other, thus ensuring 2D display.

[0130] In case of displaying a 3D image, as shown in Fig. 28B, the two prism plates 35 are laid out in such a way that the vertexes of the prism plates 35 match with each other. This allows the two prism plates 35 to function as a single virtual prism plate 35 with an inclination angle θ of 13.1°, unlike in the case of 2D display where the prism effects cancel out each other, so that good 3D display can be realized as per the fifth embodiment.

[0131] Fig. 29 shows the results of computer-aided simulation using the above-described optical model. The other conditions in the simulation than what are mentioned above are the same as those in the simulation in the first embodiment. As apparent from Fig. 29, the results of the simulation, like the simulation results of the fifth embodiment (see Fig. 26), show good effects both in 2D display and 3D display.

[0132] As a prism plate has a simple shape as compared with a lenticular lens, it can be fabricated at a lower cost. This embodiment can therefore achieve the low-cost production of a 3D image/2D image switching display apparatus.

Microsoft Exhibit 1002 - Page 964
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

The other effects of the switching display apparatus of the embodiment than are mentioned above are the same as those of the fifth embodiment.

[0133] The seventh embodiment of the invention will be described below. Figs. 30A and 30B are cross-sectional views showing a 3D image/2D image switching display apparatus according to the embodiment. Fig. 30A shows a 3D-image display state and Fig. 30B shows a 2D-image display state. Figs. 31A and 31B are top views showing the 3D image/2D image switching display apparatus, Fig. 31A showing a 3D-image display state while Fig. 31B shows a 2D-image display state.

[0134] As shown in Figs. 30A, 30B, 31A and 31B, the switching display apparatus according to the embodiment is provided with two convex fly-eye lenses 38 and 39 in place of two lenticular lenses as compared with the first embodiment. The "fly-eye lens" is a lens having ordinary lenses laid out in a matrix form. The LCD unit 2 is provided on the plane that includes the focal points of the two fly-eye lenses 38 and 39. The LCD unit 2 is provided with four kinds of pixels 44 to 47 which respectively show different images. The pixels 44 to 47 one each are laid out in two by two to constitute one set of pixels and each set of pixels or each pixel group corresponds to the each lens element of the fly-eye lens. This realizes the scheme of integral photography. Two sets of actuators (not shown) are attached to the observer side fly-eye lens 38, so that the fly-eye lens 38 is movable in an arbitrary direction orthogonal to the optical axis of the display-unit side fly-eye lens 39 with respect to the fly-eye lens 39.

[0135] The operation of the switching display apparatus according to the embodiment will be described next. In case of displaying a 3D image, as shown in Figs. 30A and 31A,the fly-eye lens 38 is arranged in such a way that the optical axis of each lens element of the fly-eye lens 38 coincides with the optical axis of the associated lens element of the fly-eye lens 39. Accordingly, the two convex fly-eye lenses 38 and 39 function as a single virtual fly-eye lens. As a result, the convex fly-eye lenses 38 and 39 respectively output lights coming from the pixels 44 to 47 in the first and fourth directions.

[0136] In case of displaying a 2D image, as shown in Figs. 30B and 31B, the fly-eye lens 38 is arranged in such a way as to be shifted from the fly-eye lens 39 by half the lens pitch in the right and left direction of the screen or the up and down direction of the screen, or in both the right and left direction and the up and down direction, so that the optical axis of the fly-eye lens 38 is shifted by half the lens pitch from the optical axis of the fly-eye lens 39. Accordingly, the two convex fly-eye lenses 38 and 39 function as a single virtual fly-eye lens. As a result, the convex fly-eye lenses 38 and 39 respectively output lights coming from the pixels 44 to 47 in the first and fourth directions. This can allow a 2D image to be displayed based on the principle similar to that of the first embodiment.

[0137] In case where one of two lenticular lenses provided is moved in the string direction of its projections as done in the first embodiment, plural images to be displayed by plural kinds of pixels can be distributed only in one direction. If two kinds of images are distributed in the right and left direction so that different images are input to the right and left eyes, 3D display can be achieved. If plural kinds of images are distributed in the right and left direction so that different images can be recognized as the viewpoint is shifted in the right and left direction, more sophisticated 3D feeling can be achieved. The illustrated structure of the first embodiment cannot however distribute images in other directions than the layout direction of the projections of the lenticular lens.

[0138] According to the seventh embodiment, by way of comparison, two fly-eye lenses are provided and plural kinds of pixels are laid out in the layout direction of the lens elements of those convex fly-eye lenses, so that plural images can be distributed in two directions or more. If not only an actuator which moves the lenses in the horizontal direction but also an actuator which moves the lenses in the vertical direction are provided, it is possible to select between horizontal 3D feeling and vertical 3D feeling. That is, if images are distributed in the up and down direction in addition to the right and left direction, 3D display is available even in case where an image is displayed in a direction orthogonal to the normal direction with respect to the screen of the switching display apparatus. That is, even in case where observation is made by changing the vertical and horizontal sides of the screen layout, it is possible to select between 3D display and 2D display which are respectively optimal to those screen layouts. In case where the switching display apparatus of the embodiment is installed in a camera-mounted portable telephone, for example, the screen is arranged vertically to display a 3D image and a 2D image when the telephone is used as an ordinary portable telephone while the screen is arranged horizontally in consideration of the layout of 3D CCDs to display a 3D image and a 2D image when the portable telephone is used as a camera. If the image of a subject as seen from obliquely above is recognized when observing the screen from obliquely above, for example, the observer can acquire 3D feeling in the up and down direction. If the pixels are laid out in an arbitrary oblique direction and the fly-eye lens 38 is made movable in this arbitrary oblique direction, it is possible to switch between the display of a 3D image and the display of a 2D image in every direction. As a result, the observer can get 3D feeling when observing the image not only in the right and left direction but also in the up and down direction and the oblique direction.

[0139] In the case that uses integral photography scheme as in the embodiment, it is preferable to employ a time-divisional display system (field sequential display system). The time-divisional display system is the method that expresses colors on the time-sequential addition by flickering the backlight in three colors of RGB without using a color filter. The reason why the time-divisional display system is preferable is that the fly-eye lens projects the pixels in

Microsoft Exhibit 1002 - Page 965
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

magnification in the up and down direction as well as the right and left direction in the integral photography. In the plane division type color display apparatus using an ordinal color filter, the lens components parallel to the extending direction of the stripes of the color filter disturbs the color elements of a magnified image and thus produces color moire, deteriorating the visibility. By way of contrast, the time-divisional display system can display a full color with a single pixel and does not therefore bring about such a problem. While the time-divisional display system requires at least three times the normal drive frequency, it can reduce the number of pixels to 1/3 and eliminates the need for a color filter and thus has an advantage such that there is no light absorption by the color filter, resulting in consumption power saving. With those features, the time-divisional display system may be adapted to the above-described first to sixth embodiments and eighth to twelfth embodiments to be discussed later.

[0140] The eighth embodiment of the invention will be described below. Fig. 32 is a cross-sectional view showing a 3D image/2D image switching display apparatus according to the embodiment and shows a 3D-image display state. Fig. 33 is a diagram showing an optical model of this switching display apparatus. As shown in Fig. 32, the switching display apparatus of the embodiment has one of the two lenticular lenses, a lenticular lens 12, formed integral with the glass substrate 25 of the LCD unit 2. 2P molding or the like can be used as means for providing a lenticular lens on the glass substrate 25 of the LCD unit 2. Specifically, a mold is prepared which has the inversion pattern of the shape of the lens to be molded and a release agent and a photo-curing resin are coated on the mold and are closely attached to the display unit. Then, the resin is cured and separated and the pattern of the lenticular lens is transferred on the display unit.

[0141] In case of preparing the lenticular lens in this manner, the position of the lens is limited by the thickness of the substrate of the display unit. In this respect, the observer side lenticular lens may be arranged in such a way that the lens surface is directed toward the observer side as shown in Fig. 32. At the center portion of the display screen of the optical model shown in Fig. 33, the following equations 31 to 36 are derived from the Snell's law and the geometric relationship.

[0142] Given that H_1 is the distance from the pixels 41 and 42 to the lens surface of the display-unit side lenticular lens 32, H_2 is the distance from the pixels 41 and 42 to the lens surface of the observer side lenticular lens 31 and the two lenticular lenses are considered as a single virtual lenticular lens, let H be the distance from the pixels 41 and 42 to the lens surface of the virtual lenticular lens, let D be the distance from the pixels 41 and 42 to the virtual lenticular lens, let n be its refractive index, let L_1 be the lens pitch of the display-unit side lenticular lens 32, let L_2 be the lens pitch of the observer side lenticular lens 31, let P be the width of each of the pixels 41 and 42, let ΔP be the distance between the center of the lenticular lens 32 and the position at which light output from that end of the pixel 42 which is located on the side far from the pixel 41 passes the lens 32, and let Δe be the distance between the center of the lenticular lens 31 and the position at which light output from that end of the pixel 42 which is located on the side far from the pixel 41 passes the lens 31.

[0143] In addition, let W_{L1} be the distance from the center of the projection located at the center of the lenticular lens 31 to the center of the projection located at the end of the lens 31, let W_{L2} be the distance from the center of the projection located at the center of the lenticular lens 32 to the center of the projection located at the end of the lens 32, let W_P be the distance between the center position of a pair of the left-eye pixel and right-eye pixel 42 located at the center of the LCD unit and the center position of the pixel pair located at the end of the LCD unit 2, let α and β be respectively the inclination angle and output angle of light at the projection located at the center of the lenticular lens 32, let β and γ be respectively the inclination angle and output angle of light at the projection located at the center of the lenticular lens 31, let δ and ε be respectively the inclination angle and output angle of light at the projection located at the end of the lenticular lens 32, let ε and Φ be respectively the inclination angle and output angle of light at the projection located at the end of the lenticular lens 31, let C_1 be the difference between the distance W_P and the distance W_{L1}, let C_2 be the difference between the distance W_P and the distance W_{L2}, and let 2m be the number of pixels included in the area of the distance W_P.

[Equation 31]

$$n \times \sin\alpha = \sin\beta$$

[Equation 32]

$$n \times \sin\beta = \sin\gamma$$

[Equation 33]

Microsoft Exhibit 1002 - Page 966
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

$$(H_2 - H) \times \tan\beta = \Delta e$$

[Equation 34]

$$(D - H_2 + H) \times \tan\gamma = e - \Delta e$$

[Equation 35]

$$H_1 \times \tan\alpha = \Delta P$$

[Equation 36]

$$(H - H_1) \times \tan\beta = P - \Delta P$$

[0144] Further, the following equations 37 to 41 are likewise derived for the end portion of the display screen.

[Equation 37]

$$n \times \sin\delta = \sin\varepsilon$$

[Equation 38]

$$n \times \sin\varepsilon = \sin\phi$$

[Equation 39]

$$H_1 \times \tan\delta = 2 \times m \times P - m \times L_1$$

[Equation 40]

$$(D - H_2 + H_1) \times \tan\phi = m \times L_2$$

[Equation 41]

$$(H_2 - H_1) \times \tan\varepsilon = m \times L_1 - m \times L_2$$

[0145] Further, suppose that the following equation 42 is satisfied.

[Equation 42]

$$H_2 - H_1 = H$$

[0146] Then, the equations 31 to 42 are solved using H = 1.57 mm, the value used in the first embodiment, as the value of the distance H from the pixels 41 and 42 to the lens surface of the virtual lens, the pixel pitch P = 0.24 mm, the refractive index n = 1.49, the distance D = 280 mm, the width of the 3D visible range e = 65 mm and m = 60. Obtained as a result are H_1 = 0.707 mm or the distance between the display-unit side lenticular lens 32 and the pixels, L_1 = 0.4795 mm or the lens pitch of the display-unit side lenticular lens 32, H_2 = 2.51 mm or the distance between the observer side lenticular lens 31 and the pixels and L_2 = 0.4795 mm or the lens pitch of the observer side lenticular lens

Microsoft Exhibit 1002 - Page 967
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

31. With the switching display apparatus designed in this way, even in case where there is a distance between the two lenticular lenses, the lenses can be laid out without degrading the display performance.

[0147] According to the embodiment, as described above, the provision of the display-unit side lenticular lens integrated with the glass substrate 25 of the LCD unit 2 can increase the thickness of the observer side lenticular lens 31 and can thus reduce the influence of the warping and deformation of the lenses, thus ensuring high-yield production of switching display apparatuses with a good display quality.

[0148] The ninth embodiment of the invention will be described next. Fig. 34 is a top view showing a 3D image/2D image switching display apparatus according to the embodiment. As shown in Fig. 34, the observer side lenticular lens 31 is cut along the string direction of the projections (direction 11) into plural band-like segments 31b to 31e whose lengthwise direction is parallel to the direction 11 as seen from the direction perpendicular to the surface of the LCD unit 2. The actuator 6 is attached to each segment to permit each segment to be movable independently. The other structure of the embodiment than what has been discussed above is the same as that of the first embodiment.

[0149] The operation of the switching display apparatus according to the embodiment will be described next. As shown in Fig. 34, the LCD unit 2 (see Fig. 7) displays an image which is partly a 2D image with the other part being a 3D image. By driving the individual actuators, the segments of the area where a 3D image is displayed, e.g., the segments 31c and 31e, are arranged in such a way that the optical axes of the lenses coincide with each other and the segments of the area where a 2D image is displayed, e.g., the segments 31b and 31d, are arranged in such a way that the optical axes of the lenses are shifted from each other by half the lens pitch. This can ensure different lens layouts within the display screen so that a mixture of a 3D image and a 2D image can be displayed within the display screen. The other operation and effects of the embodiment than what have been discussed above are the same as those of the first embodiment.

[0150] The tenth embodiment of the invention will be described below. Fig. 35 is a cross-sectional view showing a 3D image/2D image switching display apparatus according to the embodiment and shows a 3D-image display state. As shown in Fig. 35, the observer side lenticular lens 31 (see Fig. 7) in the first embodiment is constituted by a combination of two lenticular lenses 311 and 312 in the tenth embodiment. That is, the 1according to the embodiment has three lenticular lenses 32, 311 and 312 provided in the named order from the display-unit side. The lenticular lens 32 is laid on the substrate of the LCD unit 2 in such a way that its lens surface is directed toward the observer side, the lenticular lens 311 is laid out in such a way that its lens surface is directed toward the observer side, and the lenticular lens 312 is laid out in such a way that its lens surface is directed toward the display-unit side. The two lenticular lenses 311 and 312 are equivalent to the single lenticular lens 32. The lenticular lenses 311 and 312 are fixed to each other and an actuator (not shown) is attached thereto so that the lenticular lenses 311 and 312 are movable in the direction 11. The other structure of the embodiment than what has been discussed above is the same as that of the first embodiment.

[0151] The design scheme for the switching display apparatus according to the embodiment can be contrived based on the design scheme employed in the eighth embodiment. That is, as the observer side lenticular lens is separated into two, and the focal distance and lens pitch of each separated lens part are respectively set to 2.064 mm and 0.4774 mm, the structure that uses three lens substrates can be realized.

[0152] The operation of the switching display apparatus according to the embodiment will be described next. At the time of displaying a 3D image, as shown in Fig. 35, the optical axes of the lenticular lenses 32, 311 and 312 are made to match with one another. This can allow light from the left-eye pixel 41 to be output toward the left eye 52 of the observer and can allow light from the right-eye pixel 42 to be output toward the right eye 51 so that the observer can recognize a 3D image. At the time of displaying a 2D image, the actuators are driven to shift the optical axes of the lenticular lenses 311 and 312 from the optical axis of the lenticular lens 32 by half the lens pitch. At this time, the optical axis of the lenticular lens 311 remains coincident with the optical axis of the lenticular lens 312. Accordingly, the effects of the three lenticular lenses cancel out one another and the observer can recognize a 2D image. The other operation of the embodiment than what has been discussed above is the same as that of the first embodiment.

[0153] In the embodiment, the use of three lenses can reduce aberration further as compared with the case of using two lenses. This can ensure better display.

[0154] Although the foregoing description of the embodiment has been given of an example where the observer side lenticular lens is constituted by two lenses, the invention is not limited to this particular case and the observer side lenticular lens may be constituted by three lenses or more, or the display-unit side lenticular lens may be constituted by two lenses or more, or both the observer side lenticular lens and display-unit side lenticular lens may be constituted by two lenses or more.

[0155] The eleventh embodiment of the invention will be described below. Fig. 36 is a top view showing a 3D image/2D image switching display apparatus according to the embodiment, and Fig. 37 is a graph showing the characteristics of a non-linear spring with the position of displacement taken on the horizontal axis and the reaction force taken on the vertical axis. As shown in Fig. 36, the switching display apparatus according to the embodiment differs from the switching display apparatus of the first embodiment in the structure of the actuator.

Microsoft Exhibit 1002 - Page 968
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

[0156] For example, while the display of a 3D image and the display of a 2D image are switched from one to the other by moving the observer side lenticular lens 31 in the first embodiment, the position of the lenticular lens 31 should be arranged stably at the position for making 3D display or the position at which the optical axis of the lenticular lens 31 coincides with the optical axis of the lenticular lens 32 or at the position for making 2D display or the position at which the optical axis of the lenticular lens 31 is shifted from the optical axis of the lenticular lens 32. That is, neither a 3D image nor a 2D image can be displayed stably if the lenticular lens 31 stays at a midway position between those two positions.

[0157] A fixed frame 72 fixed to the casing (not shown) is provided in the switching display apparatus of the embodiment and the observer side lenticular lens 31 is retained in the opening portion of the fixed frame 72. The length of the opening portion of the fixed frame 72 in the direction 11 is longer than the length of the lenticular lens 31 in the direction 11 and the lenticular lens 31 is movable in the direction 11. Two pairs of or four non-linear springs 65 to 68 are provided between the edge of the lenticular lens 31 that is orthogonal to the moving direction 11 and the fixed frame 72. The non-linear springs 65 and 67 form a pair and are arranged in such a way as to face each other. The non-linear springs 66 and 68 form the other pair and are arranged in such a way as to face each other. The non-linear springs 65 and 66 are attached to one edge of the lenticular lens 31, and the non-linear springs 67 and 68 are attached to the other edge of the lenticular lens 31. The non-linear springs 65 to 68 press the lenticular lens 31 in the direction 11. A lever 62 which presses the lenticular lens 31 in the direction 11 is provided at the edge on that side where the non-linear springs 65 and 66 are attached, and a lever 64 which presses the lenticular lens 31 in the direction 11 is provided at the edge on that side where the non-linear springs 67 and 68 are attached. The lenticular lens 31 is restricted so as not to move in an undesirable direction or in the other directions than the direction 11 by a guide (not shown), and its moving range in the direction 11 may be restricted by a stopper (not shown).

[0158] As the pressing force to be applied to the non-linear springs is increased, the amount of displacement of the springs increases according to the pressing force, but when application of the pressing force which works against constant reaction force F_1 to the springs causes the amount of displacement of the springs to exceed a given value c, the reaction force of the springs changes from the value F_1 to a value F_2 smaller than F_1. As the pressing force to be applied to the springs is decreased gradually from the state where the amount of displacement of the springs is large, the amount of displacement of the springs decreases to the value c while showing weak reaction force F_2 and tends to return to the basic state while showing strong reaction force F_1 when the amount of displacement becomes equal to or smaller than c. In the embodiment, the amount of displacement of one of a pair of non-linear springs is set to a value a smaller than the value c and the amount of displacement of the other spring is set to a value b greater than the value c as shown in Fig. 37.

[0159] The operation of the switching display apparatus according to the embodiment will be described next. When the amount of displacement of the non-linear springs 65 and 66 is a and the amount of displacement of the non-linear springs 67 and 68 is b, as shown in Fig. 37, the reaction force of the non-linear springs 65 and 66 is larger than the reaction force of the non-linear springs 67 and 68 so that the lenticular lens 31 is pressed toward the non-linear springs 67 and 68. That is, the lenticular lens 31 is arranged at the first position indicated by the two-dot chain line in Fig. 37. When the lever 64 is pushed in this state, the lenticular lens 31 moves toward the non-linear springs 65 and 66. As a result, the amount of displacement of the non-linear springs 65 and 66 becomes b and the amount of displacement of the non-linear springs 67 and 68 becomes a, thus pressing the lenticular lens 31 toward the non-linear springs 65 and 66. That is, the lenticular lens 31 is arranged at the second position indicated by the solid line in Fig. 37. Even after the force applied to the lever 64 is released, the reaction force of the non-linear springs 67 and 68 is still greater than the reaction force of the non-linear springs 65 and 66, so that the lenticular lens 31 is kept stably at the second position. When the lever 62 is pushed in this state, the lenticular lens 31 moves to the first position again and is kept stably at the first position due to the difference between the reaction forces of the non-linear springs 65 to 68.

[0160] In the embodiment, the first position is treated as the position where, for example, 3D display is effected and the second position is treated as the position where, for example, 2D display is effected. According to the embodiment, as apparent from the above, the lenticular lens 31 can be held stably at either one of the 3D display position and the 2D display position with a simple structure. The other operation and effects of the embodiment than what have been discussed above are the same as those of the first embodiment.

[0161] The twelfth embodiment of the invention will be described below. Fig. 38 is a top view showing a 3D image/2D image switching display apparatus according to the embodiment. As shown in Fig. 38, the switching display apparatus according to the embodiment is provided with cantilevers 62a and 64a with a "<" shape in place of the levers 62 and 64 used in the eleventh embodiment, and on end of each of the cantilevers 62a and 64a abuts on the lenticular lens 31. Each of the cantilevers 62a and 64a has a center portion supported rotatably on the fixed frame 72, and one ends of actuators 61 and 63 are coupled to the other ends of the cantilevers 62a and 64a. The actuators 61 and 63 are wires made of a shape memory alloy and are contracted in a conductive state but are deformable by external force in a non-conductive state. The actuators 61 and 63 are connected to a power supply (not shown) via respective switches (not shown) independently and the current flows as the switches are closed. The reference length of the actuator 61

Microsoft Exhibit 1002 - Page 969
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

is set to such a length at which in the non-conductive state, tensile force need not be applied to the cantilever 62a when the lenticular lens 31 moves to the position on that side of the actuator 61 or the second position indicated by the solid line in Fig. 38 and the actuator 61 is expanded, and in the conductive state, the actuator 61 is contracted to cause the lenticular lens 31 to be sufficiently pushed to the position on the other end side via the cantilever 62a or the first position indicated by the two-dot chain line in Fig. 38. The length of the actuator 63 is designed in the same way as the actuator 61.

[0162] The operation of the switching display apparatus according to the embodiment will be described next. First, it is assumed that as shown in Fig. 38, the lenticular lens 31 is at the first position indicated by the two-dot chain line in Fig. 38. At this time, the lenticular lens 31 is held stably at the first position due to the difference between the reaction forces of the non-linear springs 65 to 68. As the actuator 63 is energized, the actuator 63 is contracted to turn the cantilever 64a so that the cantilever 64a pushes the lenticular lens 31 toward the second position indicated by the solid line in Fig. 38. As a result, the lenticular lens moves to the second position from the first position. Although the movement of the lenticular lens 31 turns the cantilever 62a to expand the actuator 61, the actuator 61 which is in the non-conductive state is easily deformed and does not interfere with the movement of the lenticular lens 31. Even when energization of the actuator 63 is stopped thereafter, the lenticular lens 31 is kept stably at the second position due to the difference between the reaction forces of the non-linear springs 65 to 68. In case where the lenticular lens 31 is moved to the first position from the second position, likewise, the actuator 61 is energized. As a result, the actuator 61 is contracted, turning the cantilever 62a to push the lenticular lens 31 toward the first position. The other operation of the embodiment than has been discussed above is the same as that of the eleventh embodiment.

[0163] As apparent from the above, this embodiment can electrically control the movement of the lenticular lens 31. This can permit automatic switching between the display of a 3D image and the display of a 2D image. Because wires of a shape memory alloy are used as the actuators, the structures are simple and the switching display apparatus can be constructed smaller and lighter.

[0164] The springs may be connected in such a way that the actuators 61 and 63 are always expanded in the lengthwise direction. This causes the actuators to be contracted in the conductive state, thereby moving the lenticular lens 31, but allows the actuators to be expanded sufficient in the non-conductive state, so that the cantilevers can be prevented from pushing the lenticular lens 31. This can permit the no-drive side actuator not to become a load on the drive side actuator, thus ensuring faster driving of the lenticular lens 31.

[0165] In case where the outside size of the switching display apparatus need not be made small, an electric actuator, such as an electromagnetic solenoid or electromagnetic motor, may be used. Further, the eleventh embodiment and the twelfth embodiment can be combined with the second to tenth embodiments.

Claims

1. A three-dimensional (3D) image/two-dimensional (2D) image switching display apparatus (1) comprising:

   display unit (2) having a plural of pixel groups cyclically laid out each comprised of first to n-th pixels (41, 42) (n being an integer equal to or greater than 2);
   first optical unit (32) which has first optical elements (32a) cyclically laid out in association with said individual pixel groups and refracts lights output from said pixels; and

   characterized by further comprising second optical unit (31) which has second optical elements (31a) cyclically laid out in association with said individual pixel groups and refracts lights output from said first optical unit, wherein when images displayed by said first to n-th pixels differ from one another, said second optical unit is placed in relative to said first optical unit at a first position where said first and second optical unit output lights, output from said first to n-th pixels, in first to n-th directions different from one another, and when said first to n-th pixels display a same image independently, said second optical unit is placed in relative to said first optical unit at a second position which is set apart from said first position in a layout direction (11) of said second optical elements by half a distance of a layout cycle of said second optical elements or by a distance equal to an integer multiple of said layout cycle of said second optical elements added to said half the distance and where said first and second optical unit output lights, output from said first to n-th pixels, in a same direction.

2. The 3D image/2D image switching display apparatus (1) according to claim 1, **characterized in that** a layout cycle of said first optical elements (32a) is substantially equal to said layout cycle of said second optical elements (31a).

3. The 3D image/2D image switching display apparatus (1) according to claim 1, **characterized in that** said display unit (2) has two kinds of pixels (41, 42), right-eye pixels (42) for a right eye (52) and left-eye pixels (41) for a left

Microsoft Exhibit 1002 - Page 970
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

eye (51), and at a time of displaying a 3D image, said right-eye pixels (42) display images for said right eye (52), said left-eye pixels (41) display images for said left eye (51) and said first and second optical unit (32, 31) output lights output from said right-eye pixels (42) in a first direction and output lights output from said left-eye pixels (41) in a second direction, and at a time of displaying a 2D image, said right-eye pixels (42) and said left-eye pixels (41) together display a same 2D image and said first and second optical unit (32, 31) output lights output from said right-eye pixels (42) and said left-eye pixels (41) in a same direction.

4. The 3D image/2D image switching display apparatus (1) according to claim 3, **characterized in that** said first optical unit (32) is a first lenticular lens portion which comprises one or plural convex type lenticular lenses and where said first optical elements are lens elements, said second optical unit (31) is a second lenticular lens portion which comprises one or plural convex type lenticular lenses and where said second optical elements are lens elements, at a time of displaying a 3D image, an optical axis of that lens element which is located at a center of said second lenticular lens portion substantially coincides with an optical axis of one lens element of said first lenticular lens portion, and at a time of displaying a 2D image, said optical axis of said lens element located at said center of said second lenticular lens portion is shifted from an optical axis of that lens element which is located at a center of said first lenticular lens portion, by half a length of a layout cycle of said lens elements of said second lenticular lens portion or a length equal to an integer multiple of said layout cycle of said lens elements of said second lenticular lens portion added to said half the length.

5. The 3D image/2D image switching display apparatus (1) according to claim 4, **characterized in that** at least one of said first and second lenticular lens portions comprises two or more lenticular lenses stacked one on another.

6. The 3D image/2D image switching display apparatus (1) according to claim 4, **characterized in that** a lens side of said first lenticular lens portion is so arranged as to face a lens side of said second lenticular lens portion.

7. The 3D image/2D image switching display apparatus (1) according to claim 4, **characterized in that** a lens side of said first lenticular lens portion and a lens side of said second lenticular lens portion are so arranged as to face in a same direction.

8. The 3D image/2D image switching display apparatus (1) according to claim 4, **characterized in that** a curvature of said lens elements (32a) of said first lenticular lens portion (32) is equal to a curvature of said lens elements (31a) of said second lenticular lens portion (31) and in case where said first and second lenticular lens portions are considered as a single virtual lenticular lens (37), a curvature of lens elements of said virtual lenticular lens (37) is twice said curvature of said lens elements (32a, 31a) of said first and second lenticular lens portions (32, 31).

9. The 3D image/2D image switching display apparatus (1) according to claim 4, **characterized in that** a curvature of said lens elements (32a) of said first lenticular lens portion (32) is equal to a curvature of said lens elements (31a) of said second lenticular lens portion (32) and in case where said first and second lenticular lens portions (32, 31) are considered as a single virtual lenticular lens (37), a clearance between said first and second lenticular lens portions (32, 31) is equal to or less than 20% of a focal distance of lens elements of said virtual lenticular lens (37).

10. The 3D image/2D image switching display apparatus (1) according to claim 4, **characterized in that** at a time of displaying a 3D image, an amount of deviation between said optical axis of said lens element which is located at said center of said first lenticular lens portion (32) and said optical axis of said lens element which is located at said center of said second lenticular lens portion (31) is equal to or less than 12% of a layout cycle (L) of said lens elements of said first lenticular lens portion (32).

11. The 3D image/2D image switching display apparatus (1) according to claim 4, **characterized in that** said first and second lenticular lens portions (32, 31) are provided respectively movable in relative to said display unit (2), at a time of displaying a 3D image, said optical axes of said lens elements which are located at said centers of said first and second lenticular lens portions (32, 31) pass through a center of that pixel group, consisting of said right-eye pixels (42) and said left-eye pixels (41) which is located at a center of said display unit (2), and at a time of displaying a 2D image, said optical axis of said lens element which is located at said center of said first lenticular lens portion (32) passes through a position shifted from said center of said pixel group by a length of 1/4 times a layout cycle (L) of said lens elements of said first lenticular lens portion (32) or a length equal to an integer multiple of said layout cycle (L) of said lens elements of said first lenticular lens portion (32) added to said length of 1/4 times said layout cycle (L) and said optical axis of said lens element which is located at said center of said second

Microsoft Exhibit 1002 - Page 971
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

lenticular lens portion (31) passes through a position shifted, in an opposite direction to a direction of shifting done with respect to said display unit (2), from said center of said pixel group by a length of 1/4 times said layout cycle (L) or a length equal to an integer multiple of said layout cycle (L) of said lens elements of said second lenticular lens portion (31) added to said length of 1/4 times said layout cycle (L).

12. The 3D image/2D image switching display apparatus (1) according to claim 4, **characterized in that** at a time of displaying a 2D image, a width of a 2D visible range over which a light emitting section of a pixel is projected in magnification is set greater than a distance between both eyes (51, 52) of an observer.

13. The 3D image/2D image switching display apparatus (1) according to claim 4, **characterized in that** at a time of displaying a 3D image, a width of a 3D visible range over which light output from a pixel is projected in magnification via that lens element which is closest to that pixel is set twice a distance between both eyes (51, 52) of an observer.

14. The 3D image/2D image switching display apparatus (1) according to claim 1, **characterized in that** one of said first and second optical unit (32, 31) is a convex lenticular lens portion which comprises one or plural convex type lenticular lenses, the other one of said first and second optical unit is a concave lenticular lens portion which comprises one or plural concave type lenticular lenses, at a time said first to n-th pixels respectively display first to n-th images, an optical axis of that lens element which is located at a center of said convex lenticular lens portion is shifted from an optical axis of that lens element which is located at a center of said concave lenticular lens portion, by half a length of a layout cycle of said lens elements of said convex lenticular lens portion or a length equal to an integer multiple of said layout cycle of said lens elements of said convex lenticular lens portion added to said half the length, and at a time said first to n-th pixels respectively together display a same image, said optical axis of said lens element located at said center of said convex lenticular lens portion substantially coincides with an optical axis of one lens element of said concave lenticular lens portion.

15. The 3D image/2D image switching display apparatus (1) according to claim 14, **characterized in that** at least one of said convex lenticular lens portion and said concave lenticular lens portion comprises two or more lenticular lenses stacked one on another.

16. The 3D image/2D image switching display apparatus (1) according to claim 1, **characterized in that** said first optical unit is a first fly-eye lens portion (39) which comprises one or plural fly-eye lenses, said second optical unit is a second fly-eye lens portion (38) which comprises one or plural fly-eye lenses, and said second fly-eye lens portion (38) is movable in all directions in which said pixels (41, 42) of said display unit (2) are laid out in relative to said first fly-eye lens portion (39).

17. The 3D image/2D image switching display apparatus (1) according to claim 16, **characterized in that** at least one of said first and second fly-eye lens portions comprises two or more fly-eye lenses stacked one on another.

18. The 3D image/2D image switching display apparatus (1) according to claim 16, **characterized in that** said display unit has first to fourth pixels (44, 45, 46, 47) laid out in a matrix form of two rows by two columns and said first and second fly-eye lens portions (39, 38) comprise convex type fly-eye lenses.

19. The 3D image/2D image switching display apparatus (1) according to claim 16, **characterized in that** at least one of said pixels is a right-eye pixel for a right eye and at least one of the other pixels is a left-eye pixel for a left eye, at a time of displaying a 3D image, said right-eye pixel displays an image for said right eye, said left-eye pixel displays an image for said left eye and an optical axis of that lens element which is located at a center of said second fly-eye lens portion substantially coincides with an optical axis of one lens element of said first fly-eye lens portion, and at a time of displaying a 2D image, said optical axis of said lens element located at said center of said second fly-eye lens portion is shifted from an optical axis of that lens element which is located at a center of said second fly-eye lens portion, in a direction going toward said image for said left eye from said image for said right eye or a direction opposite thereto, by half a length of a layout cycle of said lens elements of said second fly-eye lens portion or a length equal to an integer multiple of said layout cycle of said lens elements of said second fly-eye lens portion added to said half the length.

20. The 3D image/2D image switching display apparatus (1) according to claim 1, **characterized in that** said first optical unit is a first prism plate (35) on which prism elements are laid out, said second optical unit is a second prism plate (35) on which prism elements are laid out, at a time of displaying a 3D image, a vertex of that prism element which is located at a center of said second prism plate, as seen from a direction perpendicular to a display

Microsoft Exhibit 1002 - Page 972
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

surface of said display unit, substantially coincides with a trough portion between one prism element of said first prism plate and those prism elements which adjoin that one prism element, and at a time of displaying a 2D image, said vertex of said prism element which is located at said center of said second prism plate, as seen from said direction perpendicular to said display surface of said display unit, substantially coincides with a vertex of one prism element of said first prism plate.

21. The 3D image/2D image switching display apparatus (1) according to claim 1, **characterized in that** said display unit (2) has a color filter (36) which colors lights output from said pixels and has a plurality of stripe portions colored to plural kinds of colors and cyclically laid out in parallel to one another and a lengthwise direction of said stripe portions is parallel to layout directions of said first and second optical elements.

22. The 3D image/2D image switching display apparatus (1) according to claim 1, **characterized in that** said display unit (2) displays an image by color field sequential display method.

23. The 3D image/2D image switching display apparatus (1) according to claim 1, **characterized by** further comprising a casing which houses said display unit and said first and second optical unit and to which said second optical unit is fixed.

24. The 3D image/2D image switching display apparatus (1) according to claim 23, **characterized in that** said second optical unit has a capability of a protection plate, a touch panel or a front-light for said display unit (2).

25. The 3D image/2D image switching display apparatus according to claim 1, **characterized in that** at least one part of said first optical unit (31) is formed integral with a member which constitutes a display surface of said display unit (2).

26. The 3D image/2D image switching display apparatus (1) according to claim 1, **characterized in that** at least one of said first and second optical unit is divided into a plurality of portions (31b, 31c, 31d, 31e) as seen from a direction perpendicular to a display surface of said display unit and said plurality of portions are movable independently of one another.

27. The 3D image/2D image switching display apparatus (1) according to claim 1, **characterized in that** at least one of said first and second optical unit is provided with a frame (7).

28. The 3D image/2D image switching display apparatus (1) according to claim 1, **characterized in that** an antireflection coating is formed on a surface of at least one of said first and second optical unit (32, 31).

29. The 3D image/2D image switching display apparatus (1) according to claim 1, **characterized by** further comprising an actuator (6), attached to at least one of said first and second optical unit (31), for moving said one of said first and second optical unit in relative to the other optical unit.

30. The 3D image/2D image switching display apparatus according to claim 1, **characterized by** further comprising a casing (72) for housing said display unit (2) and said first and second optical unit (32, 31), and

one pair or plural pairs of non-linear springs (65, 66, 67, 68) which are located between said casing and at least one of said first and second optical unit in such a way as to be stretched and contracted in a layout direction of said first optical elements and whose reaction force is discontinuously reduced when an amount of displacement exceeds a threshold value, and which are provided in such a way that an amount of displacement of one of each pair of non-linear springs is greater than said threshold value while an amount of displacement of the other non-linear spring becomes smaller than said threshold value.

31. The 3D image/2D image switching display apparatus (1) according to claim 30, **characterized in that** at least one pair of non-linear springs (65, 66, 67, 68) is coupled to an edge extending in a direction perpendicular to said layout direction in said one of said first and second optical unit.

32. The 3D image/2D image switching display apparatus (1) according to claim 29, **characterized in that** said actuator is a linear member (61, 63) made of a shape memory alloy and connected to a power supply.

33. The 3D image/2D image switching display apparatus (1) according to claim 1, **characterized in that** said display unit (2) is a liquid crystal display unit.

Microsoft Exhibit 1002 - Page 973
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

34. A portable terminal device **characterized by** further comprising a 3D image/2D image switching display apparatus (1) according to claim 1.

35. The portable terminal device according to claim 34, **characterized in that** said portable terminal device is a portable telephone (16), a portable terminal, PDA (Personal Digital Assistant), a game machine, a digital camera or a digital video.

Microsoft Exhibit 1002 - Page 974
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 1

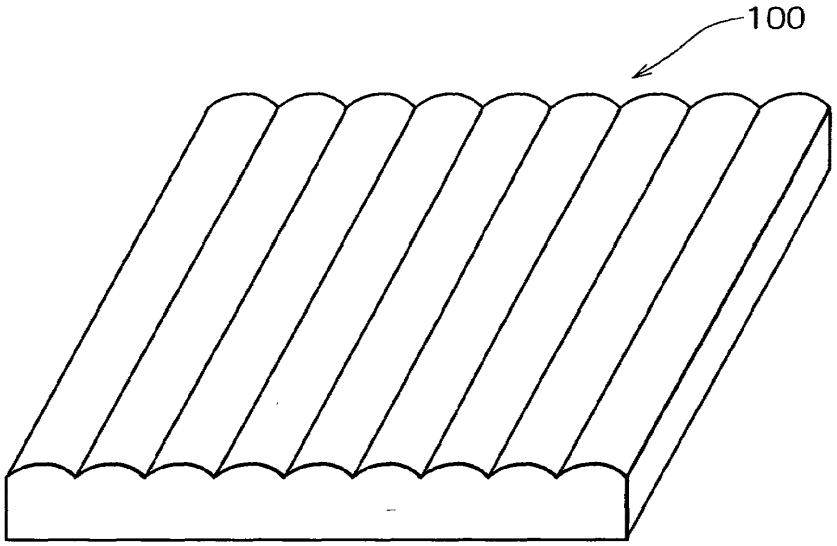
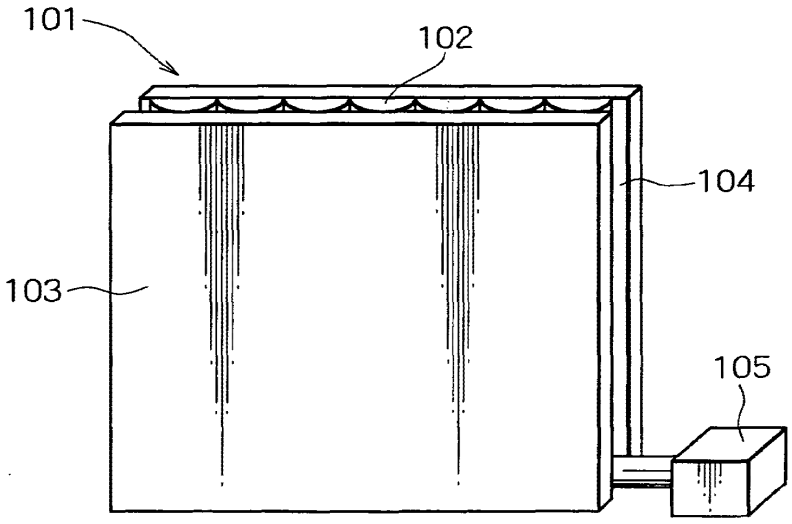
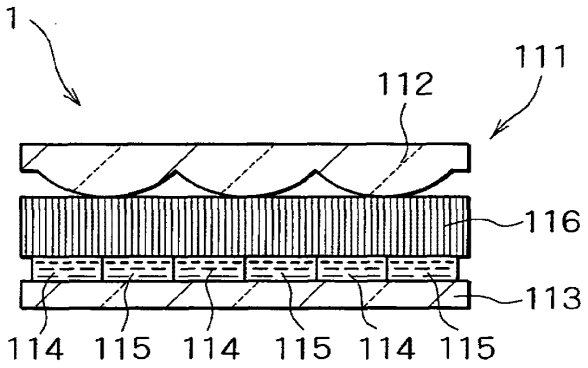


FIG. 2



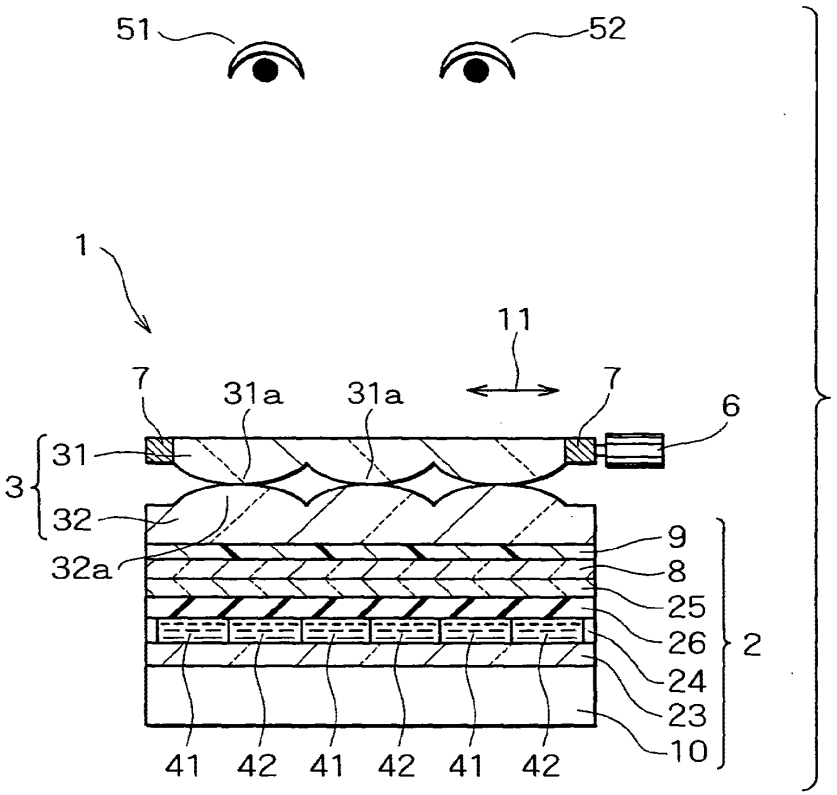
Microsoft Exhibit 1002 - Page 975
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 3



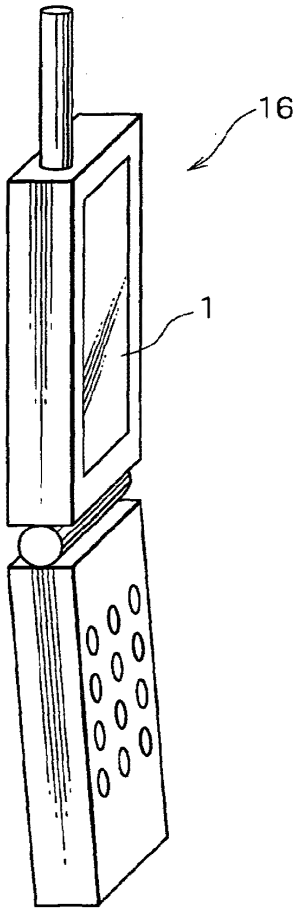
Microsoft Exhibit 1002 - Page 976
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 4



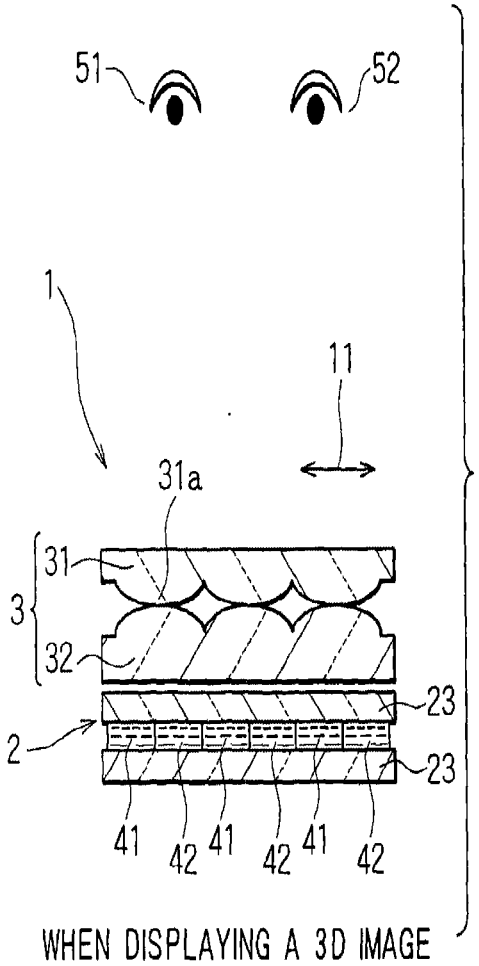
Microsoft Exhibit 1002 - Page 977
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 5



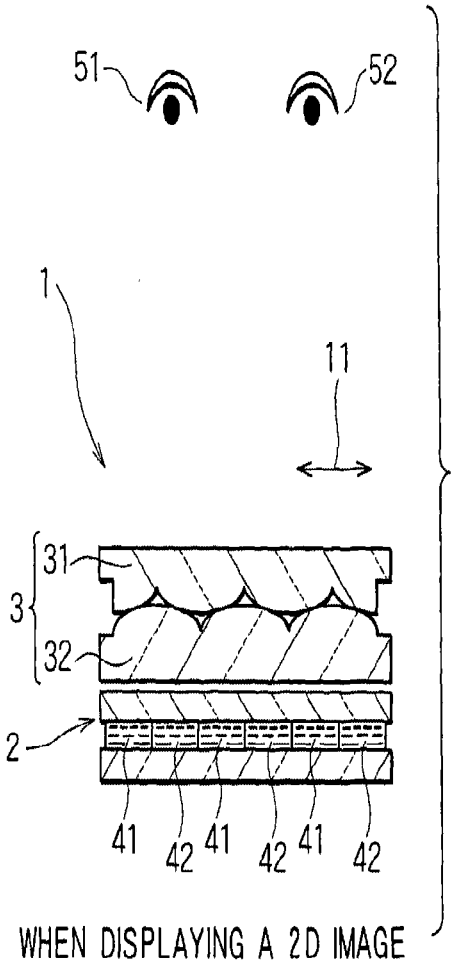
Microsoft Exhibit 1002 - Page 978
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.6A



WHEN DISPLAYING A 3D IMAGE

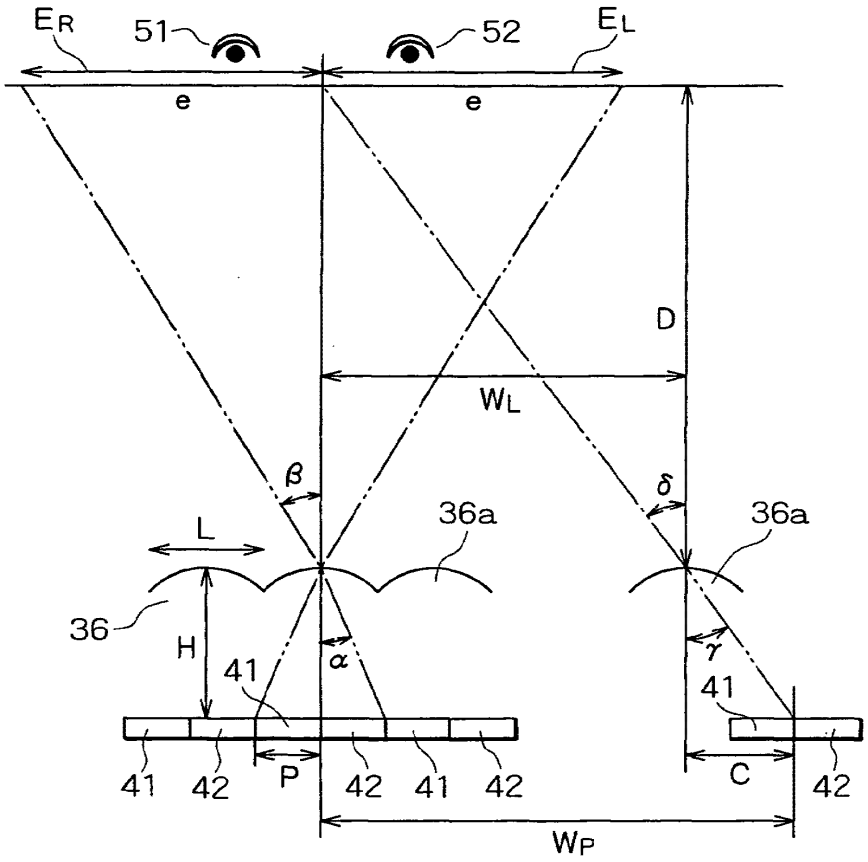
FIG.6B



WHEN DISPLAYING A 2D IMAGE

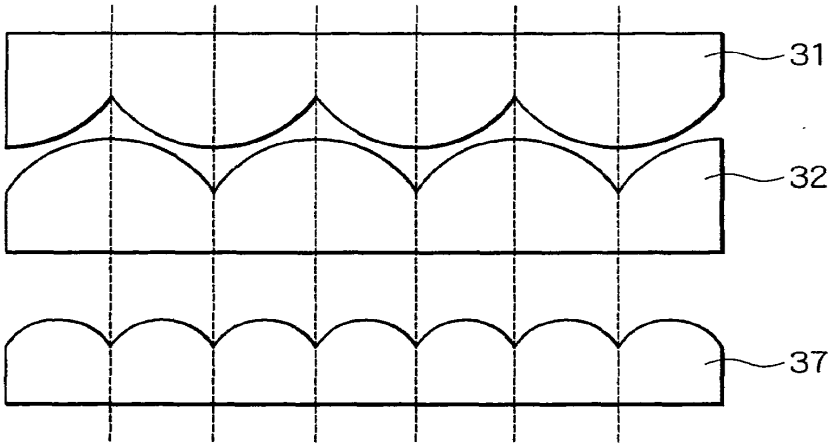
Microsoft Exhibit 1002 - Page 979
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 7



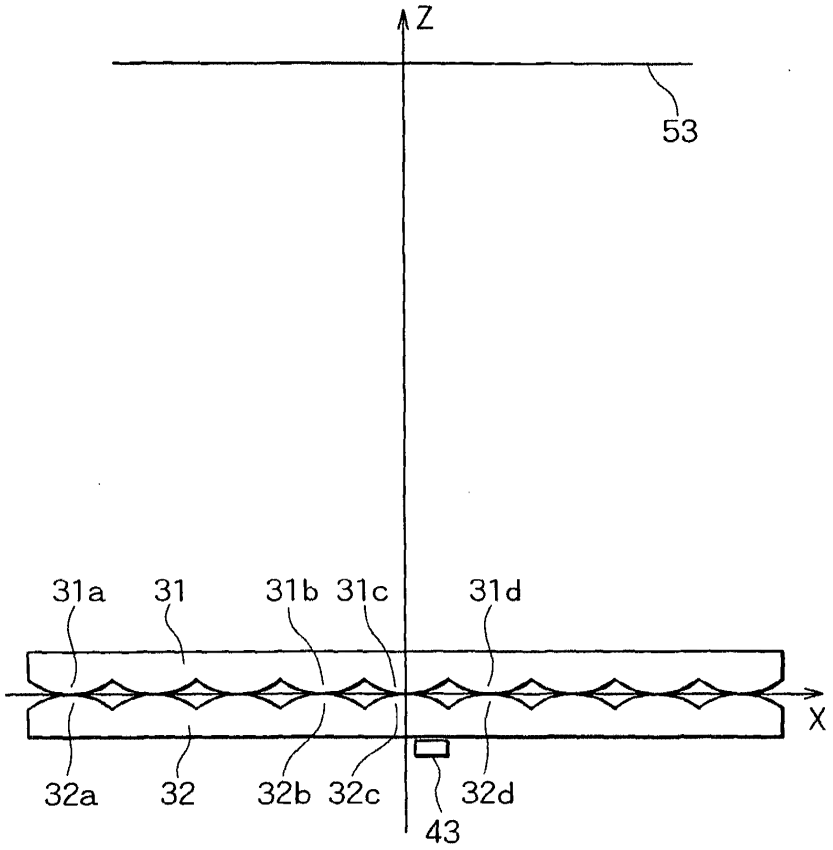
Microsoft Exhibit 1002 - Page 980
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.8



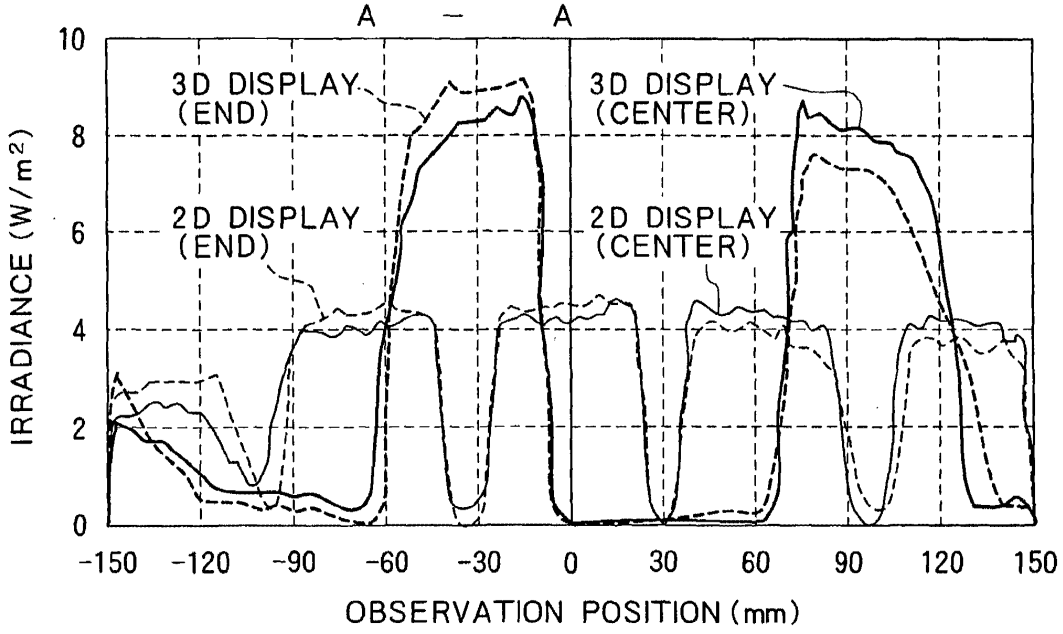
Microsoft Exhibit 1002 - Page 981
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.9



Microsoft Exhibit 1002 - Page 982
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

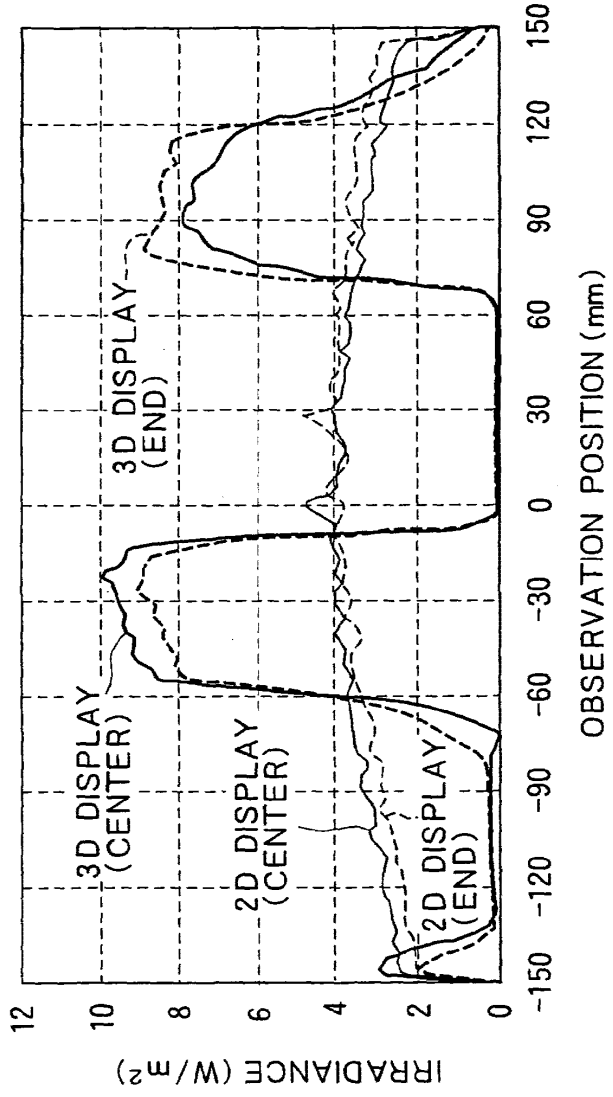
FIG.10



EP 1 394 593 A1

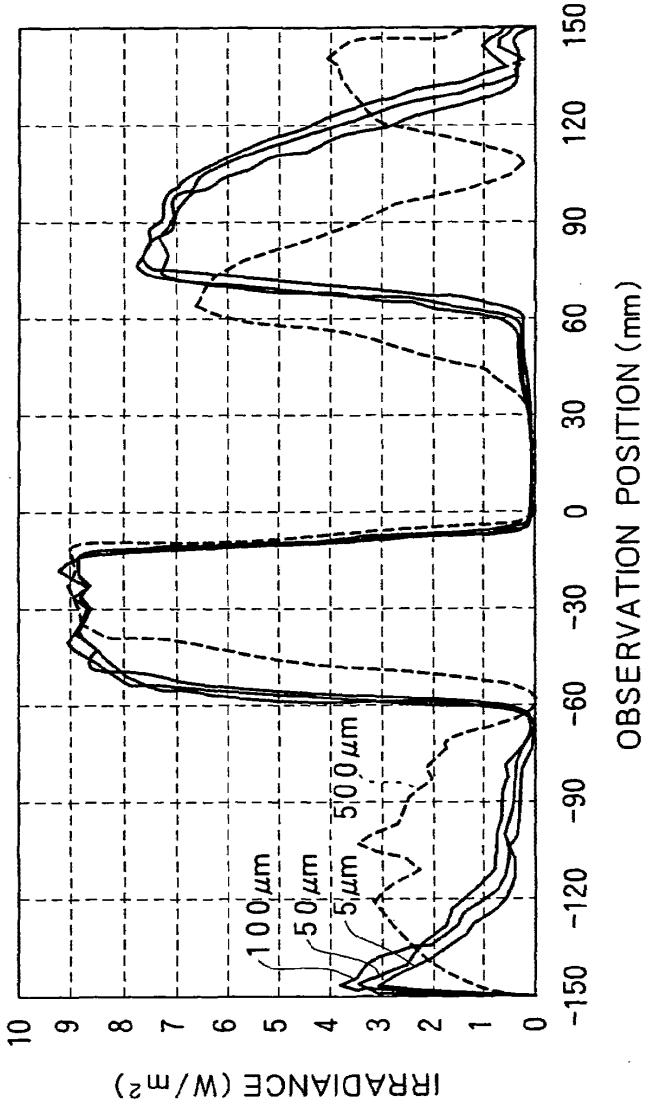
Microsoft Exhibit 1002 - Page 983
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 11



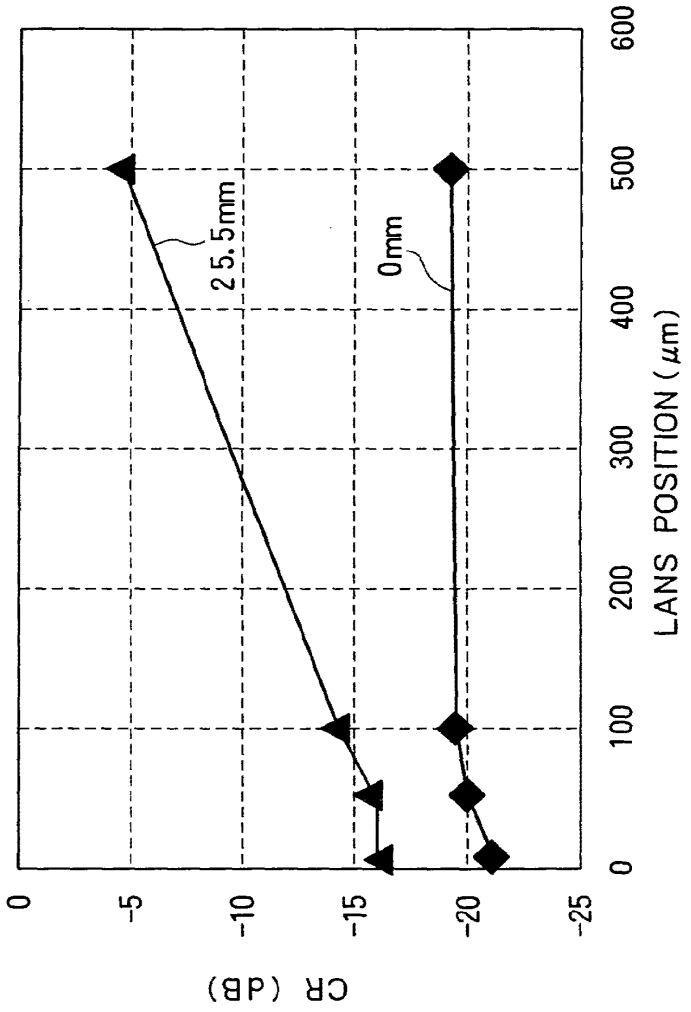
Microsoft Exhibit 1002 - Page 984
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 12



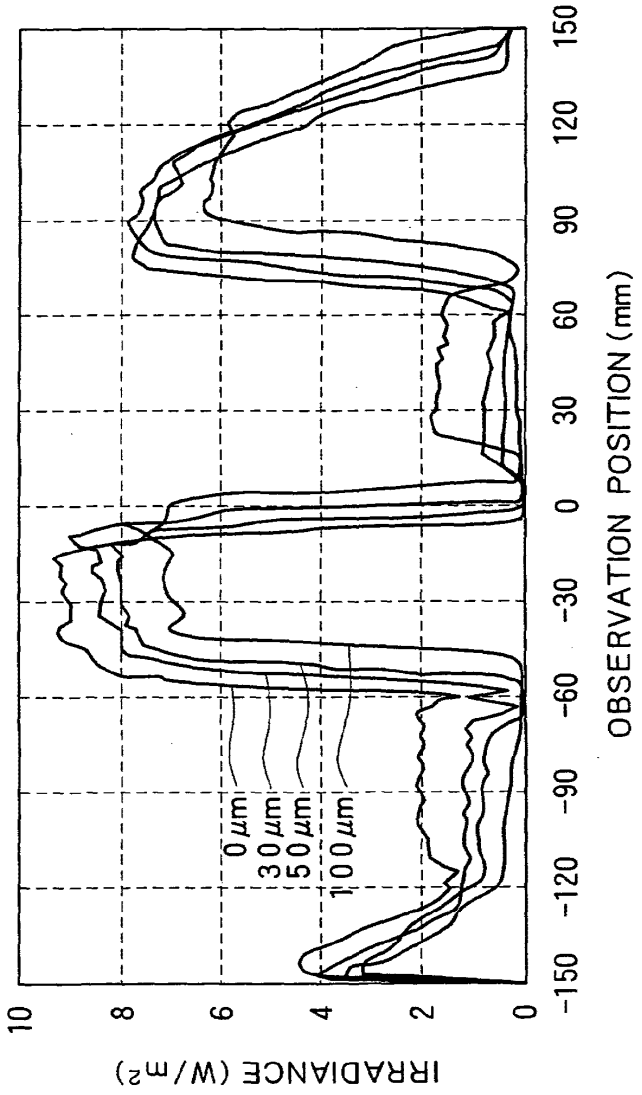
Microsoft Exhibit 1002 - Page 985
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 13



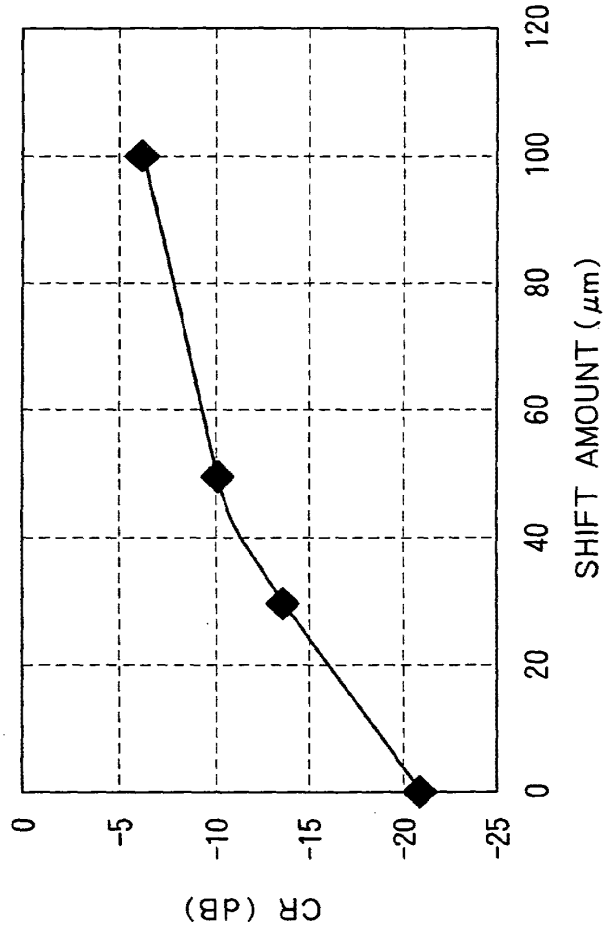
Microsoft Exhibit 1002 - Page 986
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 14



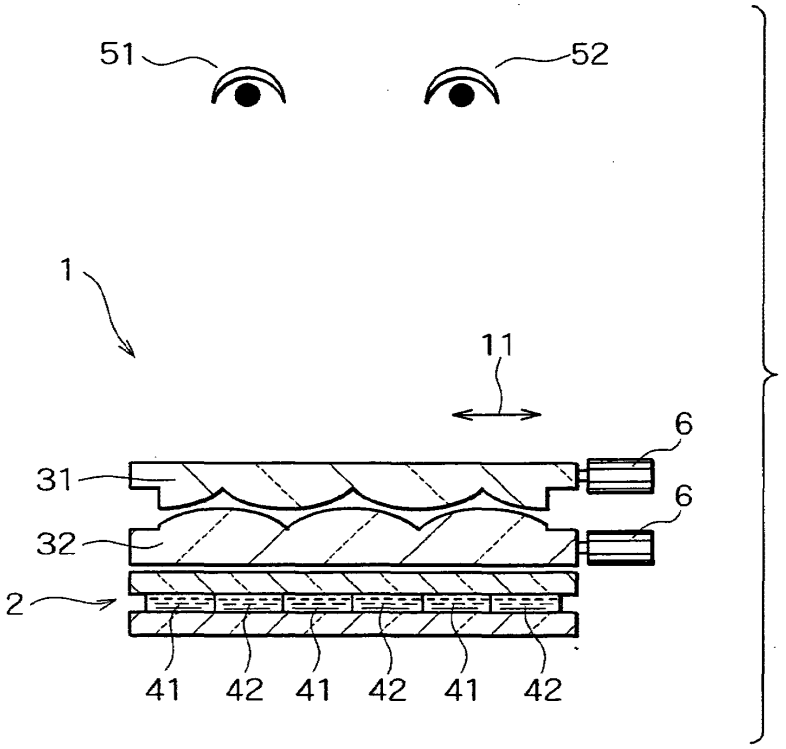
Microsoft Exhibit 1002 - Page 987
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 15



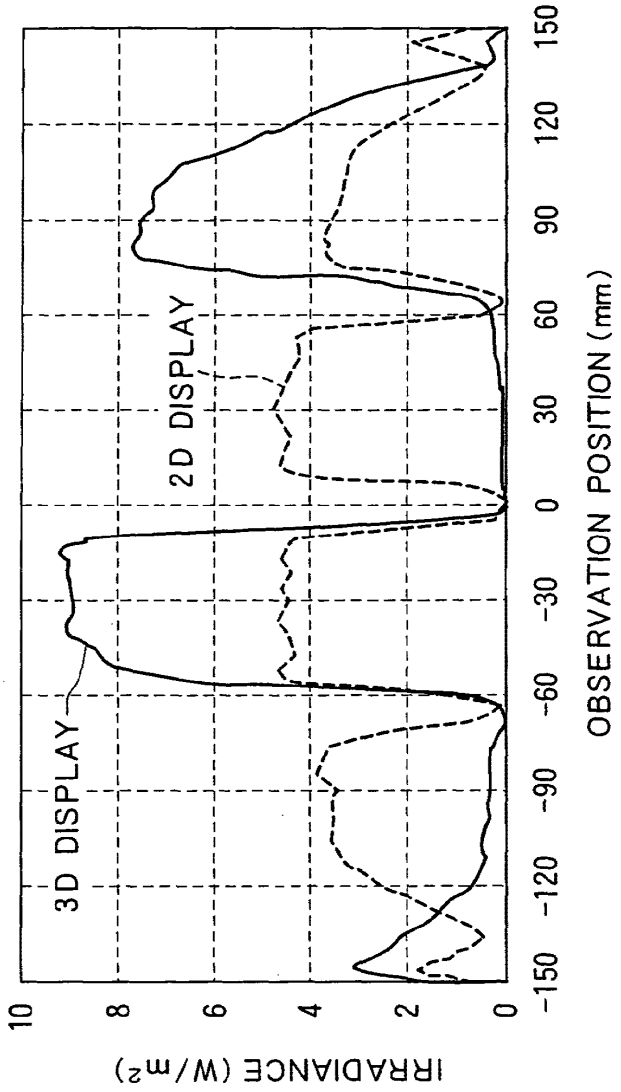
Microsoft Exhibit 1002 - Page 988
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 16



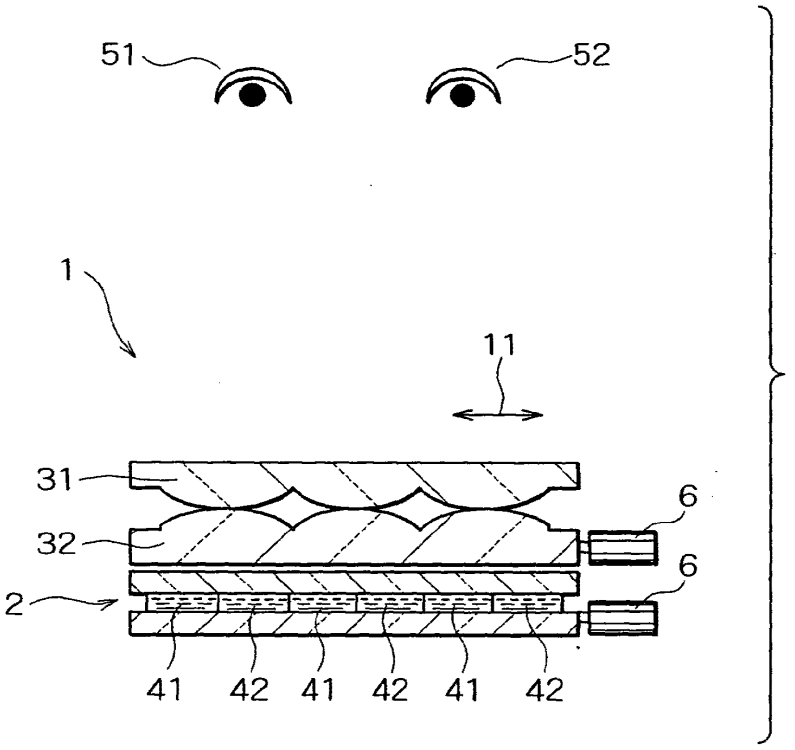
Microsoft Exhibit 1002 - Page 989
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 17



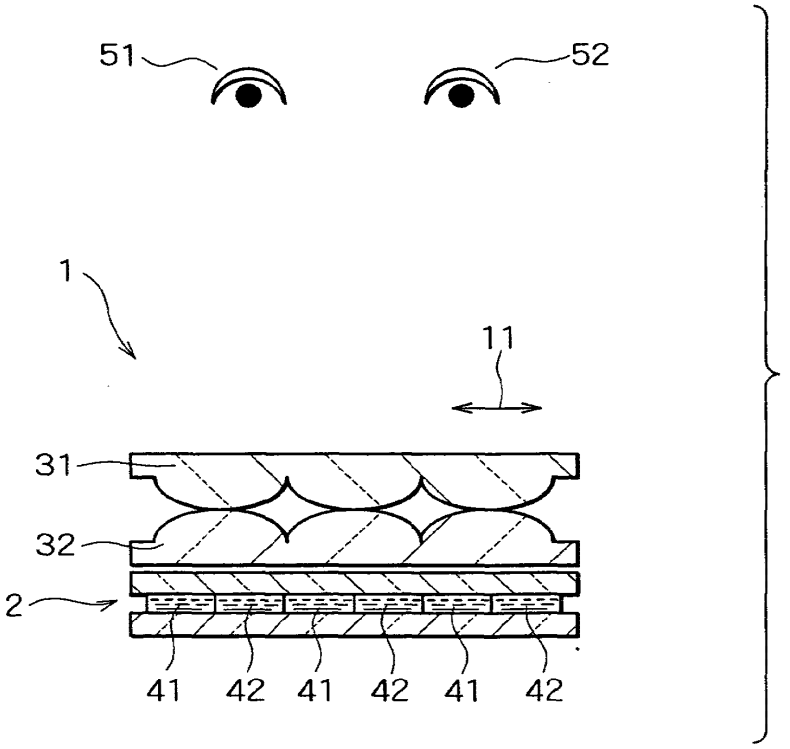
Microsoft Exhibit 1002 - Page 990
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 18



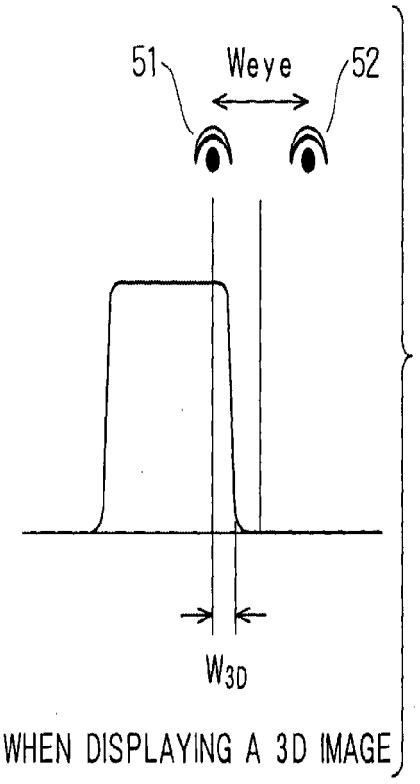
Microsoft Exhibit 1002 - Page 991
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 19



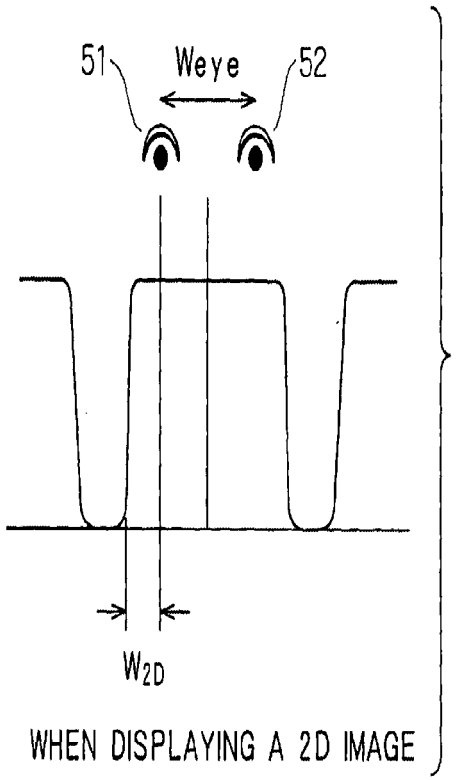
Microsoft Exhibit 1002 - Page 992
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 20A



WHEN DISPLAYING A 3D IMAGE

FIG. 20B

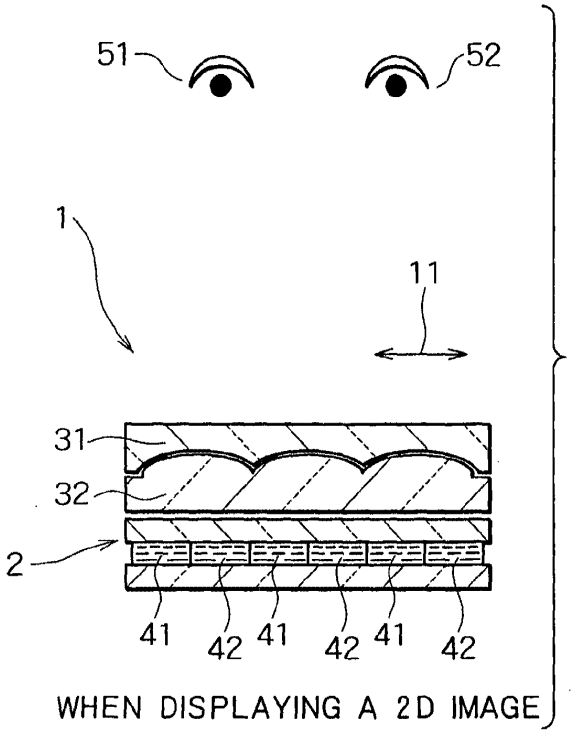


WHEN DISPLAYING A 2D IMAGE

50

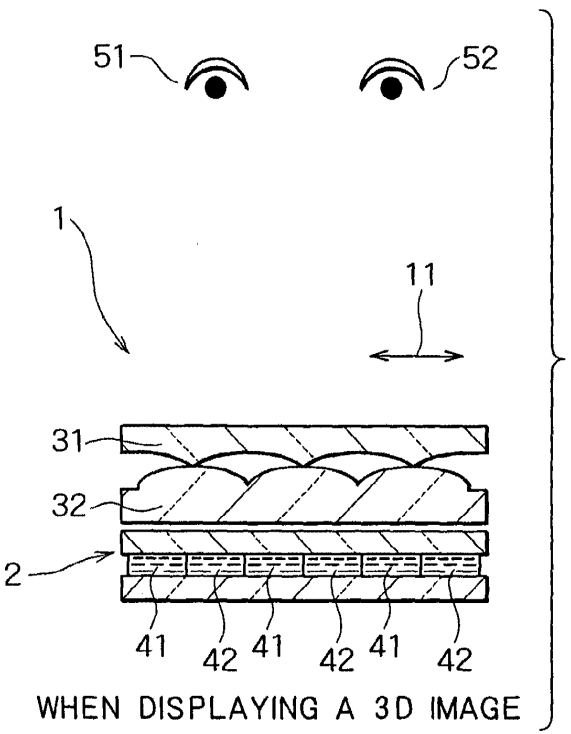
Microsoft Exhibit 1002 - Page 993
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 21A



WHEN DISPLAYING A 2D IMAGE

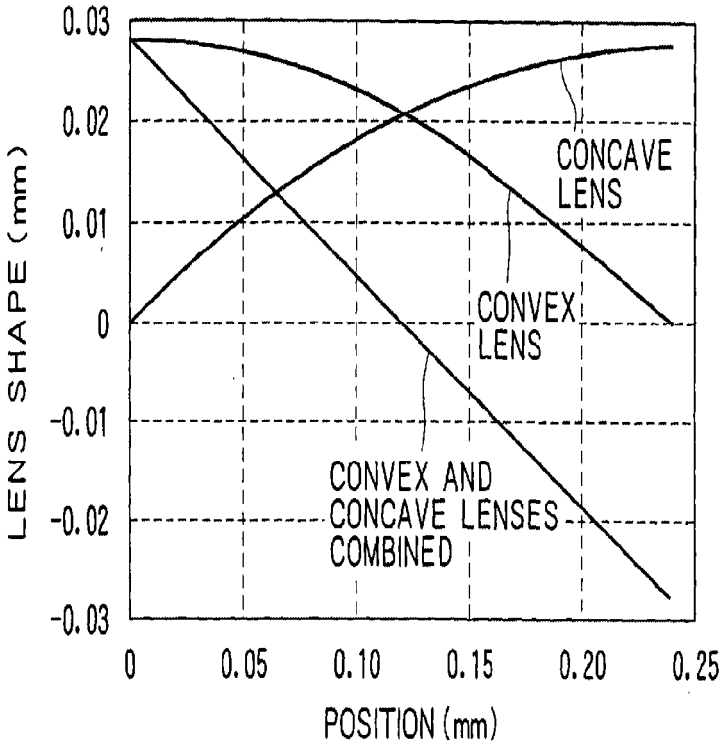
FIG. 21B



WHEN DISPLAYING A 3D IMAGE

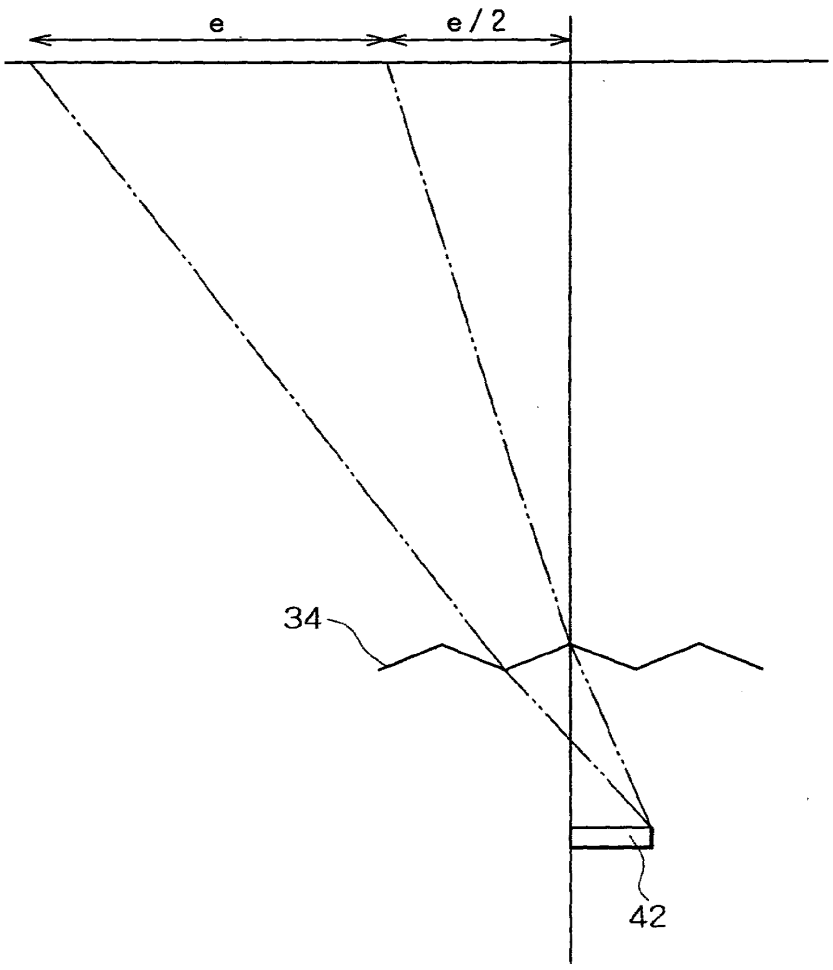
Microsoft Exhibit 1002 - Page 994
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 22



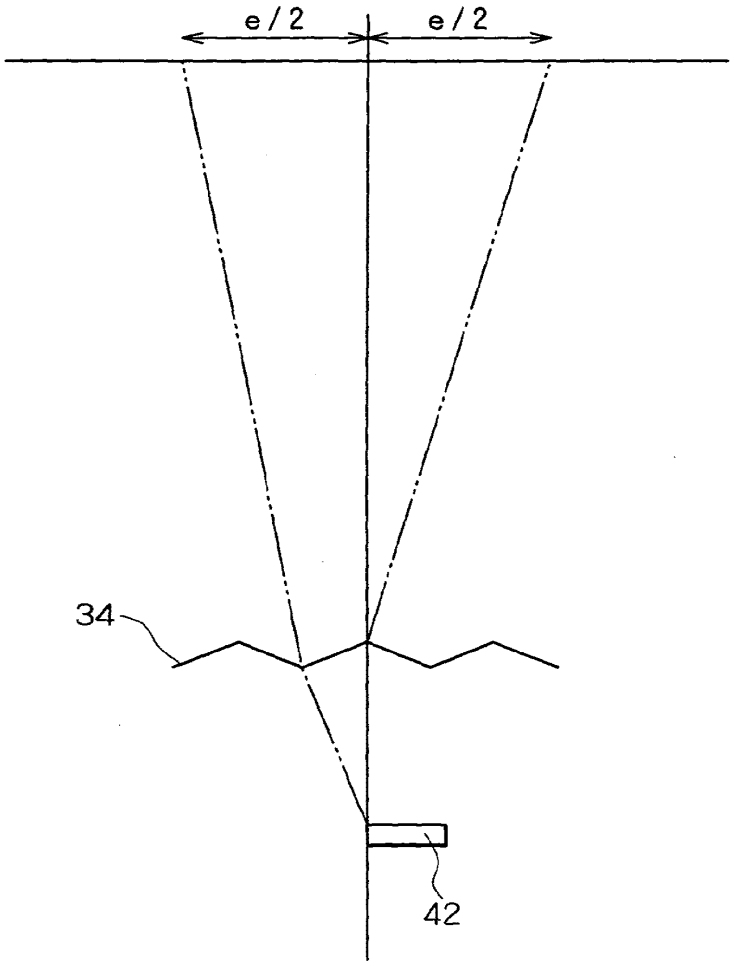
Microsoft Exhibit 1002 - Page 995
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 23



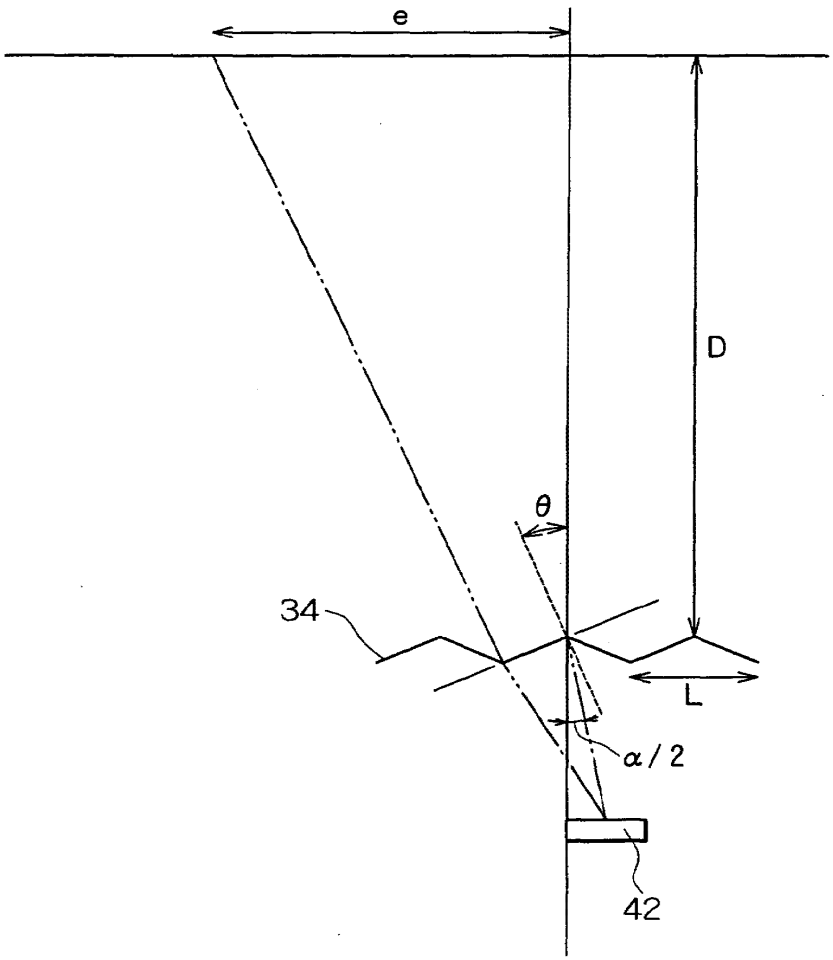
Microsoft Exhibit 1002 - Page 996
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 24



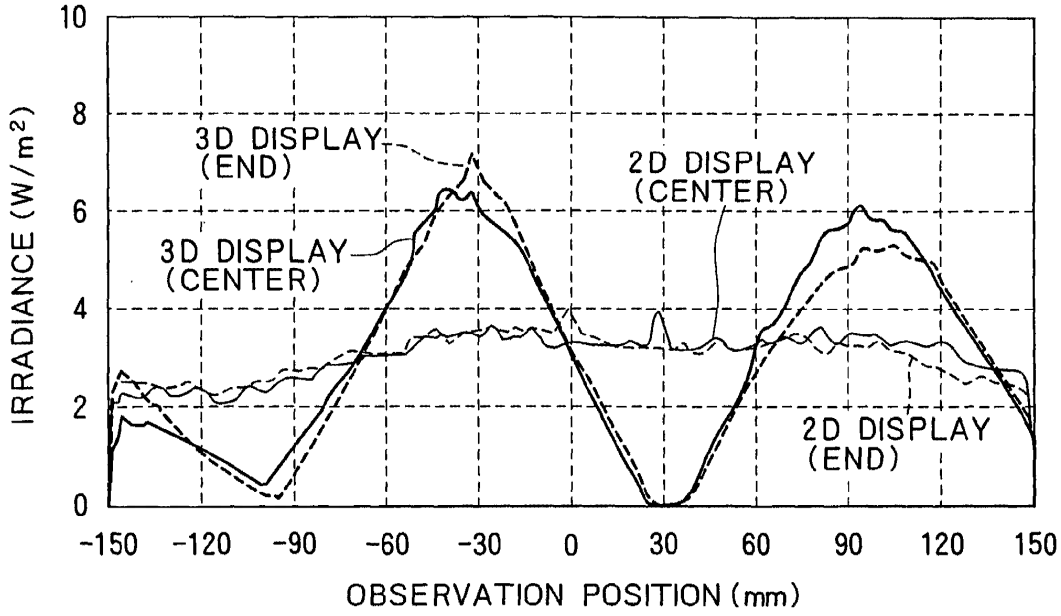
Microsoft Exhibit 1002 - Page 997
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 25



Microsoft Exhibit 1002 - Page 998
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 26



Microsoft Exhibit 1002 - Page 999
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 27A

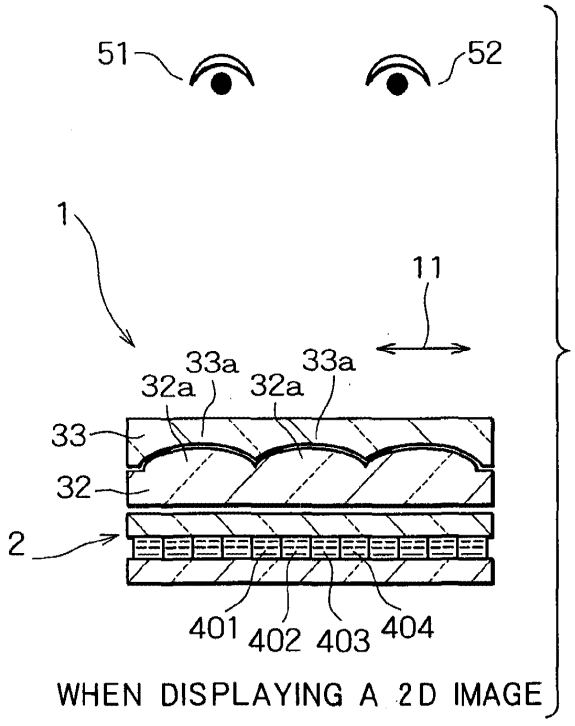
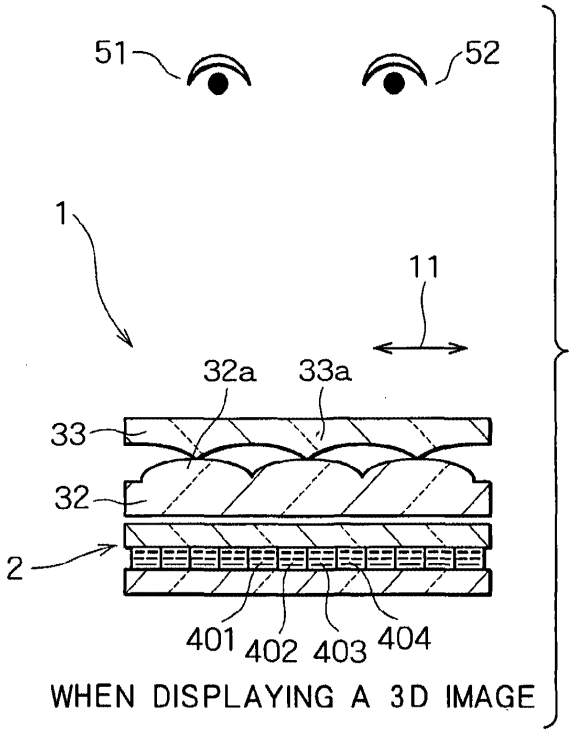


FIG. 27B



Microsoft Exhibit 1002 - Page 1000
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 28A

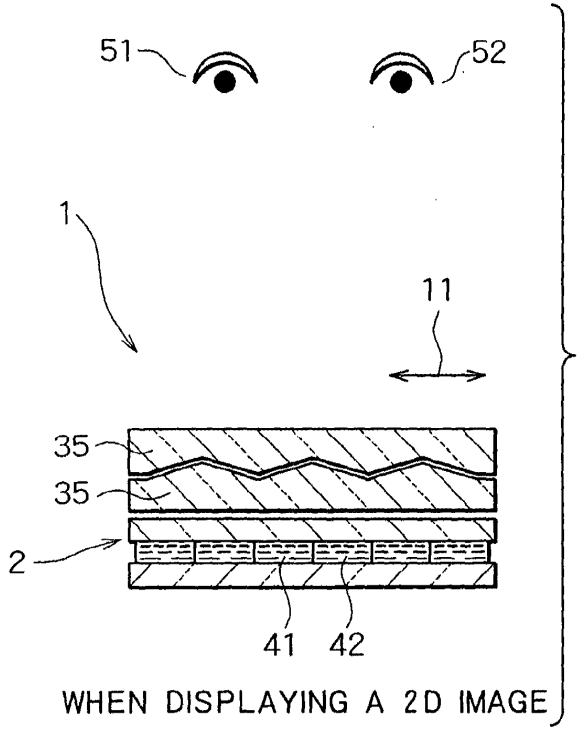
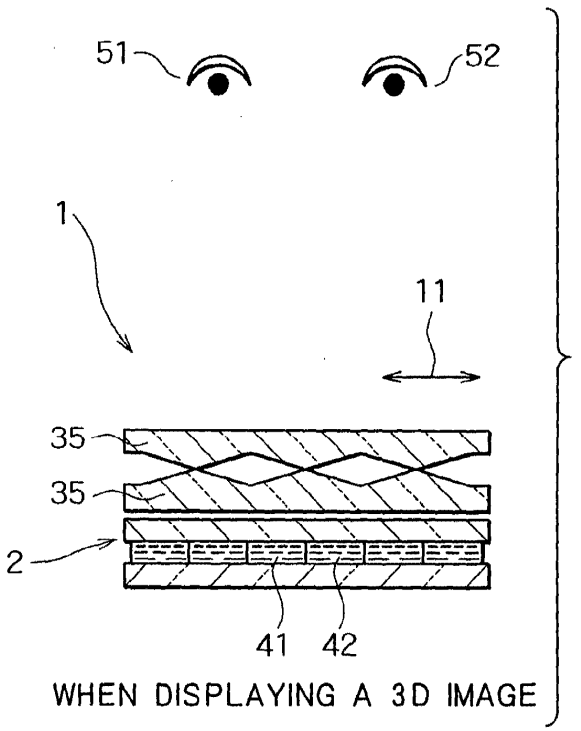
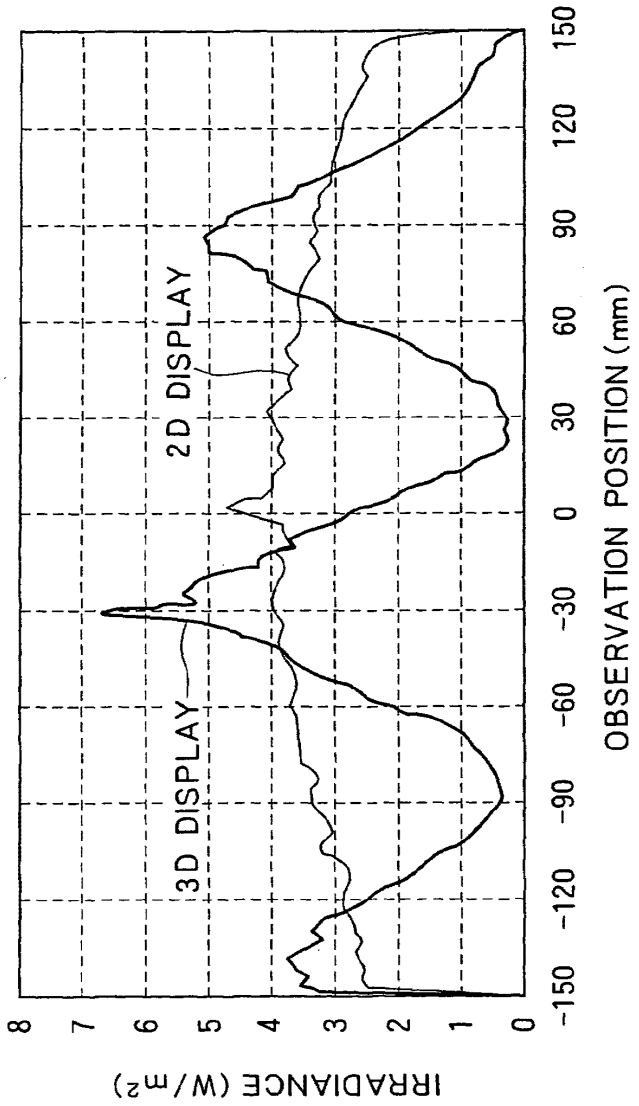


FIG. 28B



Microsoft Exhibit 1002 - Page 1001
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 29



Microsoft Exhibit 1002 - Page 1002
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 30A

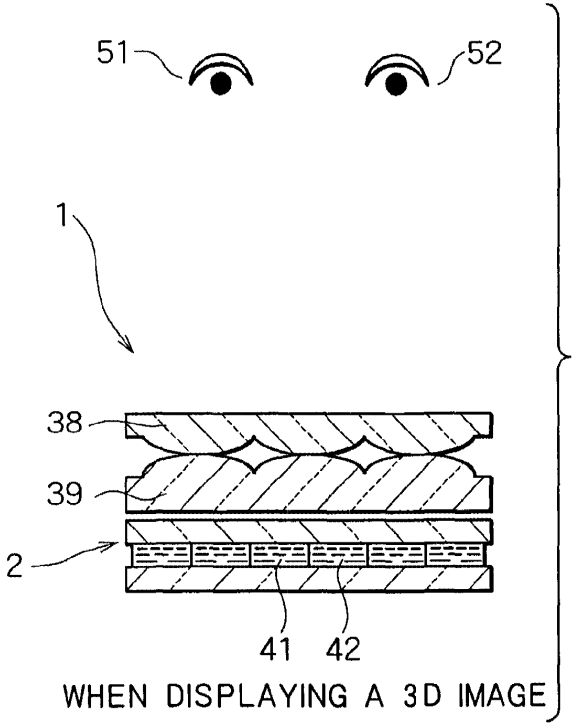
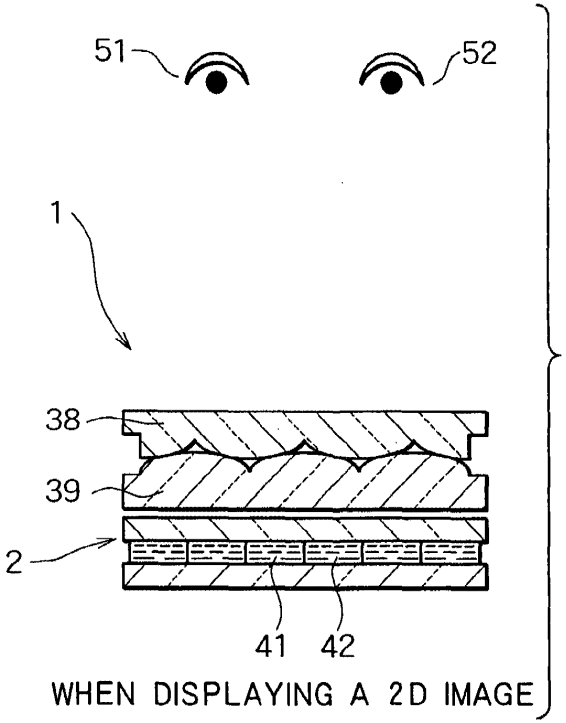
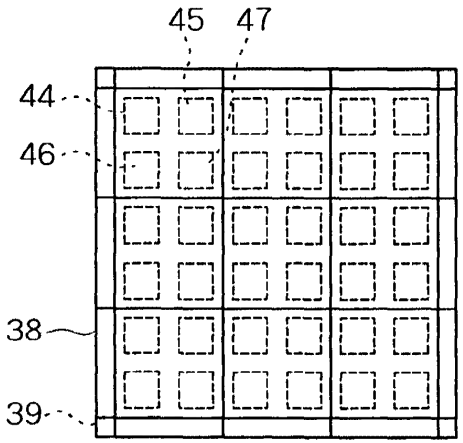


FIG. 30B



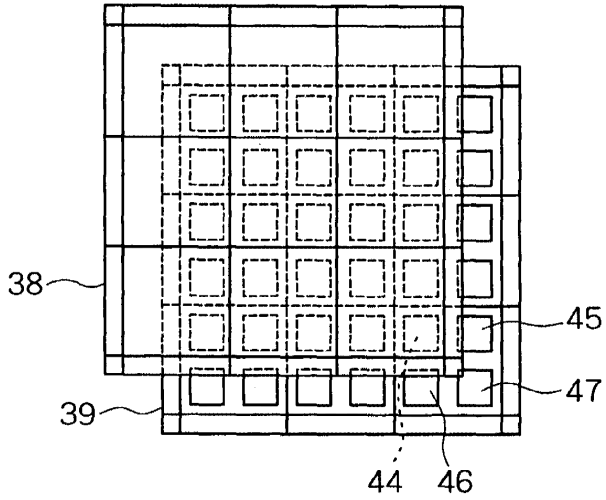
Microsoft Exhibit 1002 - Page 1003
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.31A



WHEN DISPLAYING A 3D IMAGE

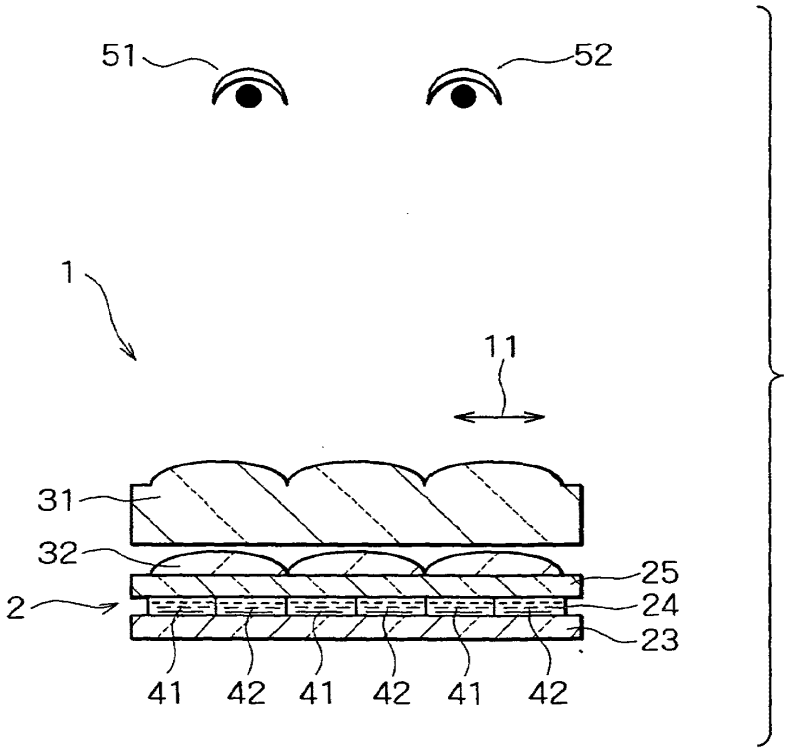
FIG.31B



WHEN DISPLAYING A 2D IMAGE

Microsoft Exhibit 1002 - Page 1004
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 32



Microsoft Exhibit 1002 - Page 1005
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.33

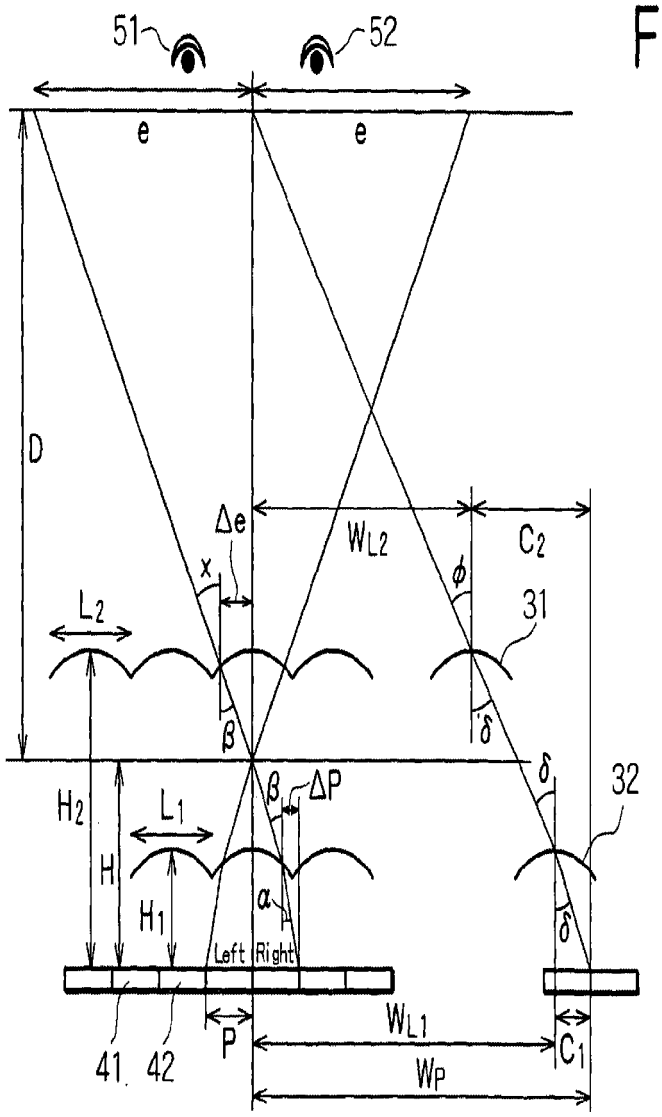
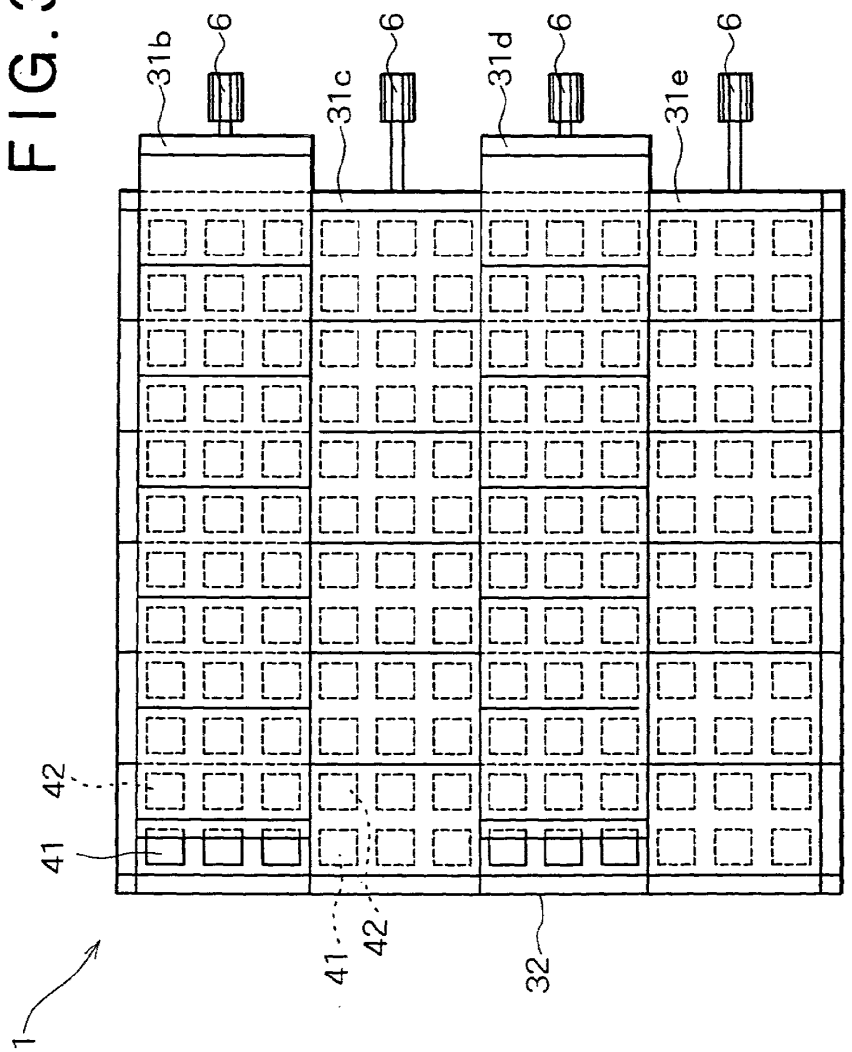
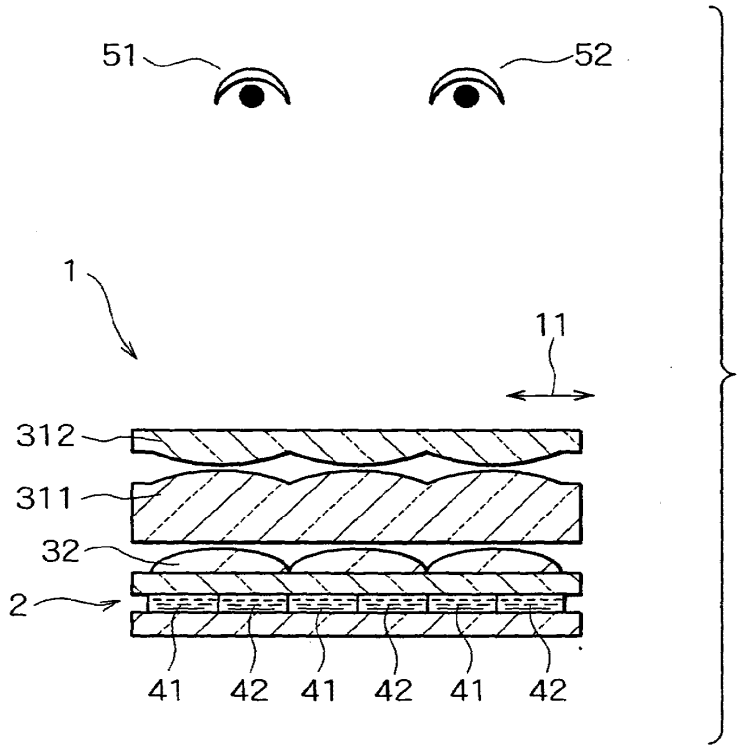

51
52
e
e
D
Δe
W_{L2}
C_2
x
φ
L_2
31
β
δ
δ
32
H_2
L_1
β
ΔP
H
H_1
α
Left
Right
δ
41
42
P
W_{L1}
C_1
W_P

FIG. 34



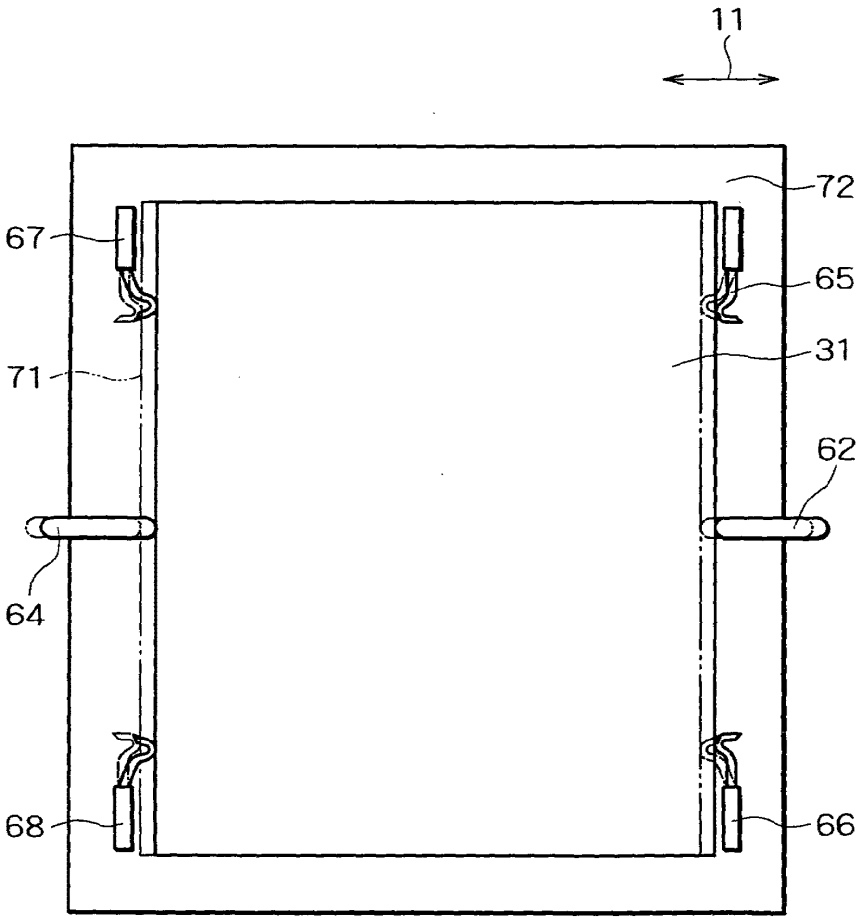
Microsoft Exhibit 1002 - Page 1007
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 35



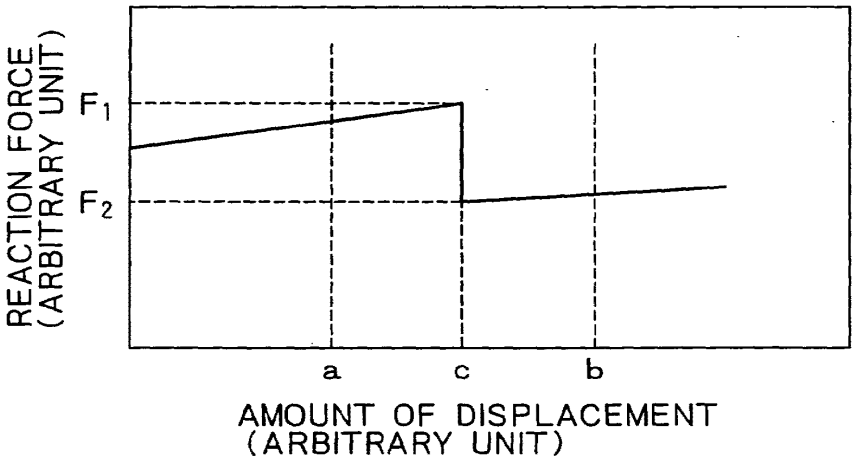
Microsoft Exhibit 1002 - Page 1008
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 36



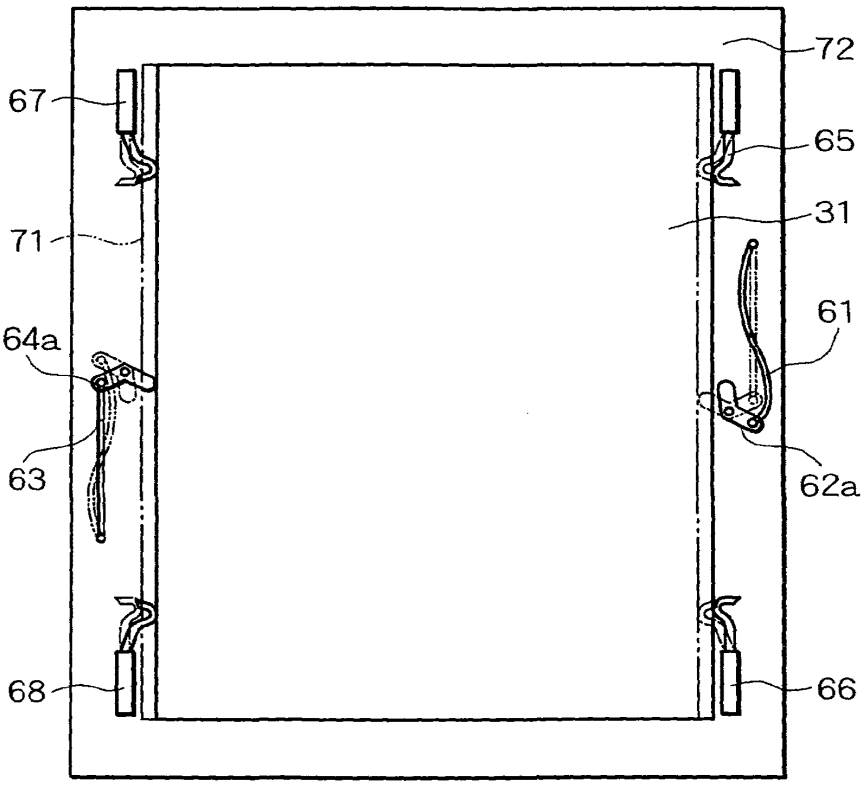
Microsoft Exhibit 1002 - Page 1009
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 37



Microsoft Exhibit 1002 - Page 1010
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 38



Microsoft Exhibit 1002 - Page 1011
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 01 9284

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 26, 1 July 2002 (2002-07-01) -& JP 2001 258051 A (MIXED REALITY SYSTEMS LABORATORY INC), 21 September 2001 (2001-09-21)	1	G02B27/22 H04N13/00
A	* abstract; figures 1,2,4,5 *	2-35	
X	EP 0 829 744 A (SHARP KK) 18 March 1998 (1998-03-18)	1	
A	* column 18, line 45; figure 12 *	2-35	
A	US 5 825 541 A (IMAI MASAO) 20 October 1998 (1998-10-20) * column 7, line 7 - column 8, line 33; figure 3 *	1-35	
A	US 5 500 765 A (EICHENLAUB JESSE B) 19 March 1996 (1996-03-19) * column 4, line 44 - column 5, line 64; figures 1,2 *	1-35	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	US 5 982 342 A (IWATA SATOSHI ET AL) 9 November 1999 (1999-11-09) * column 19, line 19 - line 53; figure 38 *	1	G02B H04N
A	US 6 157 242 A (FUKUI HARUYASU) 5 December 2000 (2000-12-05) * column 3, line 29 - column 4, line 11 *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	8 December 2003	Rödig, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

FPO FORM 1503 03.82 (P04C01)

Microsoft Exhibit 1002 - Page 1012
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 03 01 9284

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

08-12-2003

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2001258051 A	21-09-2001	NONE	
EP 0829744 A	18-03-1998	GB 2317291 A	18-03-1998
		GB 2321815 A	05-08-1998
		EP 0829743 A2	18-03-1998
		EP 0829744 A2	18-03-1998
		GB 2317295 A	18-03-1998
		JP 3401167 B2	28-04-2003
		JP 10115800 A	06-05-1998
		JP 3452472 B2	29-09-2003
		JP 10123461 A	15-05-1998
		JP 2003177357 A	27-06-2003
		US 2002001128 A1	03-01-2002
		US 6377295 B1	23-04-2002
		US 6046849 A	04-04-2000
		EP 0860728 A1	26-08-1998
		JP 10229567 A	25-08-1998
		JP 2003262827 A	19-09-2003
		US 6055013 A	25-04-2000
US 5825541 A	20-10-1998	JP 2778543 B2	23-07-1998
		JP 9043540 A	14-02-1997
US 5500765 A	19-03-1996	NONE	
US 5982342 A	09-11-1999	JP 10056654 A	24-02-1998
		GB 2316256 A ,B	18-02-1998
US 6157242 A	05-12-2000	JP 11273379 A	08-10-1999

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

Microsoft Exhibit 1002 - Page 1013
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 219 067 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
18.08.2010 Bulletin 2010/33

(51) Int Cl.:
G02F 1/13357 *(2006.01)* ***H05K 1/02*** *(2006.01)*
H01L 33/64 *(2010.01)*

(21) Application number: **10153104.4**

(22) Date of filing: **09.02.2010**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
AL BA RS

(30) Priority: **12.02.2009 KR 20090011382**

(71) Applicant: **LG Innotek Co., Ltd.**
Seoul 150-721 (KR)

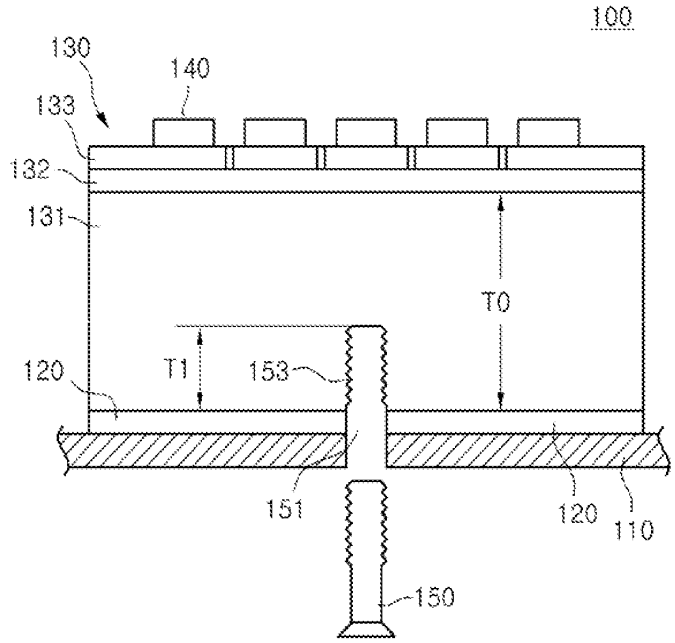
(72) Inventor: **Park, Sang Jae**
Gwangju (KR)

(74) Representative: **Cabinet Plasseraud et al**
52, rue de la Victoire
75440 Paris Cedex 09 (FR)

(54) A backlight unit comprising a light emitting diode on a module substrate, a device comprising said unit

(57) A device and a backlight unit (100,200) includes a bottom cover (110,210); a module substrate (130,230) on the bottom cover (110,210); at least one light emitting diode (140,240) on the module substrate (130,230); and a fastening unit (150,250) fastening the module substrate (130,230) to the bottom cover (110,210).

FIG.1



EP 2 219 067 A1

Printed by Jouve, 75001 PARIS (FR)

Microsoft Exhibit 1002 - Page 1014
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Description

[0001] With the development of the electronic industries, various display devices having various sizes with low energy consumption have been developed. A liquid crystal display (LCD) has been developed for the purpose of extensively being used as a display device for a monitor, a television, and a mobile communication terminal.

[0002] Since the LCD itself does not emit light, the LCD includes a backlight unit as a light source for supplying light from a rear side of an LCD panel. The backlight unit generates white light so that images displayed on the LCD panel may have colors substantially identical to original colors of the image.

[0003] The embodiment provides a backlight unit capable of preventing a position or a shape of a module substrate from being changed or deformed by fastening the module substrate, on which a light emitting diode is packaged, closely to a bottom cover.

[0004] In addition, the embodiment provides a backlight unit capable of efficiently dissipating heat generated during operation of the light emitting diode.

[0005] FIG. 1 is a sectional view showing a backlight unit according to the first embodiment; and

[0006] FIG. 2 is a sectional view showing a backlight unit according to the second embodiment.

[0007] Hereinafter, a backlight unit according to the embodiments will be described in detail with reference to accompanying drawings.

[0008] FIG. 1 is a sectional view showing the backlight unit according to the first embodiment.

[0009] Referring to FIG. 1, the backlight unit 100 includes a bottom cover 110 that can protect internal components of the backlight unit 100 from external impact, a module substrate 130 on the bottom cover 110, and one or more light emitting diodes 140 on the module substrate 130.

[0010] A thermal pad 120 is positioned between the bottom cover 110 and the module substrate 130 to dissipate heat generated during operation of the light emitting diode 140.

[0011] A fastening unit 150 is coupled to the module substrate 130 which passes through the bottom cover 110. The fastening unit 150 fastens the module substrate 130 closely to the bottom cover 110, so that the module substrate 130 can be prevented from being deformed by heat. In addition, since a part of the fastening unit 150 is exposed to the outside, the fastening unit 150 may effectively dissipate heat of the module substrate 130.

[0012] The fastening unit 150 will be described later in more detail.

[0013] Meanwhile, the bottom cover 110 may have a recess to receive the module substrate 130, and an optical sheet and a display panel may be aligned with the bottom cover 110.

[0014] The bottom cover 110 not only protects the module substrate 130 from external impact, but also serves as a heat sink. The bottom cover 110 may include aluminum (Al), magnesium (Mg), zinc (Zn), titanium (Ti), tantalum (Ta), hafnium (Hf) or niobium (Nb), but the embodiment is not limited thereto.

[0015] The thermal pad 120 interposed between the module substrate 130 and the bottom cover 110 may include silicon and may be attached to the bottom cover 110 or the module substrate 130 to dissipate heat generated from the module substrate 130.

[0016] For instance, the thermal pad 120 is made of material having superior thermal conductivity to transfer the heat generated from the module substrate 130 to the bottom cover 110.

[0017] In addition, the thermal pad 120 may have a function of absorbing external impact such that the external impact can be prevented from being transferred to the module substrate 130 and the light emitting diode 140.

[0018] The module substrate 130 may be a printed circuit board (PCB) used to drive the light emitting diode 140, and includes an electric conductive layer 131, an insulating layer 132 and a metal plate 133. The electric conductive layer 131 includes aluminum having thickness of about 0. 6mm to 1.0mm. The thickness T0 of the electric conductive layer 131 can be changed by taking into consideration the heat dissipation efficiency for the heat generated by the light emitting diode 140.

[0019] The insulating layer 132 is provided to electrically insulate the electric conductive layer 131 from the metal plate 133.

[0020] In addition, the metal plate 133 can be prepared as a circuit pattern and the light emitting diode 140 is mounted on the metal plate 133 to emit light. A plurality of light emitting diodes 140 can be provided in the form of an array. For instance, plural light emitting diodes 140 can be mounted on the metal plate 133 in the form of a chip or a package.

[0021] The shape or position of the module substrate 130 may deform or change due to the heat generated during the operation of the light emitting diode 140. If the shape of the module substrate 130 is deformed, quantity of light transferred to the display panel from the light emitting diode 140 may vary, thereby causing problems, such as hot spot.

[0022] In order to dissipate heat of the module substrate 130, the module substrate 130 adheres closely to the bottom cover 110, so that the heat transfer efficiency can be improved. In addition, since the thermal pad 120 is interposed between the module substrate 130 and the bottom cover 110, the heat dissipation efficiency can be improved.

[0023] In order to fasten the module substrate 130 closely to the bottom cover 110, the fastening unit 150 extends by passing through the bottom cover 110. One end of the fastening unit 150 is positioned in the electric conductive layer 131. Due to the fastening unit 150, the module substrate 130 may adhere closely to the bottom cover 110, and the heat of the module substrate 130 can be effectively dissipated. To this end, the fastening unit

Microsoft Exhibit 1002 - Page 1015
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

150 may include a screw. In addition to the screw, the fastening unit 150 may include a hook, a link or forceps. For example, after forming a hole in the electric conductive layer, the hook, the link or the forceps is inserted into the hole to fasten the bottom cover 110 closely to the electric conductive layer 131.

[0024] Due to the fastening unit, the heat dissipation efficiency of the module substrate 130 can be improved without changing the structure of the backlight unit.

[0025] In the following description, the screw will be adopted as the fastening unit 150 for the purpose of convenience of explanation.

[0026] At least one fastening hole 151 is formed through the bottom cover 110, the thermal pad 120 and a lower portion of the electric conductive layer 131. The fastening hole 151 can be formed by laser processing, mechanical drilling or hot embossing.

[0027] A female screw 153 corresponding to the screw 150 is formed at an inner wall of the fastening hole 151 formed in the electric conductive layer 131. The fastening hole 151 formed in the electric conductive layer 131 may have depth T1 corresponding to 1/3 to 2/3 of thickness T0 of the electric conductive layer 131 such that the fastening hole 151 can be spaced apart from the metal plate 133 by a predetermined distance.

[0028] In addition, one end of the screw 150 serving as the fastening unit has a diameter larger than a diameter of the fastening hole 151 such that the one end of the screw 150 may be blocked by the bottom cover 110 when the screw 150 has been inserted into the fastening hole 151.

[0029] If the screw 150 is screwed into the fastening hole 151, the electric conductive layer 131 is biased toward the bottom cover 110, so that the electric conductive layer 131 is fixed to the bottom cover 110.

[0030] At this time, an insertion depth of the screw 150 can be adjusted by adjusting the depth T1 of the fastening hole 151. Preferably, the depth T1 of the fastening hole 151 is set such that the screw 150 does not electrically connect with the metal plate 133.

[0031] Since the module substrate 130 is fixedly fastened to the bottom cover 110, variation of the module substrate 130, such as delamination or twist, can be prevented so that variation of light quantity and hot spot can be reduced. In addition, since the module substrate 130 is fastened closely to the bottom cover 110, the heat dissipation efficiency can be improved.

[0032] FIG. 2 is a sectional view showing a backlight unit according to the second embodiment. The second embodiment will be described with reference to the first embodiment and the description about the same elements will be omitted in order to avoid redundancy.

[0033] Referring to FIG. 2, the backlight unit 200 includes a module substrate 230 having a plurality of electric conductive layers 2311 and 2312 and a plurality of insulating layers 232 and 234.

[0034] That is, the module substrate 230 includes a first electric conductive layer 2311, which is positioned at the bottom of the module substrate 230, a first insulating layer 232, a second electric conductive layer 2312, a second insulating layer 234 and a metal plate 233.

[0035] The first electric conductive layer 2311 makes contact with the thermal pad 220. The first insulating layer 232 includes insulating material for insulating between the first and second electric conductive layers 2311 and 2312 and the second insulating layer 234 is aligned on the second electric conductive layer 2312.

[0036] The first and second electric conductive layers 2311 and 2312 may include aluminum and the first insulating layer 232 is interposed between the first and second electric conductive layers 2311 and 2312. It should be noted that plural second electric conductive layers 2312 and second insulating layers 234 can be provided while being alternately stacked on each other, but the embodiment is not limited thereto.

[0037] The fastening hole 251 extends through the bottom cover 210, the thermal pad 220 and the first electric conductive layer 2311.

[0038] According to the second embodiment, a screw 250 is provided as a fastening unit to fasten the first electric conductive layer 2311 closely to the bottom cover 210. A fastening hole 251 for the screw 250 is formed in the first electric conductive layer 2311.

[0039] The fastening hole 251 is formed through the whole thickness T2 of the first electric conductive layer 2311, and a female screw 253, which corresponds to the screw 250, is formed in the first electric conductive layer 2311 such that the screw 250 can be fastened within the first electric conductive layer 2311. The first electric conductive layer 2311 may have thickness T2 in the range of about 0.6mm to 1.0mm.

[0040] The screw 250 is inserted into the fastening hole 251 of the bottom cover 210 and the thermal pad 220, and then fixedly fastened in the fastening hole 251 of the first electric conductive layer 2311 due to engagement between the screw 250 and the female screw 253. Thus, the bottom cover 210, the thermal pad 220 and the first electric conductive layer 2311 are integrally fastened by the screw 250, thereby fixing the module substrate 230. In addition, when the screw 250 is fastened, the first insulating layer 232 aligned on the first electric conductive layer 2311 can prevent the error during fastening.

[0041] Embodiments of the backlight unit have been described. A device having a liquid crystal display (LCD) where the LCD includes a backlight unit and an LCD panel are well known and will not be further described. The device may be a monitor, a television, and a mobile communication terminal.

[0042] Any reference in this specification to "one embodiment," "an embodiment," "example embodiment," etc., means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature,

Microsoft Exhibit 1002 - Page 1016
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to effect such feature, structure, or characteristic in connection with other ones of the embodiments.

[0043] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the scopeof this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

Claims

1. A module substrate (130, 230) in a backlight unit (100, 200) comprising at least one light emitting diode (140, 240) on a upper surface of the module substrate wherein the module substrate (130, 230) comprises a fastening blind hole (151, 251) for a fastening unit (150, 250) for attaching the module substrate (130, 230) to the backlight unit (100, 200).

2. The module substrate of claim 1 wherein the module substrate (130, 230) comprises a bottom and an upper surface and wherein the fastening blind hole (151, 251) is located on the bottom surface.

3. The module substrate of claim 2 wherein the fastening blind hole (151, 251) is located under at least one light emitting diode (140, 240).

4. A backlight unit (100, 200) comprising:

   a bottom cover (110, 210);
   the module substrate (130, 230) of any of preceding claims on the bottom cover;

   wherein the fastening unit (150, 250) fastens the module substrate (130, 230) to the bottom cover (110, 210).

5. The backlight unit of claim 4, wherein the bottom cover (110, 210) and the module substrate (130, 230) are formed with a fastening hole (151, 251) into which the fastening unit (150, 250) is inserted.

6. The backlight unit of any of claims 4 or 5, wherein the fastening unit (150, 250) is fixed in the module substrate (130, 230) by passing through the bottom cover (110, 210).

7. The backlight unit of any of claims 4 to 6, wherein the bottom cover (110, 201) is formed with a fastening hole (151, 251) into which the fastening unit (150, 250) is inserted, the fastening unit includes a screw having one end configured to be blocked by the bottom cover when the screw has been inserted into the fastening hole, and a female screw (153, 253) corresponding to the screw is formed in the module substrate to engage with the screw.

8. The backlight unit of any of claims 4 to 7, wherein a thermal pad (120, 220) is positioned between the bottom cover and the module substrate, and the fastening unit is fixed in the module substrate by passing through the bottom cover and the thermal pad.

9. The backlight unit of any of claims 4 to 8, wherein the module substrate includes an electric conductive layer (131) aligned on the bottom cover, an insulating layer (132) aligned on the electric conductive layer, and a metal plate (133) interposed between the insulating layer and the light emitting diode, and the fastening unit is fixed in the electric conductive layer by passing through the bottom cover.

10. The backlight unit of claim 9, wherein the fastening unit is inserted into the electric conductive layer by a depth corresponding to 1/3 to 2/3 of a thickness of the electric conductive layer.

11. The backlight unit of claim 9, wherein the electric conductive layer includes a first electric conductive layer (2311) into which the fastening unit is inserted, and a second electric layer (2312) making contact with the insulating layer.

12. The backlight unit of claim 11, wherein the fastening unit is inserted into the first electric conductive layer through a whole thickness of the first electric conductive layer (2311).

13. The backlight unit of claims 11 or 12, wherein first electric conductive layer has a thickness in a range of 0.6 mm to 1.0 mm.

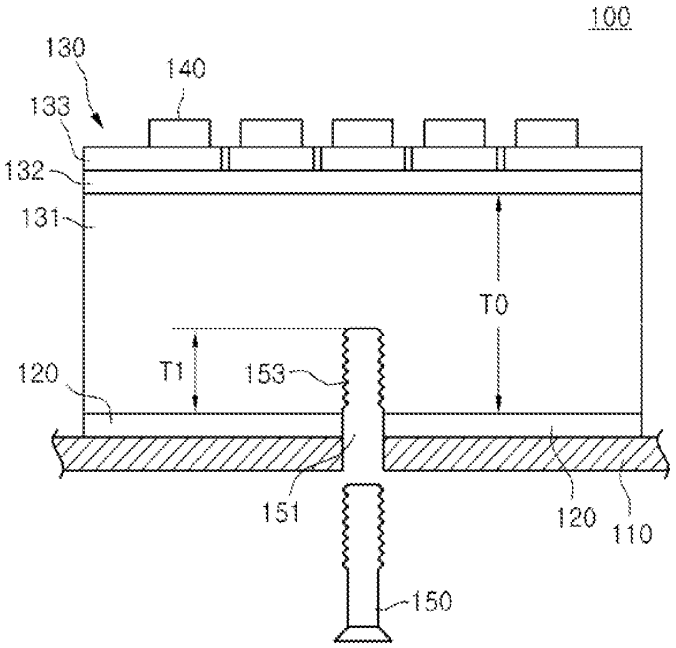
14. A device comprising:

   a liquid crystal display (LCD) panel;
   a backlight unit according to any of claims 4 to 13 aligned with the LCD panel.

15. The device of preceding claim, wherein the device includes one of a monitor, a television, and a mobile communication device.

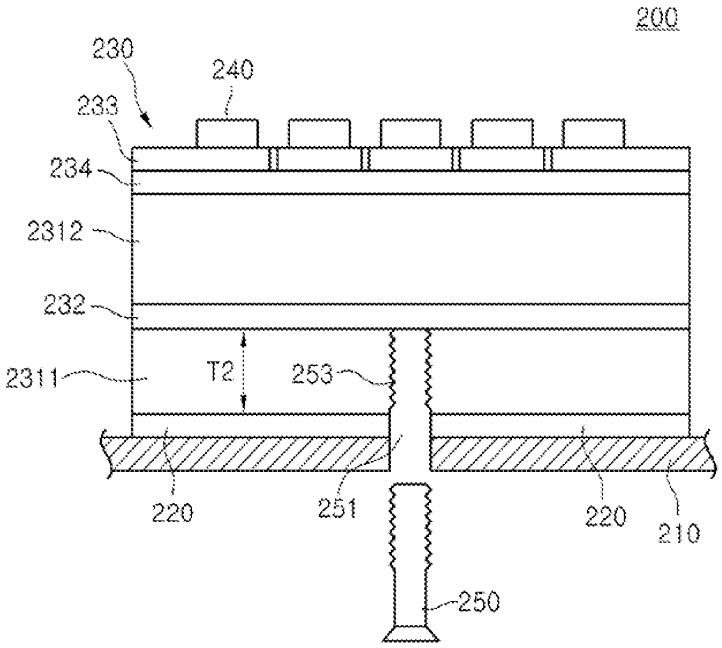
Microsoft Exhibit 1002 - Page 1017
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.1



Microsoft Exhibit 1002 - Page 1018
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG.2



Microsoft Exhibit 1002 - Page 1019
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 10 15 3104

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2008/078587 A1 (SHOWA DENKO KK [JP]; GOMI SHUJI [JP]) 3 July 2008 (2008-07-03) * abstract * * figures 1-7 * * paragraph [0018] - paragraph [0049] * & EP 2 101 360 A1 (SHOWA DENKO KK [JP]) 16 September 2009 (2009-09-16) * abstract * * figures 1-7 * * paragraph [0018] - paragraph [0049] *	1-6,8, 14,15	INV. G02F1/13357 H05K1/02 H01L33/64
X	EP 1 765 764 A1 (SONY CORP [JP]) 16 May 2007 (2007-05-16) * figures 2,5,6 * * paragraph [0031] - paragraph [0036] * * paragraph [0082] - paragraph [0084] * * paragraph [0099] - paragraph [0102] *	1-15	
X,P	US 2009/237916 A1 (PARK JUN SEOK [KR]) 24 September 2009 (2009-09-24) * abstract * * figures 1-3 * * paragraph [0022] - paragraph [0033] * * paragraph [0046] - paragraph [0050] *	1-5,14, 15	

TECHNICAL FIELDS SEARCHED (IPC)

G02F
H05K
H01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 March 2010	Kentischer, Florian

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

Microsoft Exhibit 1002 - Page 1020
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 15 3104

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

29-03-2010

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2008078587 A1	03-07-2008	CN 101563792 A	21-10-2009
		EP 2101360 A1	16-09-2009
		KR 20090093963 A	02-09-2009
EP 1785764 A1	16-05-2007	CN 101044427 A	26-09-2007
		JP 2006058487 A	02-03-2006
		WO 2006019085 A1	23-02-2006
		KR 20070052315 A	21-05-2007
		US 2007211205 A1	13-09-2007
US 2009237916 A1	24-09-2009	WO 2008078896 A1	03-07-2008
		KR 100820516 B1	07-04-2008

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

Microsoft Exhibit 1002 - Page 1021
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 451 180 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
09.05.2012 Bulletin 2012/19

(51) Int Cl.:
H04N 13/04 *(2006.01)*

(21) Application number: **11184866.9**

(22) Date of filing: **12.10.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **05.11.2010 KR 20100109874**

(71) Applicant: **Samsung Electronics Co., Ltd.**
Gyeonggi-do 443-742 (KR)

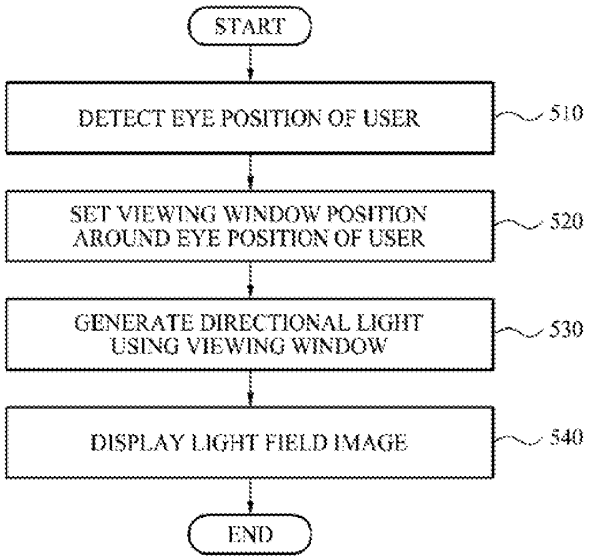
(72) Inventors:
- **Nam, Dong Kyung**
  446-592 Gyeonggi-do (KR)
- **Park, Dong Kyung**
  151-818 Seoul (KR)
- **Hwang, Kyu Young**
  445-735 Gyeonggi-do (KR)
- **Ha, In Woo**
  135-080 Seoul (KR)

(74) Representative: **Jacobs, Bart et al**
Arnold & Siedsma
Sweelinckplein 1
2517 GK Den Haag (NL)

(54) Display apparatus and method

(57) A display apparatus that may generate a high density light field image is provided. The display apparatus may identify an eye position of a user and set a virtual viewing window around the eye of the user. The display apparatus may generate a directional light corresponding to the viewing window and generate a high density light field image.

FIG. 5



EP 2 451 180 A2

Printed by Jouve, 75001 PARIS (FR)

Microsoft Exhibit 1002 - Page 1022
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Description

[0001] This application claims the priority benefit of Korean Patent Application No. 10-2010-0109874, filed on November 5, 2010, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

[0002] One or more example embodiments of the present disclosure relate to a general display such as a TV, a monitor, a display of a portable device, an advertising display, an educational display field, and the like, and more particularly, to a high density light field display apparatus and method for reproducing and displaying a three-dimensional (3D) image without causing fatigue due to 3D viewing.

[0003] A 3D image display apparatus may refer to an image display apparatus that may provide different images reflecting a viewpoint difference in the left eye and the right eye of a human to make a 3D effect.

[0004] A 3D image display apparatus may include a stereoscopic type display providing a left eye viewpoint image and a right eye viewpoint image, and a multi-view image providing an image from more various viewpoints.

[0005] Recently, the 3D image apparatus in the form of eyewear has become common considering marketability such as ease of technical configuration, a unit cost of production, and the like. To alleviate the inconvenience in wearing and keeping 3D eyewear, an interest in a non-eyewear type of the 3D display apparatus has increased.

[0006] When configuring a 3D display, viewing fatigue due to a convergence-accommodation conflict may occur. Research is being carried out to resolve the convergence-accommodation conflict using a light field image display technique, and the like.

[0007] The light field display corresponds to a concept including a widely known integral photography scheme, and the like, which may generate a light field on a space using a sufficient number of directional lights, and may configure a 3D image without a convergence-accommodation conflict occurring.

[0008] However, a full HD (high definition) image content is becoming common. Thus, to provide a high density light field to generate an HD image, resources available in a display apparatus may be insufficient to provide a high density light field to generate an HD image in 3D.

[0009] The foregoing and/or other aspects are achieved by providing a display apparatus including a position sensor to sense an eye position of a user, a controller to set a virtual viewing window corresponding to the eye position of the user, and to provide a control signal generating a directional light toward the viewing window, and a light generator to generate the directional light based on the control signal.

[0010] The display apparatus may include a light modulator to modulate an intensity of the directional light based on the control signal.

[0011] The position sensor may include at least one camera that may photograph the eye position of the user.

[0012] The position sensor may include at least one camera that may identify the eye position of the user by photographing an identifier fixed around the eye position of the user.

[0013] The light generator may include a backlight to generate a non-directional light, a variable slit to convert, based on the control signal, the non-directional light to a plurality of point light sources, each having a different position, and a lens to generate a directional light toward the viewing window by refracting at least a part of the plurality of the point light sources.

[0014] Here, the variable slit may correspond to a plurality of pixels of a liquid crystal display (LCD) panel.

[0015] The controller may include an eye position detector to calculate a coordinate value of the eye position of the user on a space coordinate using the sensed eye position of the user, and a viewing window setting unit to determine at least one of a position of the viewing window and a size of the viewing window to cover the eye of the user using the coordinate value of the eye position of the user.

[0016] The controller may further include a directional light source controller to control a control signal to generate a directional light toward the viewing window, and a light field image generator to provide a control signal to generate a 3D image of a light field scheme by adjusting an intensity of the directional light toward the viewing window.

[0017] The foregoing and/or other aspects are achieved by providing a display method including sensing an eye position of a user, setting a virtual viewing window corresponding to the eye position of the user, and generating a directional light toward the viewing window.

[0018] The display method may further include displaying, on the viewing window, a light field image by controlling the directional light.

[0019] The generating of the directional light may include generating a non-directional light using a backlight, converting, using a variable slit, the non-directional light to a plurality of point light sources, each having a different position, and generating a directional light toward the viewing window by refracting at least a part of the plurality of point light sources using a refracting lens.

[0020] The setting of the virtual viewing window may include calculating a coordinate value of the eye position of the user on a space coordinate using the sensed eye position of the user, and determining, to cover the eye of the user using the coordinate value of the eye position of the user, at least one of a position of the viewing window and a size of the viewing window.

Microsoft Exhibit 1002 - Page 1023
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

[0021] The foregoing and/or other aspects are achieved by providing a display apparatus. The display apparatus includes a position sensor to sense an eye position of a user using at least one of a visible light band camera, an infrared camera, and a depth camera, a controller to set a size of a virtual viewing window and to determine a position of the virtual viewing window based on the eye position of the user and a size of the eye, and to provide a control signal to generate a directional light toward the virtual viewing window, and a light generator including a backlight providing a standard light source, a variable slit to modulate the standard light source to a point light source at a predetermined position, and a lens to generate, based on the control signal, the directional light by refracting the point light source toward the virtual viewing window.

[0022] The foregoing and/or other aspects are achieved by providing a display method. The display method includes continuously tracing a pupil position of an eye of a viewer of a display, dynamically setting a virtual viewing window of the display to correspond to the continuously traced pupil position, and generating an image in the virtual viewing window while not generating an image in portions of the display that do not correspond to the virtual viewing window.

[0023] Additional aspects of embodiments will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the disclosure.

[0024] These and/or other aspects will become apparent and more readily appreciated from the following description of embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1 illustrates a display apparatus according to example embodiments;
FIG. 2 illustrates a diagram to describe a progression of a directional light for generating a viewing window and a high density light field image which are set by a controller of the display apparatus of FIG. 1;
FIG. 3 illustrates a diagram of generating a high density light field image in a viewing window by a light generator and a light modulator of the display apparatus of FIG. 1;
FIG. 4 illustrates a diagram to describe an example of a parameter calculation process to design a light generator of the display apparatus of FIG. 1;
FIG. 5 illustrates a flowchart of a display method according to example embodiments;
FIGS. 6A through 6D illustrate diagrams of a generating process of a high density light field image using the display method of FIG. 5;
FIG. 7 illustrates a flowchart of the display method of FIG. 5;
FIG. 8 illustrates a configuration of a controller of the display apparatus of FIG. 1; and
FIG. 9 illustrates a diagram of a generating process of a high density light field image in the detailed configuration of the controller of FIG. 1.

[0025] Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. Embodiments are described below to explain the present disclosure by referring to the figures.

[0026] FIG. 1 illustrates a display apparatus 100 according to example embodiments.

[0027] Referring to FIG. 1, the display apparatus 100 may include, for example, a position sensor 110, a controller 120, a light generator 130, and a light modulator 140.

[0028] The position sensor 110 may refer to an apparatus for sensing, for example, an eye position of a user, which may be configured using at least one of a visible light band camera, an infrared camera, and a depth camera, or using a combination of the visible light band camera, the infrared camera, and the depth camera.

[0029] The display apparatus 100 may include an identifier that may correspond to a landmark, e.g., a feature point, an adhesive, and the like, (not shown) for easily detecting the eye position of the user, and the position sensor 110 may sense the eye position of the user by photographing the identifier.

[0030] The controller 120 may calculate the eye position of the user by receiving at least one of a parameter and a camera parameter that sensed the eye position, and may determine a position of a virtual viewing window and a size of a virtual viewing window to cover the calculated eye position of the user.

[0031] The controller 120 may generate a control signal to control the light generator 130 and the light modulator 140 to generate a light field image at a position of the virtual viewing window.

[0032] The light generator 130 may include, based on the control signal, a backlight that may provide a standard light source to generate a light field, a variable slit that may modulate the standard light source to a point light source at a predetermined position, a lens that may generate a directional light toward the viewing window by refracting the point light source, and the like.

[0033] The backlight of the light generator 130 may be configured as a Cold Cathode Fluorescent Lamp (CCFL), a light emitting diode (LED), an organic light emitting diode (OLED), a laser, and the like, and may also include an optical film, a prism, a filter, a mirror, and the like to improve straightness and directivity of a generated light.

[0034] The variable slit of the light generator 130 may generate, on a side of the refracting lens, a point light that may have a moving direction toward the viewing window by dividing a plane light generated by the backlight.

Microsoft Exhibit 1002 - Page 1024
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

[0035] The variable slit may include an optical shutter, a prism, a filter, a mirror, and the like to control a direction and a brightness of a light source.

[0036] The generated point light may penetrate through a convex lens such as a Lenticular lens and the like to be refracted toward the viewing window, and may generate a light field image.

[0037] The light modulator 140 may adjust an intensity of a light field using the light source generated by the light generator 130.

[0038] When a point light is refracted through a lens toward a viewing window, an intensity of light may be required to be controlled to display a gradation of color. The controller 120 may provide the control signal, and the light modulator 140 may adjust an actual intensity of light.

[0039] The light modulator 140 may be configured as a pixel of a liquid crystal display (LCD) element.

[0040] A generating process of a high density light field image of the display apparatus 100 will be described more fully hereinafter with reference to FIG. 2 and the remaining drawings.

[0041] FIG. 2 illustrates a diagram to describe a progression of a directional light for generating a viewing window and a high density light field image which are set by a controller of the display apparatus 100 of FIG. 1.

[0042] The controller 120 of the display apparatus 100 may calculate an eye position of a user using an eye position sensing measurement of the position sensor 110, a camera parameter, and/or the like, and may set a small viewing window 220 to cover the calculated eye position, and more particularly, a pupil.

[0043] For example, a diameter of a human pupil may range from about 2 mm to about 8 mm depending on surrounding brightness and thus, the controller 120 may set the size of the viewing window 220 to about 8 mm x 8 mm, which may generate a light field image by concentrating light.

[0044] At least two lights may be displayed within a pupil with respect to width and length by displaying four lights 211 in each of width and length on the inside of the viewing window.

[0045] Here, each of 3D element points 210 included in the light modulator 140 of the display apparatus 100 may generate sixteen lights. When a number of the 3D element points is VGA 300,000, a high density light field display may be configured using about 4,800,000 lights in total.

[0046] 4,800,000 pixels may correspond to about 2.3 times greater than the number of pixels of a current full HD display, which may be configured in a currently commercialized high resolution monitor.

[0047] In contrast, in order to generate a high density light field image in the entire viewing space without setting a viewing window corresponding to the eye position of the user, a much larger number of pixels may be required than the 4,800,000 pixels described above.

[0048] For example, when each of the 3D element points 210 generates a light projecting at about 30° to 15° every 0.1° that corresponds to an angle where at least two lights may enter a pupil of an observer 1 m away from the high density light field display, the number of lights to be generated in each of the 3D element points 210 may correspond to 45,000 (= 300 x 150), and the total number of required lights may correspond to more than 13.5 billion by multiplying a position resolution of 300,000 by a direction resolution of 45,000.

[0049] Accordingly, the number of pixels used for the display apparatus 100 may be significantly reduced by detecting a position of an eye 201 of the user, tracing the eye position of the user continuously, dynamically setting the viewing window 220, and generating a high density light field image only in the viewing window 220.

[0050] FIG. 3 illustrates a diagram of generating a high density light field image in the viewing window 220 by the light generator 130 and the light modulator 140 of the display apparatus of FIG. 1 according to example embodiments.

[0051] As described above, the light generator 130 may include a backlight 311 to generate a plane light, a variable slit 312 to generate a point light in a predetermined position by dividing the plane light based on a control signal, and a lens 313 to generate a directional light toward the viewing window 220.

[0052] The light modulator 140 may display a gradation of color and generate a light field by at least one of readjusting a direction of the directional light based on a control signal, and adjusting an intensity of the directional light.

[0053] The light modulator 140 may control a detailed direction of a directional light 321 or adjust an intensity of the directional light 321 that penetrates through the lens, and may generate a light field corresponding to the four lights 211 using an LCD pixel 141.

[0054] The generated light field may be concentrated and displayed on the viewing window 220 around the eye of the user to display an image with a high density to the user.

[0055] FIG. 4 illustrates a diagram to describe an example of a parameter calculation process to design the light generator 130 of the display apparatus 100 of FIG. 1.

[0056] In a design for the lens 313 to configure a source of the directional light 321, as an example, a pitch g of the variable slit 312 corresponding to 0.15 mm, a size q of the 3D element points 210 corresponding to 0.6 mm, a size S_W of the viewing window corresponding to 8 mm x 8 mm, and a viewing distance d corresponding to a distance between the lens 313, and the viewing window 220 corresponding to 1000 mm, may be assumed.

[0057] Here, an object distance S1 is expressed as [Equation 1] :

Microsoft Exhibit 1002 - Page 1025
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

$$S1 : g = d : S\_W.$$

Substituting the above values into Equation 1, S1 is calculated to be

[Equation 2]:

$$S1 = g*d / S\_W = 18.75 \text{ mm}.$$

[0058] An image distance S2 is calculated by

[Equation 3]:

$$S2 : q = S2 + d : S\_W.$$

[0059] Substituting the above values into Equation 3, S2 is calculated to be

[Equation 4]:

$$S2 = (d * q) / (S\_W - q) = 81.06 \text{ mm}.$$

[0060] Accordingly, a focal distance f_L of the lens is calculated to be

[Equation 5]:

$$1/S1 - 1/S2 = 1/F\_L;$$

and

[Equation 6]:

$$F\_L = (S1 * S2) / (S2 - S1) = 24.39 \text{ mm}.$$

[0061] According to the calculation results, by arranging, in front of the variable slit 312, the micro lens 313 with a thickness of about 18.75 mm and a focal distance of about 24.39 mm, a directional light source may be generated to constitute the virtual viewing window 220 of about 8 mm x 8 mm around the eye 201 of the user.

[0062] The above described calculation should not be construed as being limited to the example embodiments as various modifications and variations can be made without departing from the spirit of the disclosure or the scope of which is defined by the claims and their equivalents.

[0063] FIG. 5 illustrates a flowchart of a display method according to example embodiments.

[0064] In operation 510, an eye position of a user may be sensed, for example, by a position display apparatus, and the eye position of the user may be detected using the sensing result, for example, by the controller 120.

[0065] In operation 520, a position of a virtual viewing window and a size of the virtual viewing window may be determined to concentrate a light field around the eye position, for example, by the controller 120.

[0066] In operation 530, a directional light source may be generated and directed toward the viewing window 220, for example, by the light generator 130 and the light modulator 140 and based on a signal from the controller 120. A high density light field image may be displayed in operation 540, for example, using the generated directional light source.

[0067] FIG. 6A through 6D illustrate diagrams of a generating process of a high density light field image using the display method of FIG. 5.

[0068] FIG. 6A illustrates measuring of an eye position of the user, and more particularly, a pupil position, for example, u^*, v^*, and z^* corresponding to operation 510 of FIG. 5, and FIG. 6B illustrates setting the viewing window 220 corre-

Microsoft Exhibit 1002 - Page 1026
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

sponding to operation 520 of FIG. 5.

[0069] FIG. 6C illustrates generating a directional light corresponding to operation 530 of FIG. 5, and FIG. 6D illustrates generating a light field image corresponding to operation 540 of FIG. 5.

[0070] FIG. 7 illustrates a flowchart of the display method of FIG. 5, more particularly, FIG. 7 illustrates a flowchart of the display method of FIG. 5 from recursively inputting an image to a proceeding process of an entire display procedure.

[0071] In operation 710, an image may be input. The image may correspond to a frame image signal corresponding to each viewpoint of a multi-view image.

[0072] A process of detecting eye position of a user in operation 720 corresponds to operation 510 of FIG. 5, and a process of setting a viewing window in operation 730 corresponds to operation 520 of FIG. 5.

[0073] In operation 740, whether there is a change in the eye position of the user may be determined, that is, a change in a position of the viewing window, compared with an image display viewpoint of a prior frame.

[0074] In operation 770, when the position of the view window is unchanged, a light field image may be immediately generated based on the input image signal without additionally controlling the directional light source direction.

[0075] Conversely, when there is a change in the position of the view window, the controller 120 of the display apparatus 100 may dynamically reflect the change, and may provide a control signal with the light generator 130 and the light modulator 140 to control the direction of the directional light in operation 750.

[0076] In operation 760, the light generator 130 and the light modulator 140 may control the directional light by determining a light field position in the viewing window, and a light field image may be generated in operation 770.

[0077] The user may view a light field image displayed in operation 780, and the above described procedure may recursively repeat until terminating an image display in operation 790.

[0078] FIG. 8 illustrates a configuration of the controller 120 of the display apparatus of FIG. 1.

[0079] The controller 120 may include an eye position detector 810 to calculate an eye position of a user, for example, a pupil position using a photographing result of the eye position of the user and/or using a camera parameter of the position sensor 110, and a viewing window setting unit 820 to determine a position of the viewing window and a size of the viewing window to cover the pupil of the user using the calculating result.

[0080] A directional light source controller 830 may provide a control signal to the light generator 130 to generate a directional light based on the position of the viewing window and the size of the viewing window set by the viewing window setting unit 820.

[0081] A light field image generator 840 may consider the position of the viewing window and the size of the viewing window, and may provide a control signal to adjust a detailed direction of the directional light or an intensity of the directional light in the light modulator 140 based on an input image 801.

[0082] FIG. 9 illustrates a diagram of a generating process of a high density light field image in the detailed configuration of the controller 120 of FIG. 1.

[0083] The position sensor may provide a sensed value 901 with the eye position detector 810, and the eye position detector 810 may calculate a pupil position.

[0084] Here, the eye position detector 810 may calculate the pupil position, for example, u^*, v^*, and z^* by receiving a camera parameter 901 or using a pre-stored camera parameter.

[0085] Then, the viewing window setting unit 820 may set a viewing window. Here, the viewing window setting unit 820 may set a minimum u_min and a maximum u_max of a horizontal direction coordinate u and set a minimum v_min and a maximum v_max of a vertical direction coordinate v, and may specify a viewing window by setting a distance direction coordinate z of the viewing window in operation 821.

[0086] The viewing window setting unit 820 may set a position of a light field, which corresponds to a process of specifying n horizontal direction position(s) and m vertical direction position(s).

[0087] The specified light field position may be transmitted to the light field image generator 840, and the input 3D image 801 and a screen parameter 903 specifying a viewing environment are reflected to generate a light field image in the light modulator 140.

[0088] When the viewing window area is set, the result may be transmitted to the directional light source controller 830, and whether a change occurs in the viewing window position in operation 831 corresponding to operation 740 of FIG. 7 may be determined, and the result may also be transmitted to a variable slit controller 832, and a control signal may be transmitted to the variable slit 131.

[0089] For ease of description, the above processes of setting a viewing window and generating a light field have been described with respect to a single viewpoint, for example, a left viewpoint or a right viewpoint. However, the above description may be simultaneously applicable for generating a light field of a left viewpoint image and a right viewpoint light field without any particular difficulty. Here, it may be obviously configured, using the above described process, to set each viewing window with respect to the left eye and the right eye and to generate each of the light fields using each directional light source.

[0090] A process of generating a light field image by setting a viewing window for the left eye and generating a light field image by setting a viewing window for the right eye may be feasible by configuring a viewing window by spatially

Microsoft Exhibit 1002 - Page 1027
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

allocating a pixel resource, or by temporally dividing the pixel resource.

[0091] The description may be understood without additional disclosure describing that a current 3D display alternately provides a left image and a right image.

[0092] For example, a projector to configure a light field image may be used, and a light field may be generated by arranging a lens on a display surface.

[0093] The method according to the above-described embodiments may be recorded in non-transitory computer-readable media including program instructions to implement various operations embodied by a computer. The media may also include, alone or in combination with the program instructions, data files, data configurations, and the like. Examples of non-transitory computer-readable media include magnetic media such as hard disks, floppy disks, and magnetic tape; optical media such as CD ROM disks and DVDs; magneto-optical media such as optical disks; and hardware devices that are specially configured to store and perform program instructions, such as read-only memory (ROM), random access memory (RAM), flash memory, and the like.

[0094] Examples of program instructions include both machine code, such as produced by a compiler, and files containing higher level code that may be executed by the computer using an interpreter. The described hardware devices may be configured to act as one or more software modules in order to perform the operations of the above-described embodiments, or vice versa. Any one or more of the software modules or units described herein may be executed by a dedicated processor unique to that unit or by a processor common to one or more of the modules. The described methods may be executed on a general purpose computer or processor or may be executed on a particular machine such as the display apparatuses described herein.

[0095] Although embodiments have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the scope of the present invention which is defined by the claims and their equivalents.

Claims

1. A display apparatus, comprising:

   a position sensor to sense an eye position of a user;
   a controller to set a virtual viewing window corresponding to the sensed eye position of the user and to provide a control signal to generate a directional light toward the virtual viewing window; and
   a light generator to generate a directional light based on the control signal.

2. The display apparatus of claim 1, further comprising:

   a light modulator to modulate an intensity of the directional light based on the control signal.

3. The display apparatus of claim 1, wherein the position sensor comprises at least one camera to photograph the eye position of the user.

4. The display apparatus of claim 1, wherein the position sensor comprises at least one camera to identify the eye position of the user by photographing an identifier fixed around the eye position of the user.

5. The display apparatus of claim 1, wherein the light generator comprises:

   a backlight to generate a non-directional light;
   a variable slit to convert, based on the control signal, the non-directional light to a plurality of point light sources, each having a different position; and
   a lens to generate a directional light toward the virtual viewing window by refracting at least a part of the plurality of point light sources;
   wherein the variable slit preferably corresponds to a plurality of pixels of a liquid crystal display (LCD) panel.

6. The display apparatus of claim 1, wherein the controller comprises:

   an eye position detector to calculate a coordinate value of the eye position of the user on a space coordinate using the sensed eye position of the user; and
   a viewing window setting unit to determine at least one of a position of the virtual viewing window and a size of the virtual viewing window to cover the eye of the user using the coordinate value of the eye position of the user;

Microsoft Exhibit 1002 - Page 1028
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

wherein the controller preferably further comprises:

a directional light source controller to control a control signal to generate a directional light toward the virtual viewing window; and
a light field image generator to provide a control signal to generate a three-dimensional (3D) image of a light field scheme by adjusting an intensity of the directional light toward the virtual viewing window.

7. A display method, comprising:

sensing an eye position of a user;
setting a virtual viewing window corresponding to the sensed eye position of the user; and
generating a directional light toward the virtual viewing window.

8. The display method of claim 7, further comprising:

displaying, on the virtual viewing window, a light field 3D image by controlling generated the directional light.

9. The display method of claim 7, wherein the generating of the directional light comprises:

generating a non-directional light using a backlight; converting, using a variable slit, the non-directional light to a plurality of point light sources, each having a different position; and
generating a directional light toward the virtual viewing window by refracting at least a part of the plurality of point light sources using a refracting lens.

10. The display method of claim 7, wherein the setting of the virtual viewing window comprises:

calculating a coordinate value of the eye position of the user on a space coordinate using the sensed eye position of the user; and
determining, to cover the eye of the user using the coordinate value of the eye position of the user, at least one of a position of the virtual viewing window and a size of the virtual viewing window;
wherein the position of the virtual viewing window and the size of the virtual viewing window are preferably determined based on a position of a pupil of the eye of the user and a size of the pupil, respectively.

11. The display method of claim 7, wherein the sensing of the eye position of the user comprises:

photographing a front image using at least one camera; and
sensing the eye position of the user by identifying the eye of the user from the front image.

12. The display method of claim 7, wherein the sensing of the eye position of the user comprises:

photographing an identifier fixed around the eye position of the user using at least one camera.

13. A non-transitory computer-readable medium comprising a program for instructing a computer to perform the display method of claim 7.

14. A display apparatus, comprising:

a position sensor to sense an eye position of a user using at least one of a visible light band camera, an infrared camera, and a depth camera;
a controller to set a size of a virtual viewing window and to determine a position of the virtual viewing window based on the eye position of the user and a size of the eye, and to provide a control signal to generate a directional light toward the virtual viewing window; and
a light generator including a backlight providing a standard light source, a variable slit to modulate the standard light source to a point light source at a predetermined position, and a lens to generate, based on the control signal, the directional light by refracting the point light source toward the virtual viewing window;
preferably further comprising a light modulator to adjust at least one of an actual intensity of the point light and a direction of the directional light based on a control signal from the controller;
wherein the controller preferably sets the size of the virtual viewing window based on a size of a pupil of the

Microsoft Exhibit 1002 - Page 1029
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

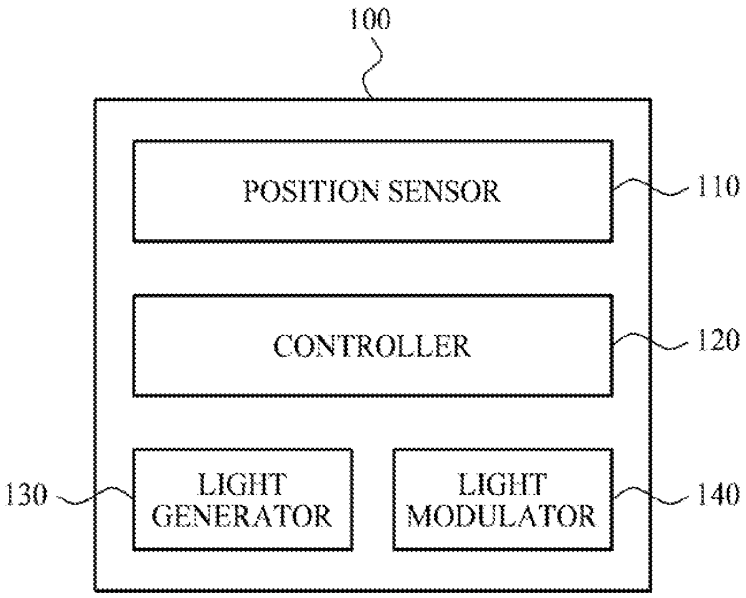
eye of the user and determines the position of the virtual viewing window based on a position of the pupil.

15. A display method comprising:

continuously tracing a pupil position of an eye of a viewer of a display;
dynamically setting a virtual viewing window of the display to correspond to the continuously traced pupil position; and
generating an image in the virtual viewing window while not generating an image in portions of the display that do not correspond to the virtual viewing window.

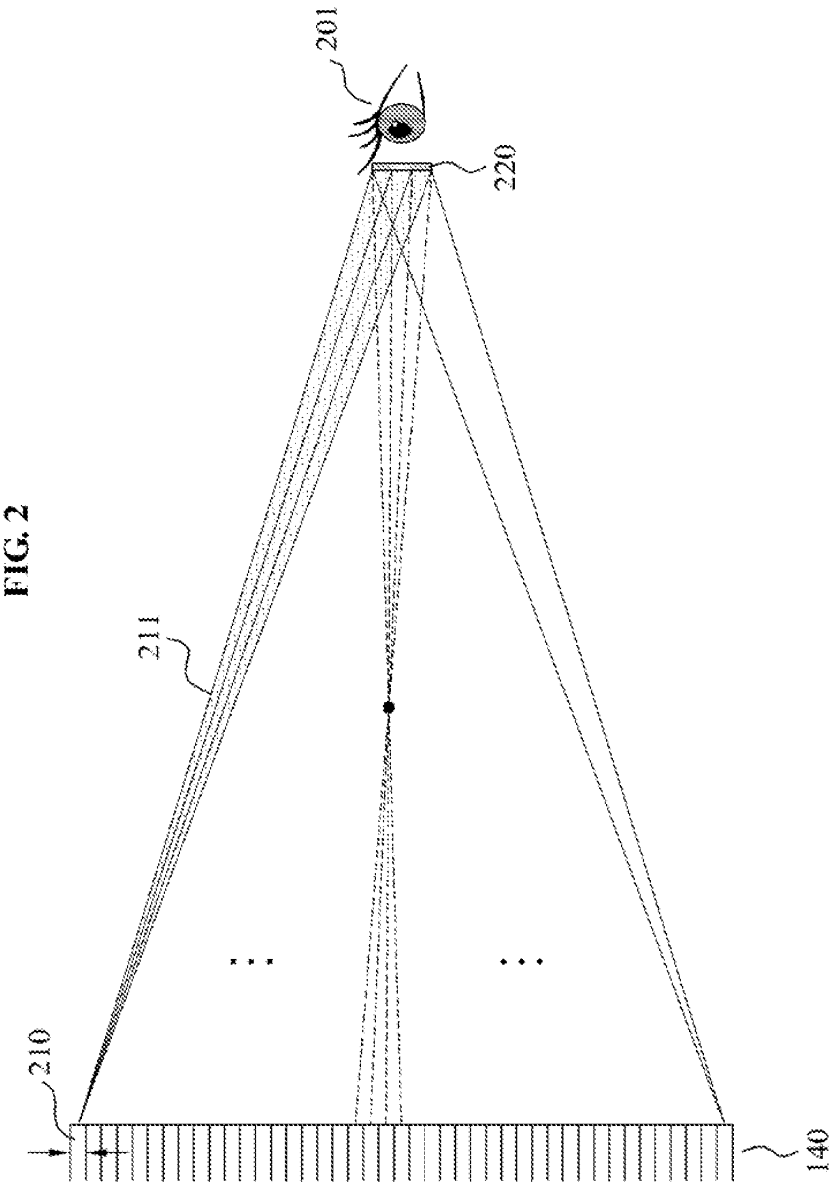
Microsoft Exhibit 1002 - Page 1030
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 1



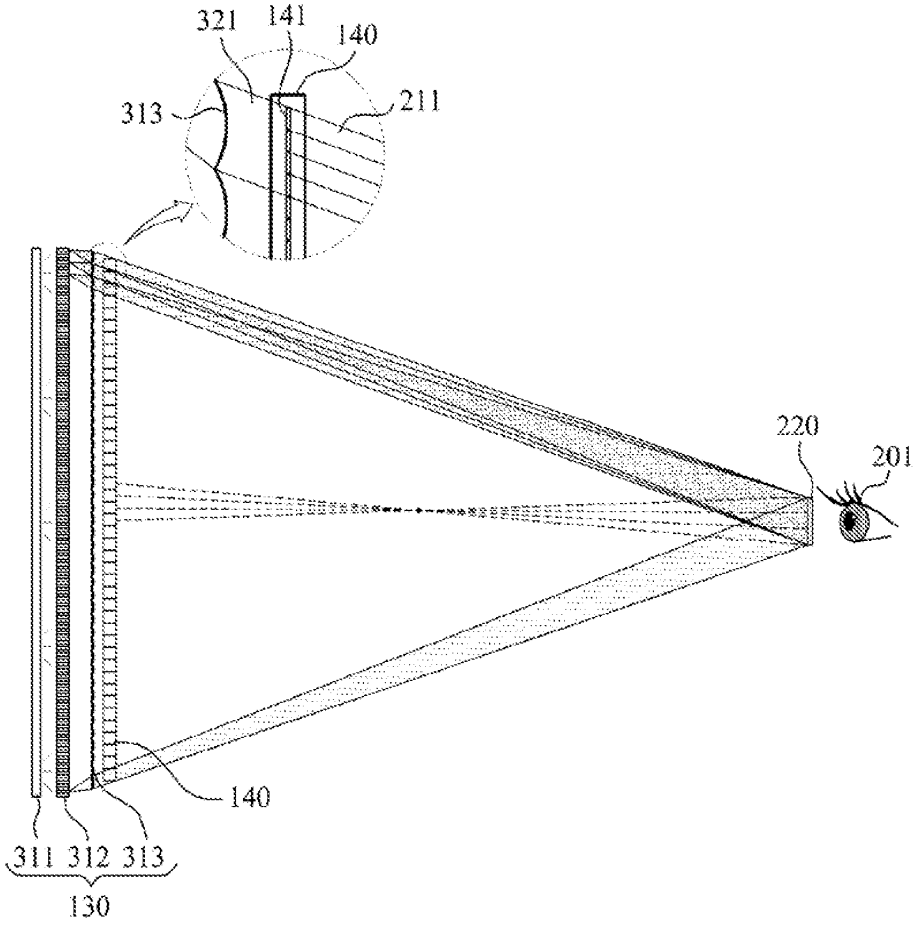
Microsoft Exhibit 1002 - Page 1031
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 2



Microsoft Exhibit 1002 - Page 1032
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 3



Microsoft Exhibit 1002 - Page 1033
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 4

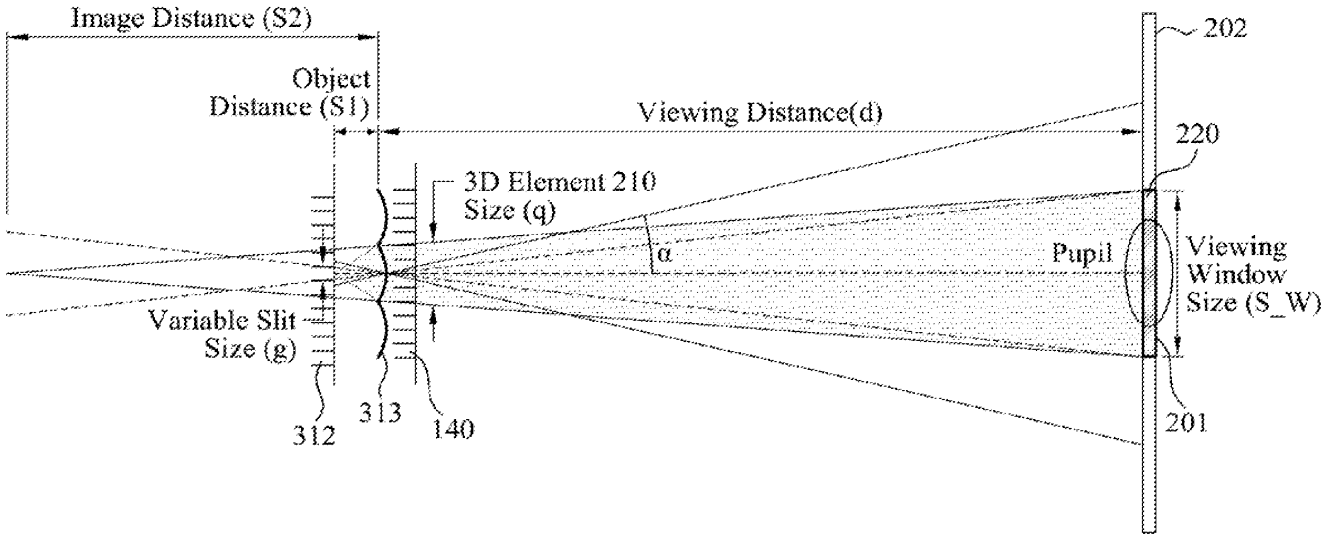
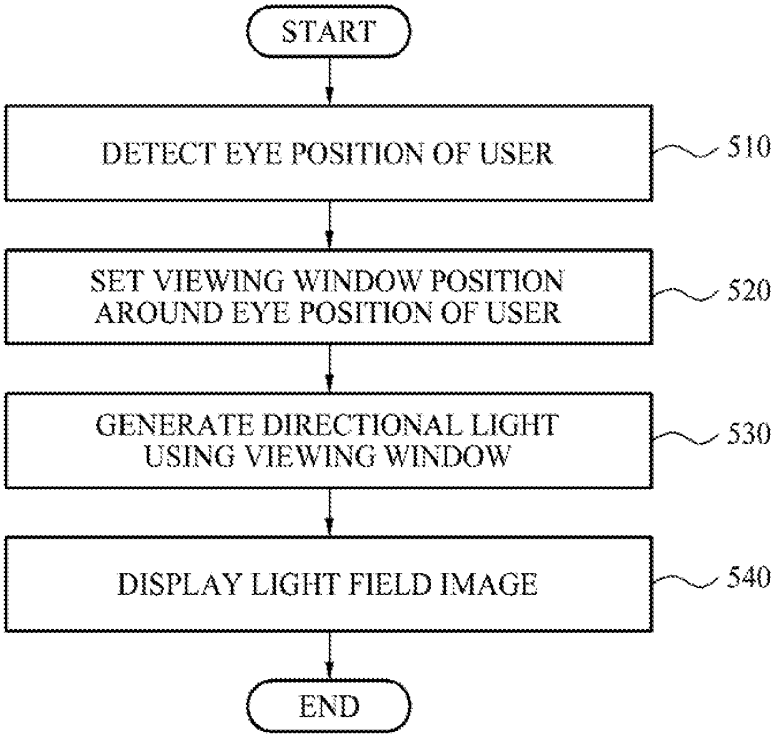

Image Distance (S2)
Object Distance (S1)
Viewing Distance(d)
202
220
3D Element 210 Size (q)
α
Pupil
Viewing Window Size (S_W)
Variable Slit Size (g)
312
313
140
201

FIG. 5



Microsoft Exhibit 1002 - Page 1035
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 6A

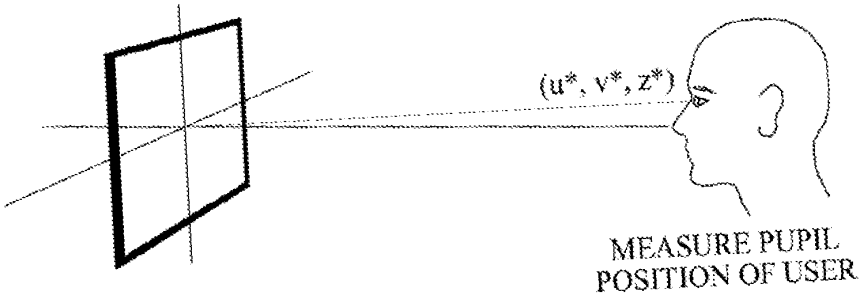


FIG. 6B

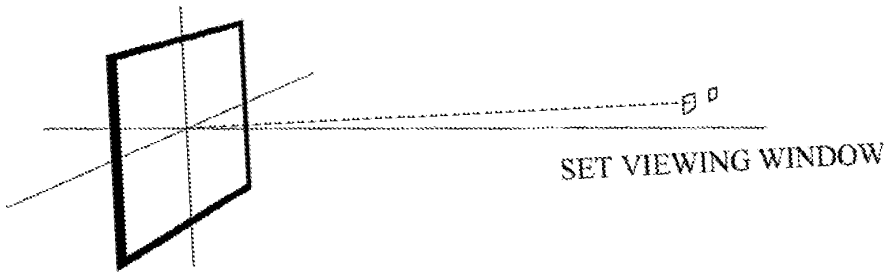
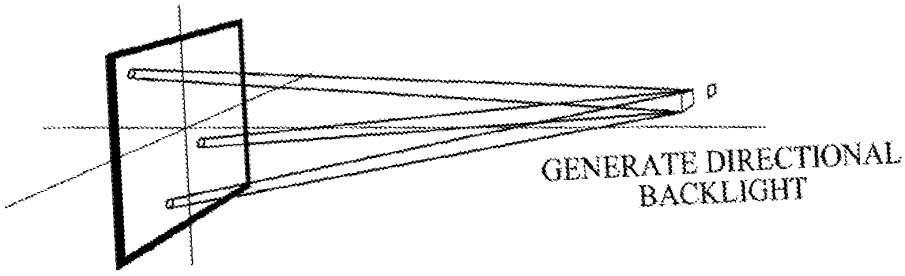
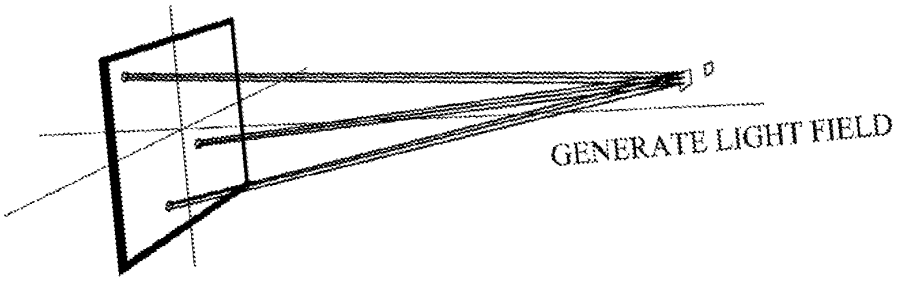


FIG. 6C



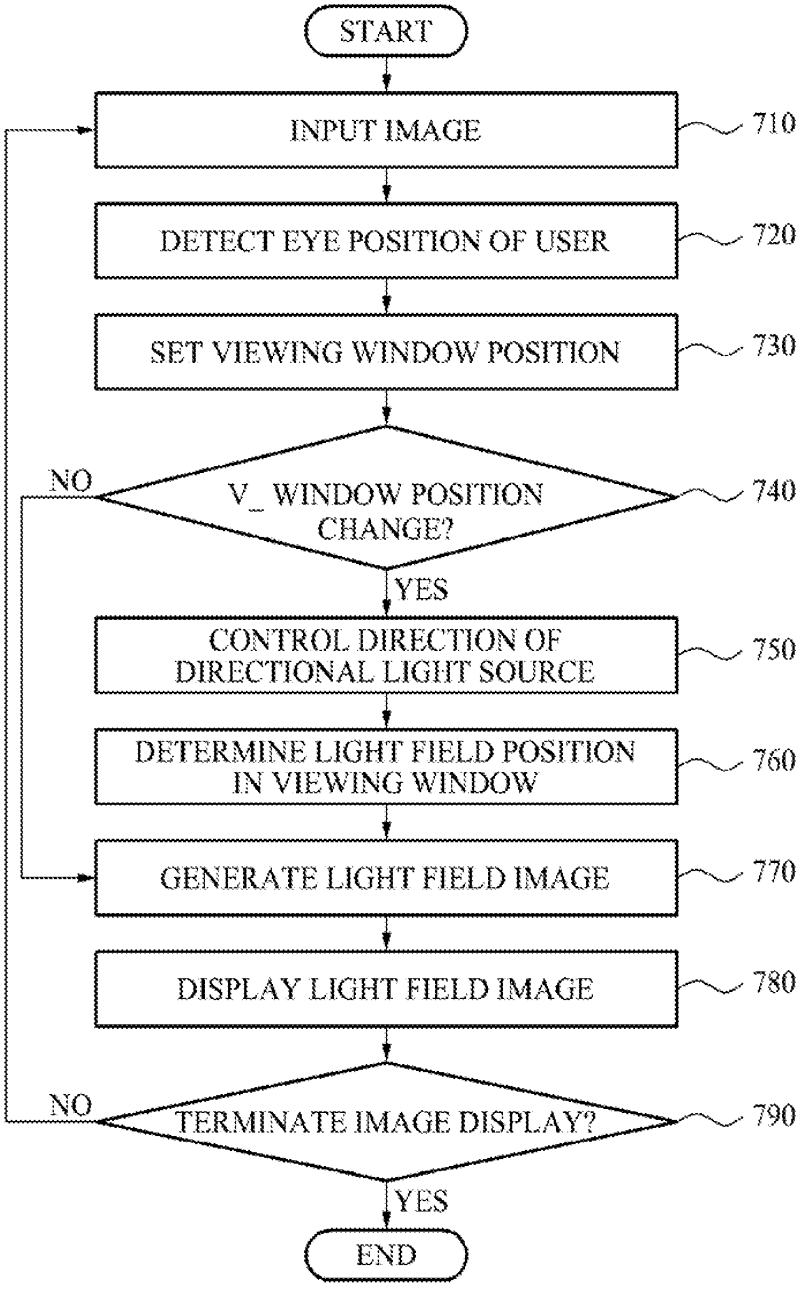
Microsoft Exhibit 1002 - Page 1036
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 6D



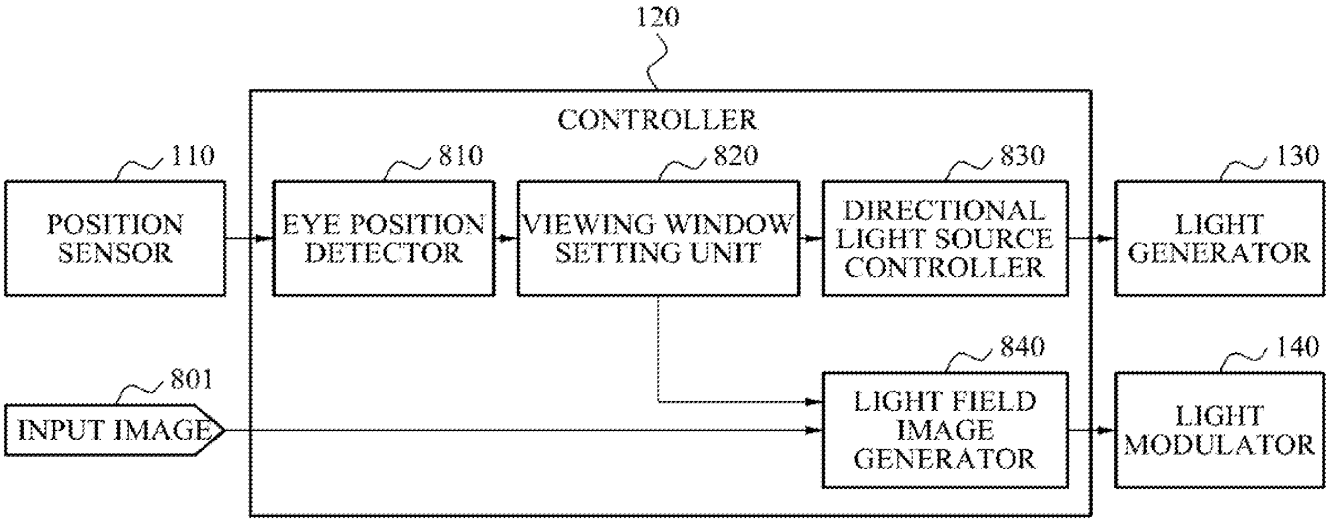
Microsoft Exhibit 1002 - Page 1037
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 7



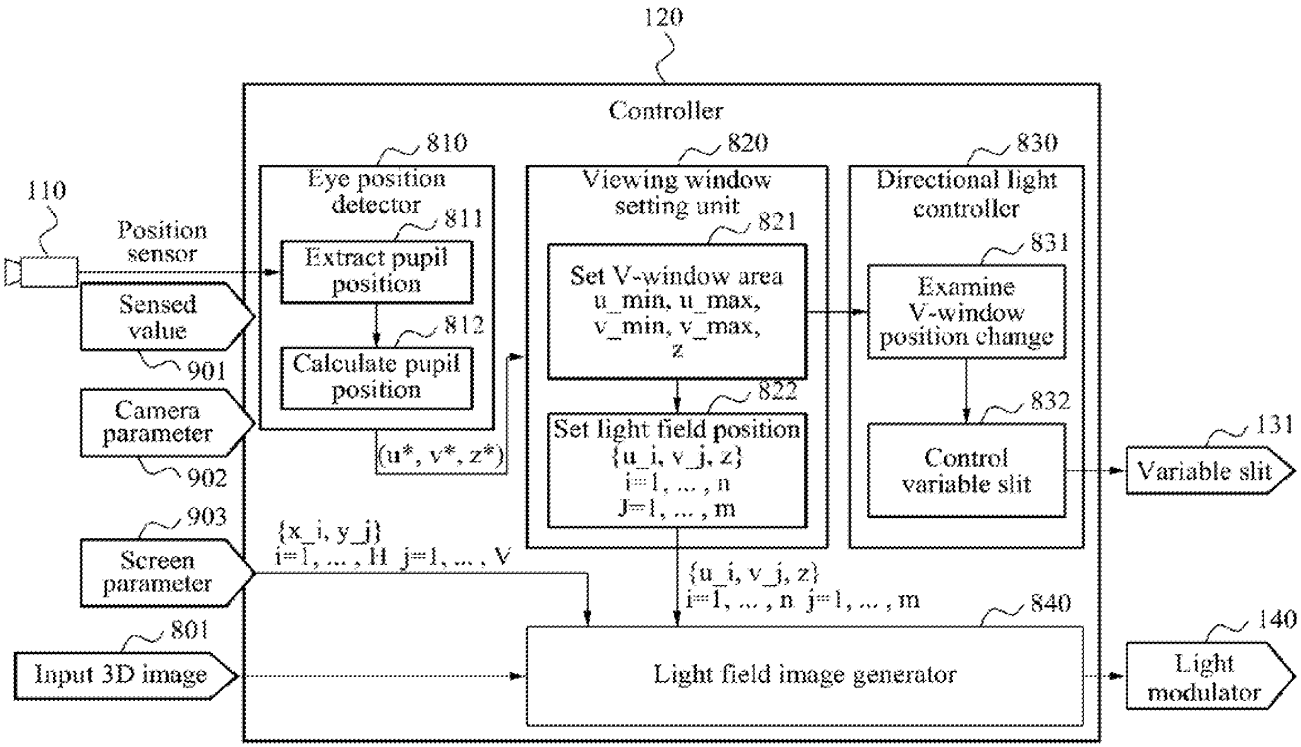
Microsoft Exhibit 1002 - Page 1038
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 8



Microsoft Exhibit 1002 - Page 1039
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG. 9



Microsoft Exhibit 1002 - Page 1040
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- KR 1020100109874 **[0001]**

Microsoft Exhibit 1002 - Page 1041
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

(12) UK Patent Application (19) GB (11) 2 405 542 (13) A

(43) Date of A Publication 02.03.2005

(21) Application No: 0320358.5

(22) Date of Filing: 30.08.2003

(71) Applicant(s):
Sharp Kabushiki Kaisha
(Incorporated in Japan)
22-22 Nagaike-Cho, Abeno-ku, Osaka 545,
Japan

(72) Inventor(s):
Jonathan Mather
Diana Kean
Robert Winlow
Grant Bourhill
Akira Nakagawa

(74) Agent and/or Address for Service:
Marks & Clerk
4220 Nash Court,
Oxford Business Park South, OXFORD,
OX4 2RU, United Kingdom

(51) INT CL[7]:
H04N 13/04 , G02B 27/22 , G02F 1/335 , H04N 13/00

(52) UK CL (Edition X):
H4F FCW FDD FJH F15 F42V
G2J JX15

(56) Documents Cited:
GB 2296099 A **GB 2278222 A**
US 5831765 A **US 4404471 A**

(58) Field of Search:
UK CL (Edition W) **G2J, G5C, H4F**
INT CL[7] **G02B, G02F, H04N**
Other: **WPI, EPODOC, JAPIO, INSPEC**

(54) Abstract Title: **Multiple view directional display having display layer and parallax optic sandwiched between substrates.**

(57) A multiple view display 58, for example for use in an autostereoscopic system or dual view display, comprises an image display layer or element 8 such as a liquid crystal display (LCD), plasma display or organic light-emitting device (OLED) sandwiched between first and second transparent substrates 6 and 7. A parallax optical device 13, such as a parallax barrier aperture array, may be disposed within or adjacent the image display element or the substrates. Colour filters 18 may be positioned in second substrate 7 and switching elements such as thin film transistors (TFTs) may be provided in substrate 6. A resin, plastics or glass spacer 20 may be present. A range of further embodiments are disclosed, including: providing the parallax barrier and colour filters in the same plane and substrate (Figures 6(c) and 6(d)); forming the parallax barrier elements in recesses below the filter elements (e.g. see 14, 16: Figures 9(a) and 9(b)), which may be triangular recesses - see Figure 12(a); and incorporating various types of lenticular lens arrays.

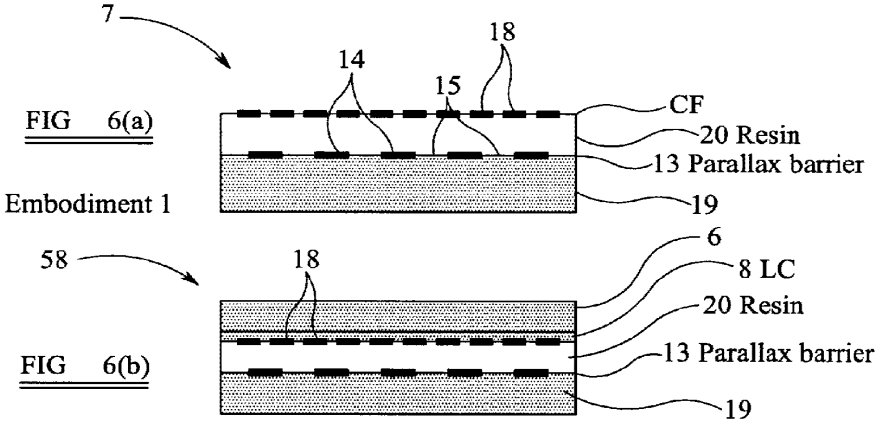


FIG 6(a)

Embodiment 1

FIG 6(b)

GB 2 405 542 A

Original Printed on Recycled Paper

Microsoft Exhibit 1002 - Page 1042
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

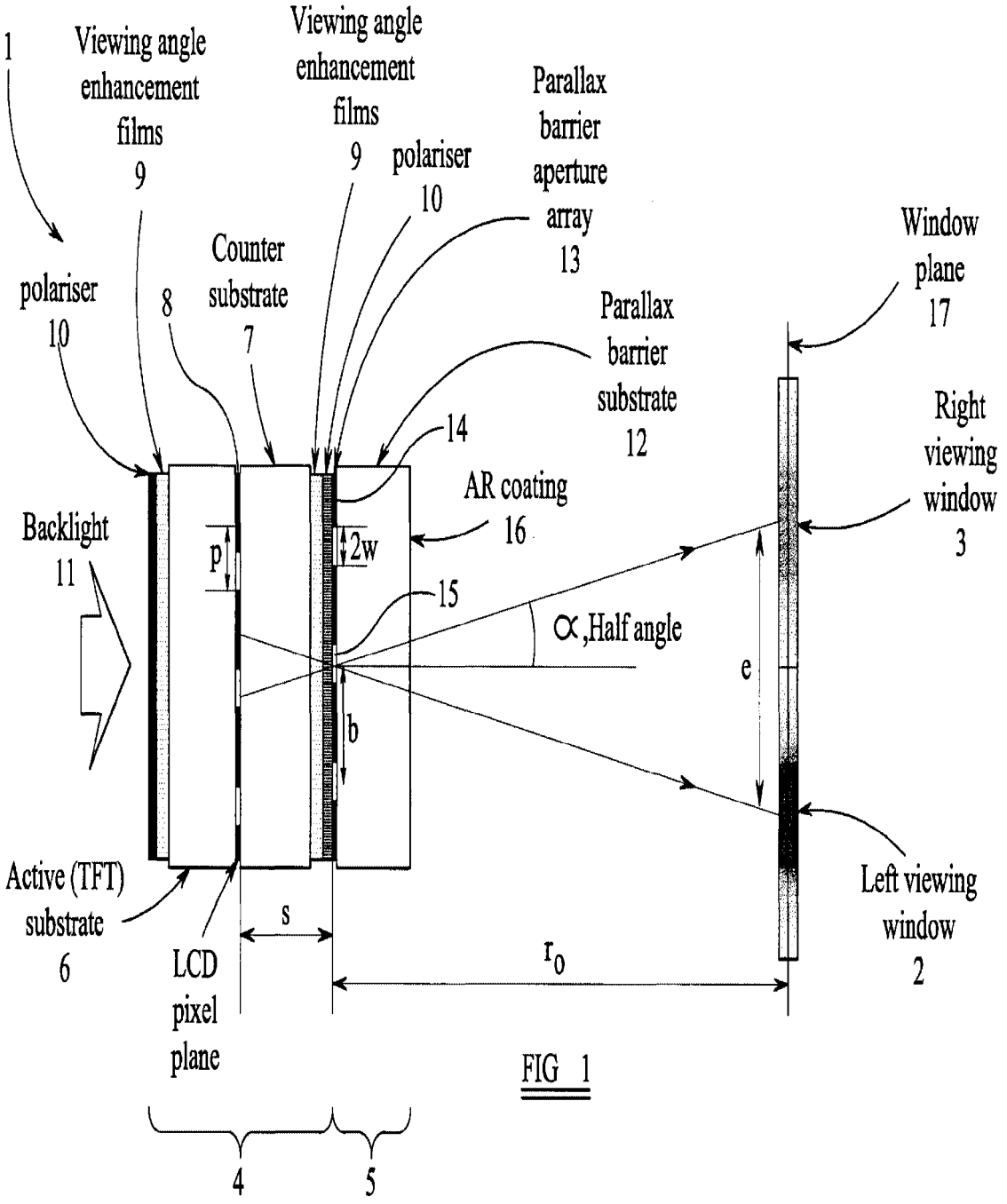


FIG 1

Microsoft Exhibit 1002 - Page 1043
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

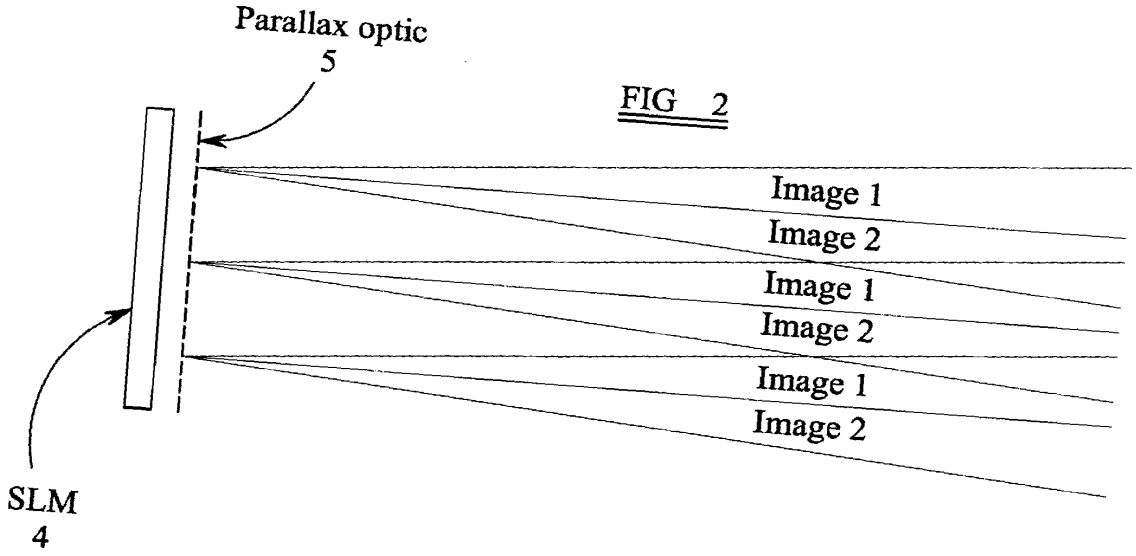


FIG 2

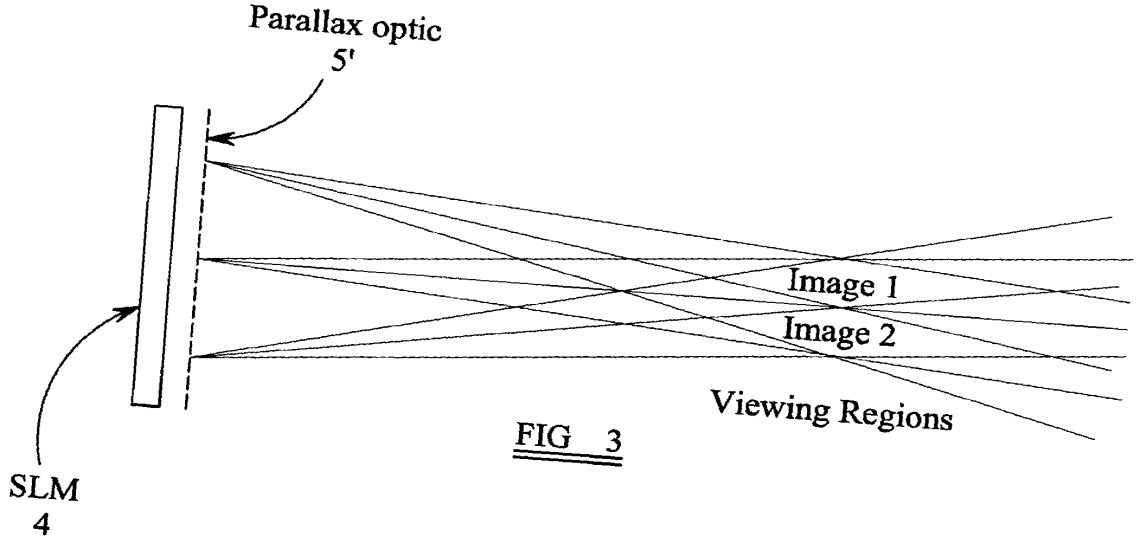


FIG 3

Microsoft Exhibit 1002 - Page 1044
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

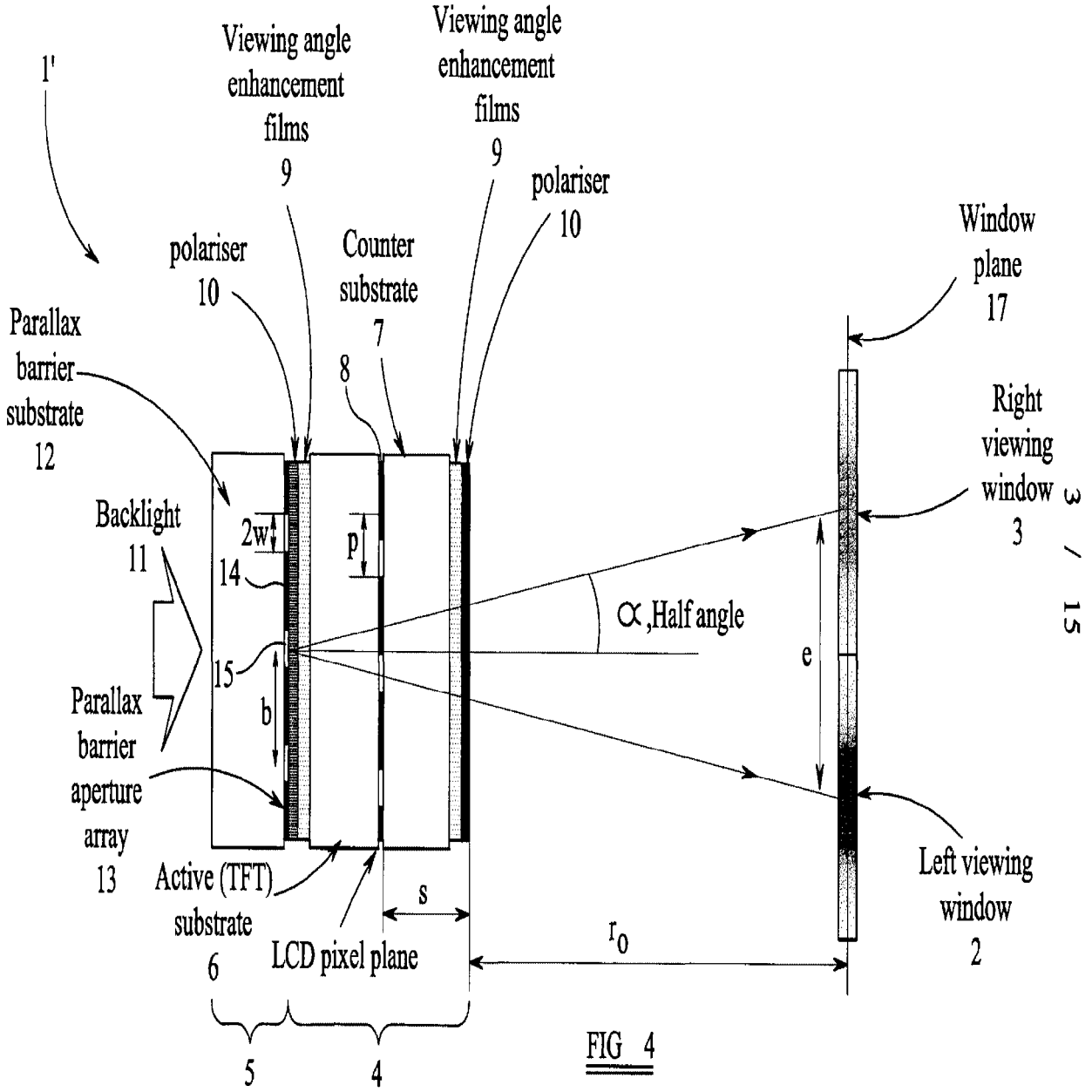


FIG 4

Microsoft Exhibit 1002 - Page 1045
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

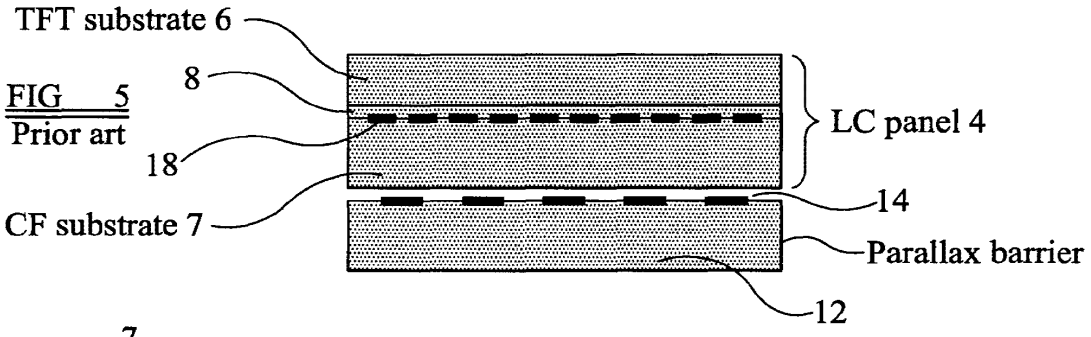


FIG 5
Prior art

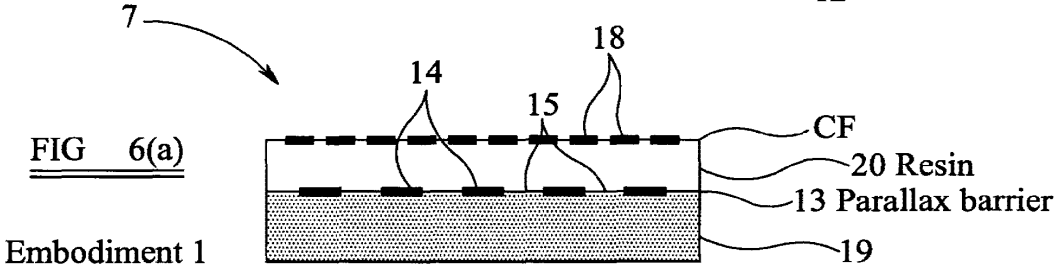


FIG 6(a)

Embodiment 1

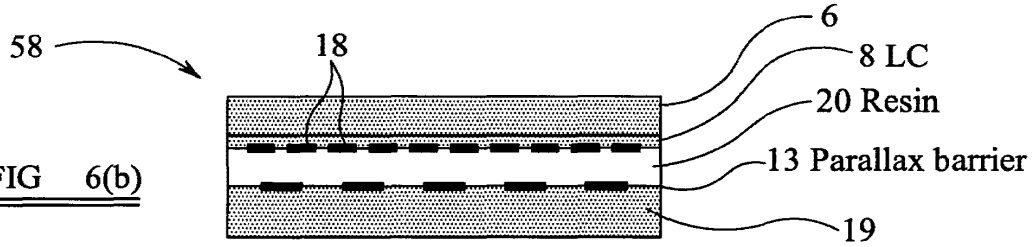


FIG 6(b)

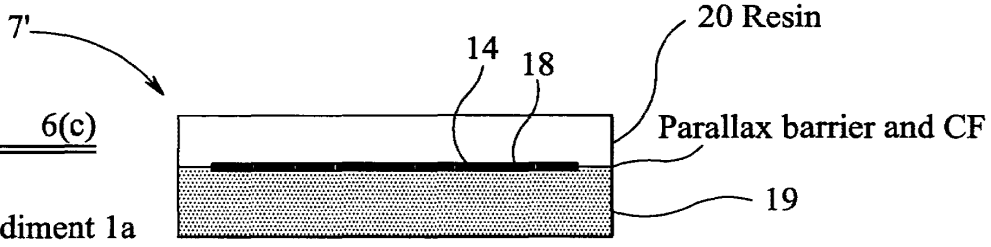


FIG 6(c)

Embodiment 1a

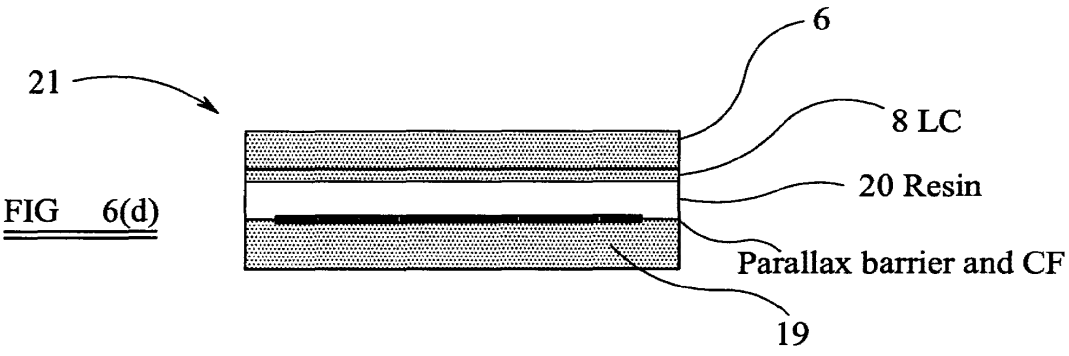


FIG 6(d)

Microsoft Exhibit 1002 - Page 1046
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

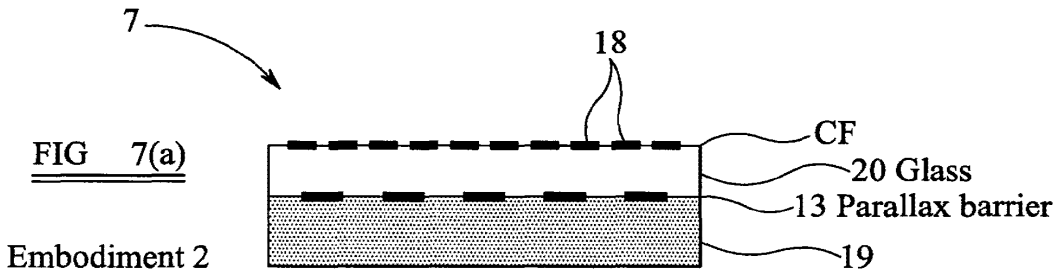


FIG 7(a)

Embodiment 2

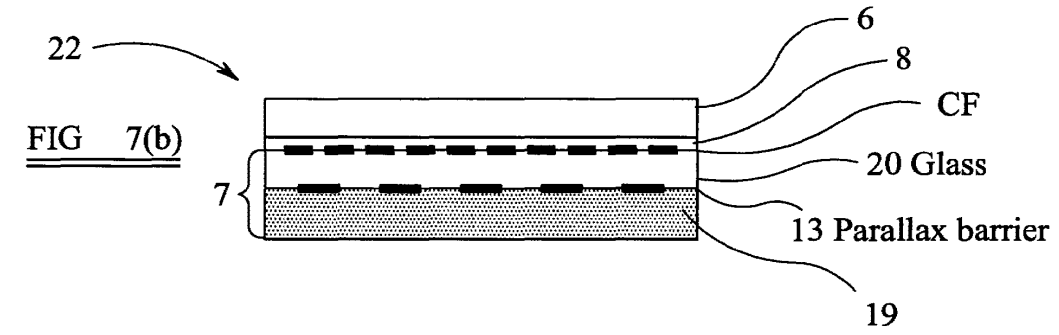


FIG 7(b)

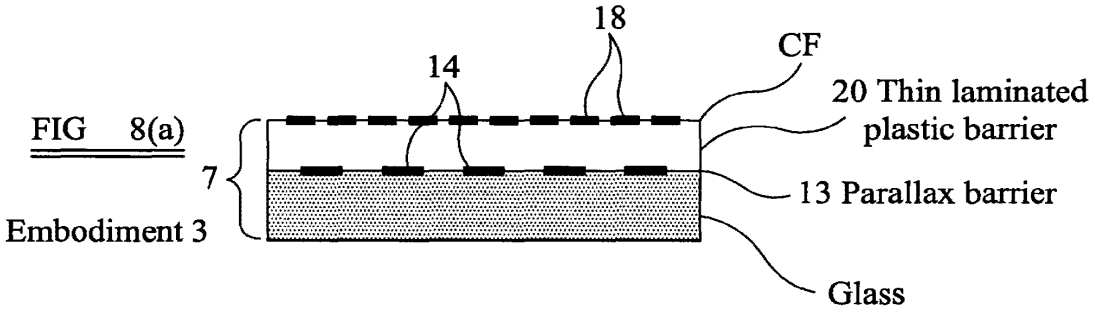


FIG 8(a)

Embodiment 3

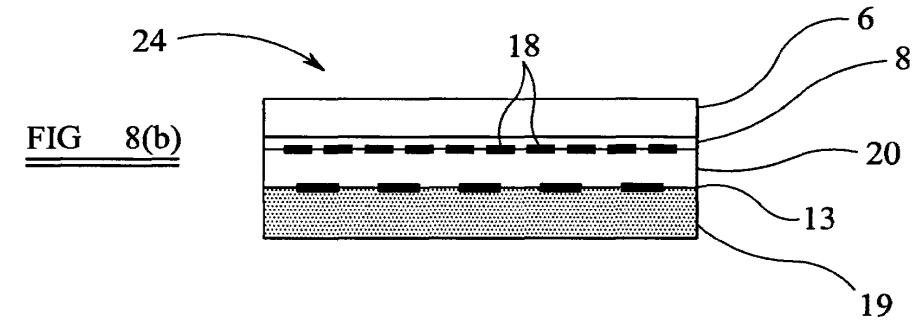


FIG 8(b)

Microsoft Exhibit 1002 - Page 1047
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

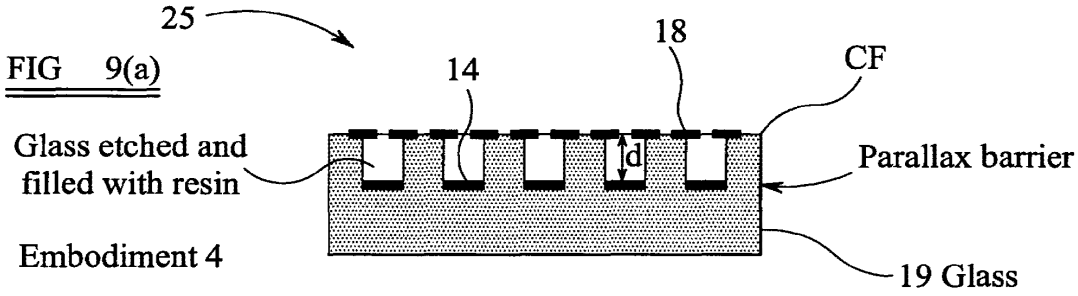


FIG 9(a)

Embodiment 4

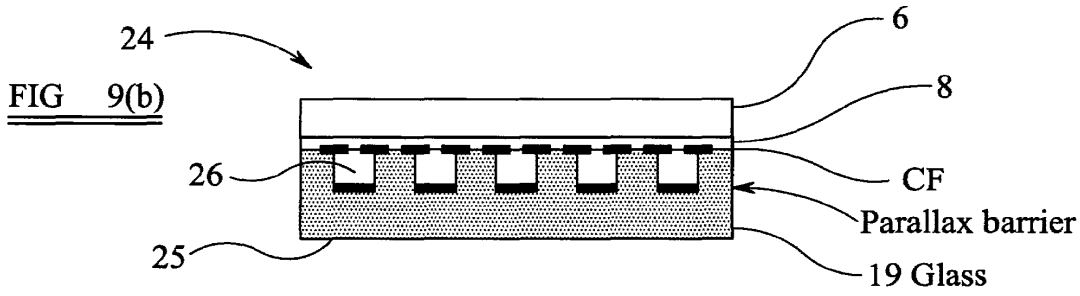


FIG 9(b)

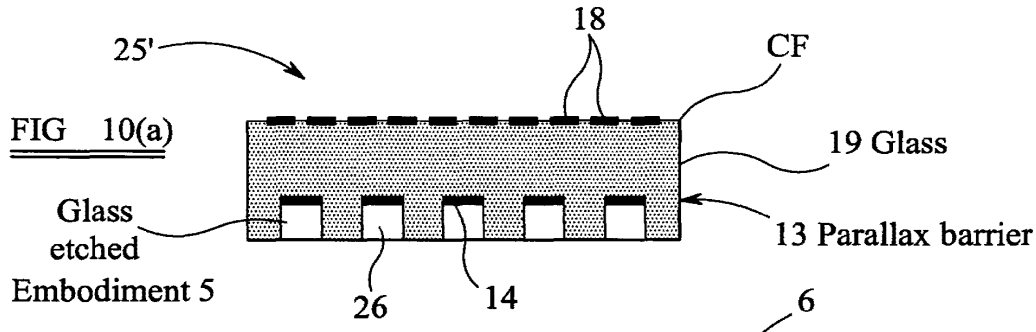


FIG 10(a)

Embodiment 5

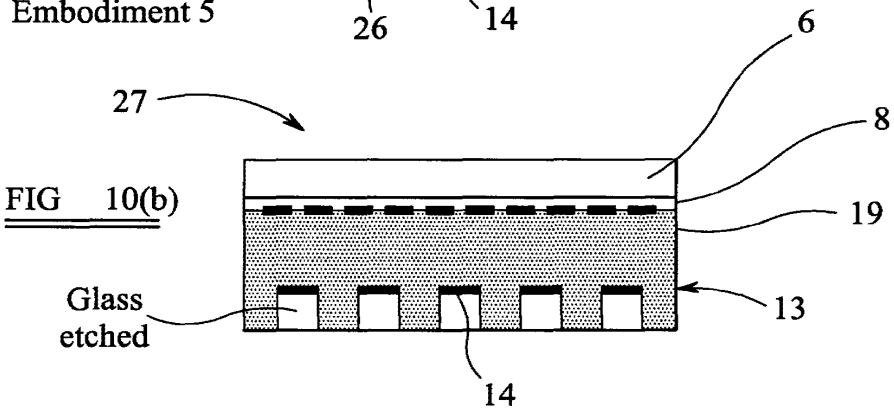


FIG 10(b)

Microsoft Exhibit 1002 - Page 1048
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

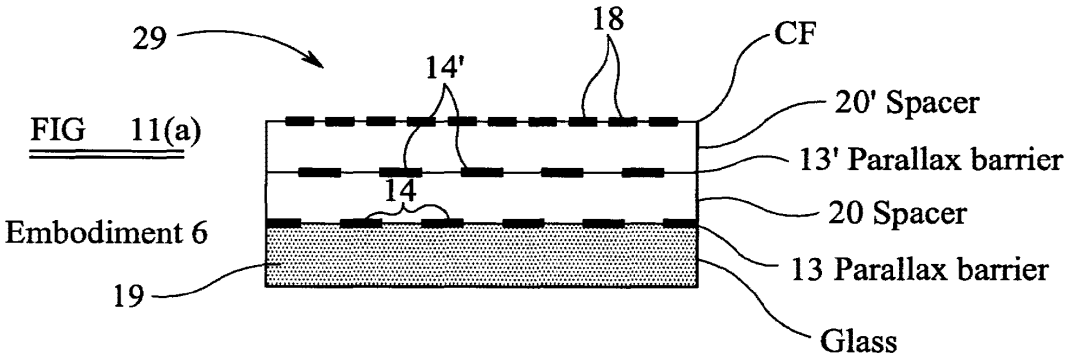


FIG 11(a)

Embodiment 6

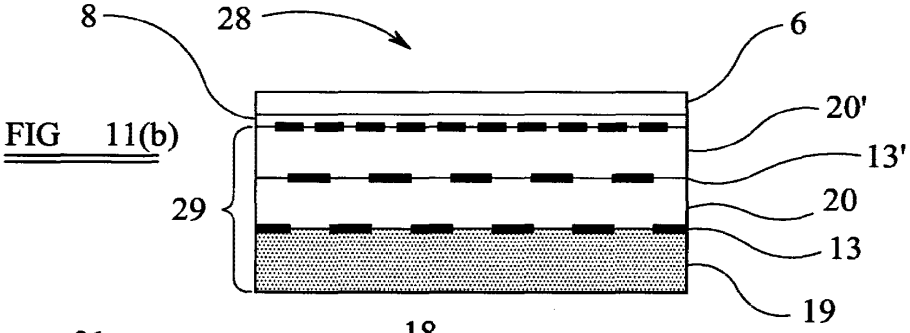


FIG 11(b)

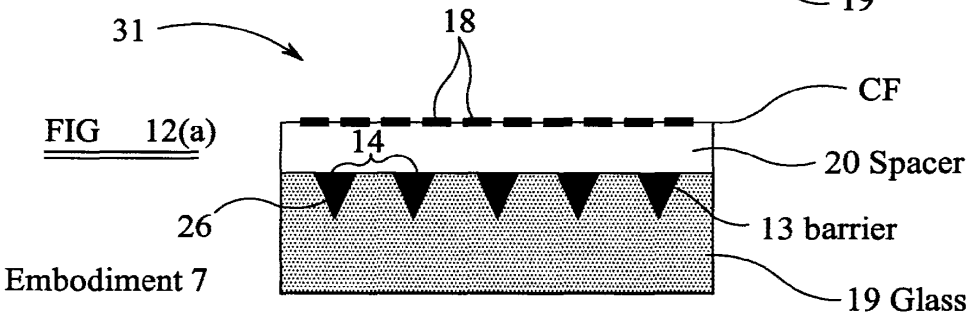


FIG 12(a)

Embodiment 7

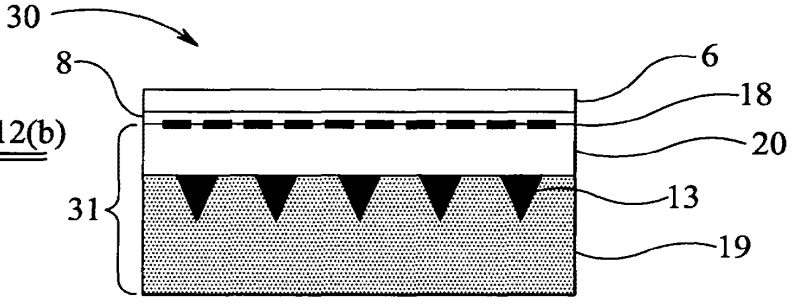


FIG 12(b)

Microsoft Exhibit 1002 - Page 1049
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

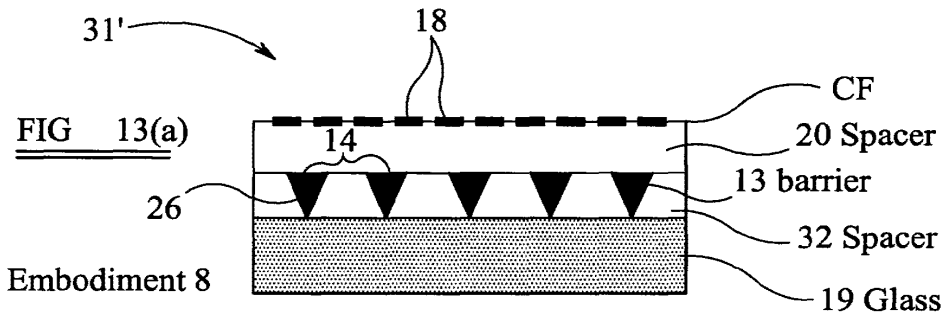


FIG 13(a)

Embodiment 8

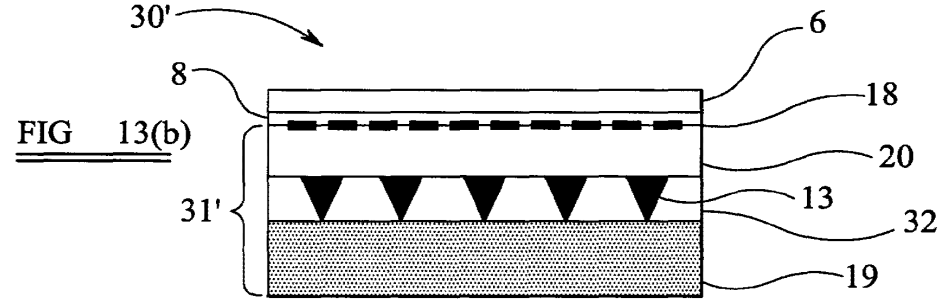
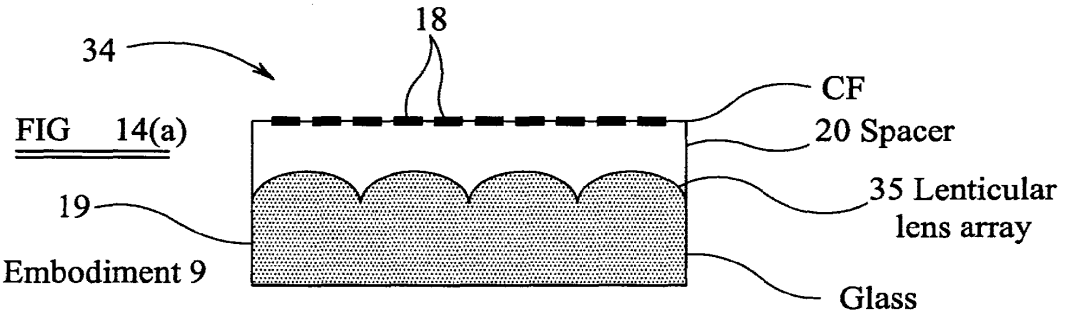


FIG 13(b)



Embodiment 9

FIG 14(a)

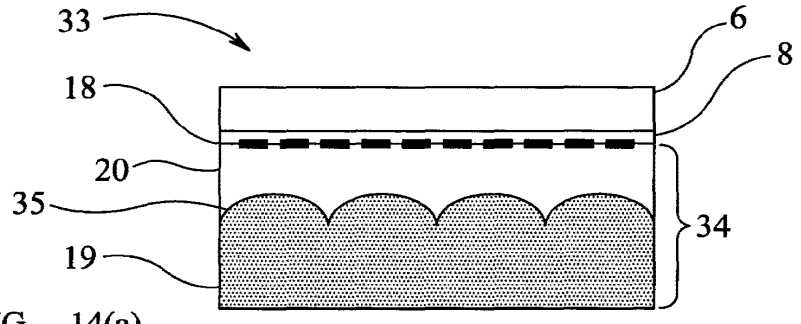


FIG 14(a)

Microsoft Exhibit 1002 - Page 1050
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

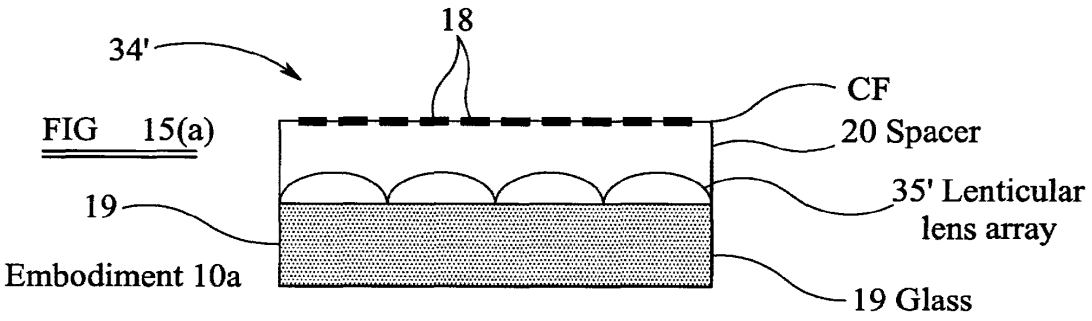


FIG 15(a)

Embodiment 10a

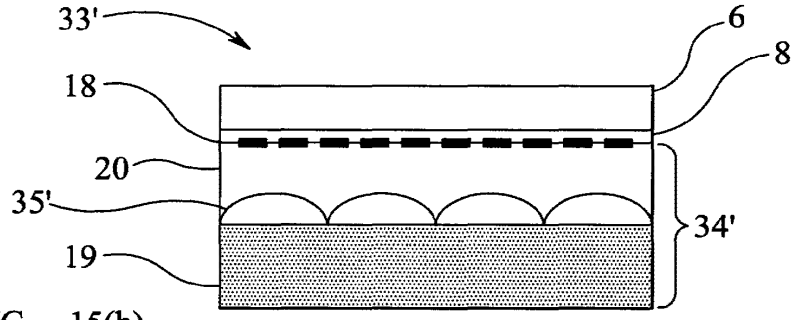


FIG 15(b)

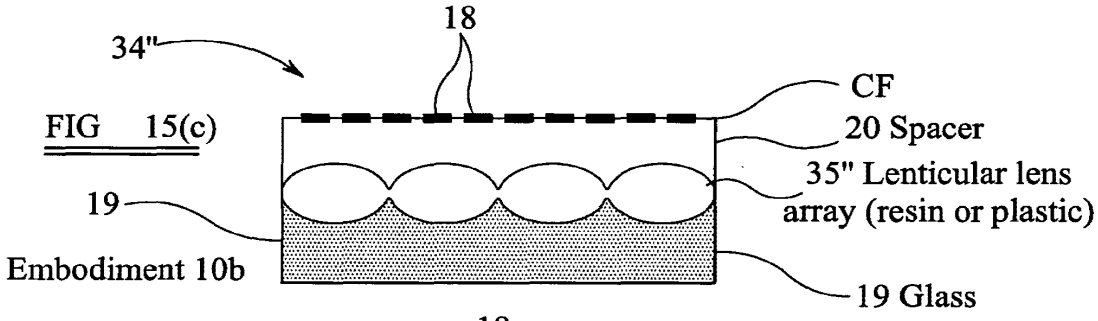


FIG 15(c)

Embodiment 10b

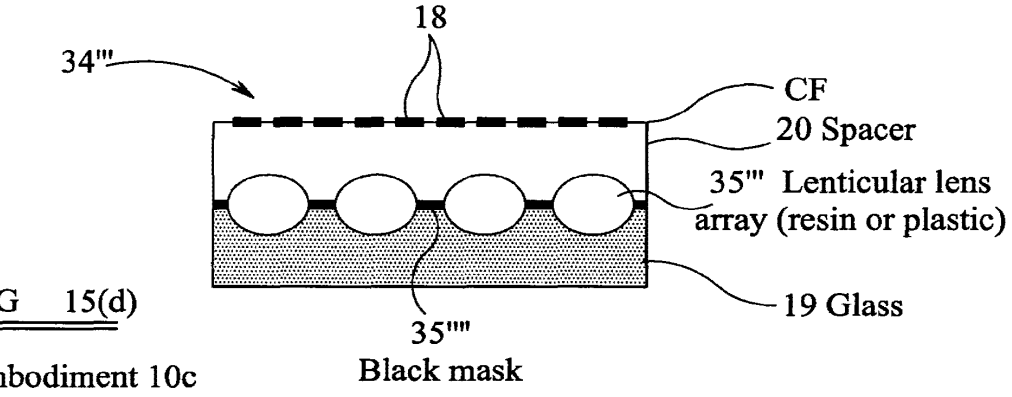
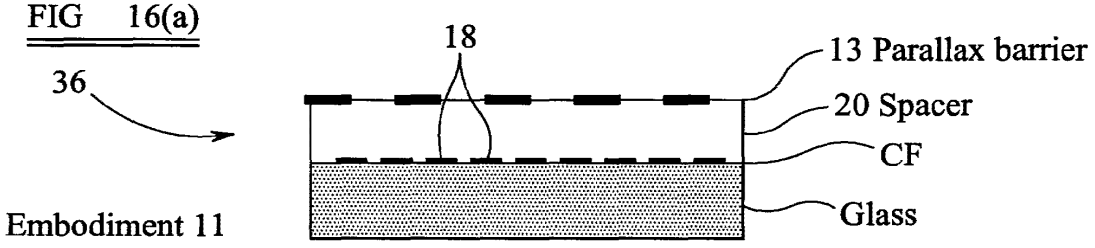


FIG 15(d)

Embodiment 10c

Microsoft Exhibit 1002 - Page 1051
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG 16(a)



Embodiment 11

FIG 16(b)

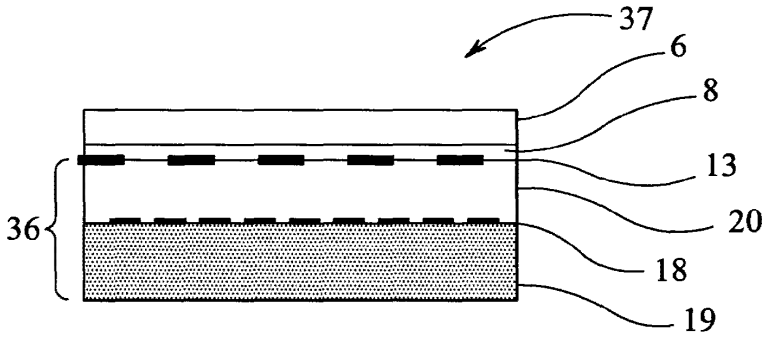
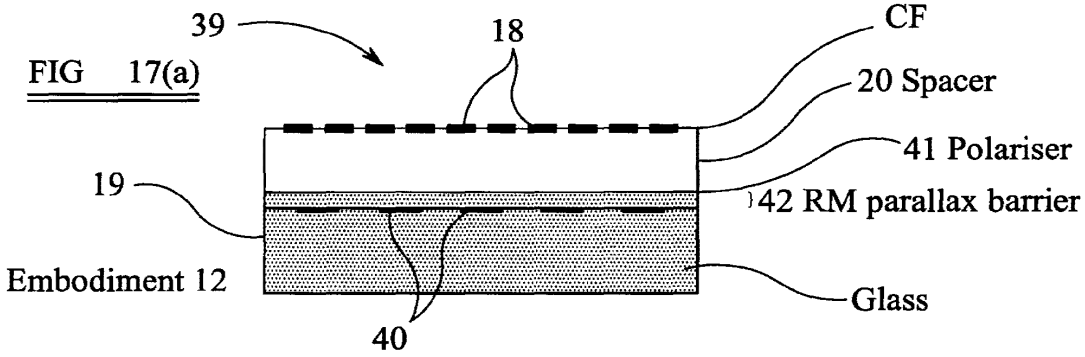
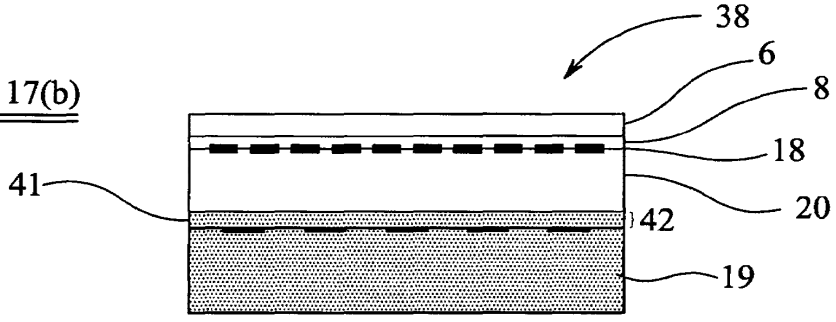


FIG 17(a)



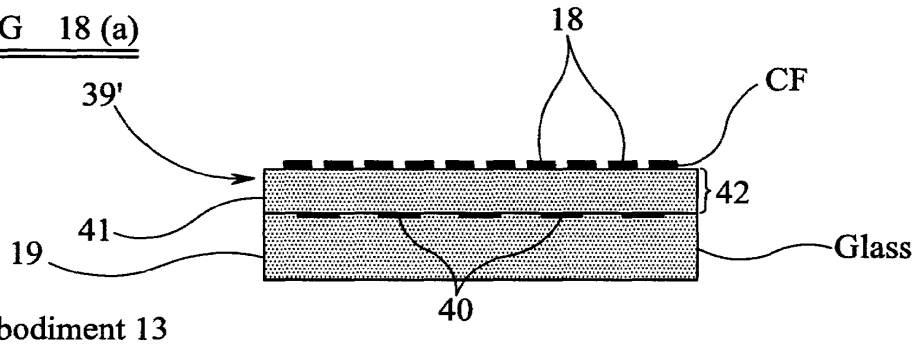
Embodiment 12

FIG 17(b)



Microsoft Exhibit 1002 - Page 1052
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG 18 (a)



Embodiment 13

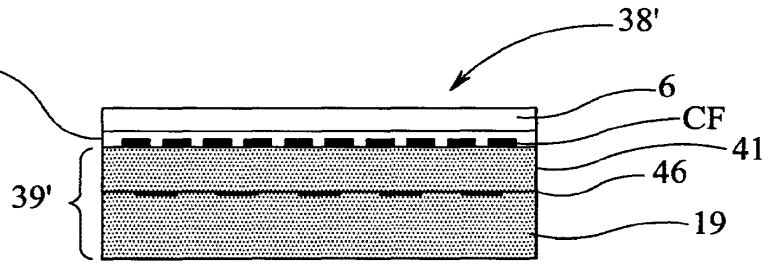
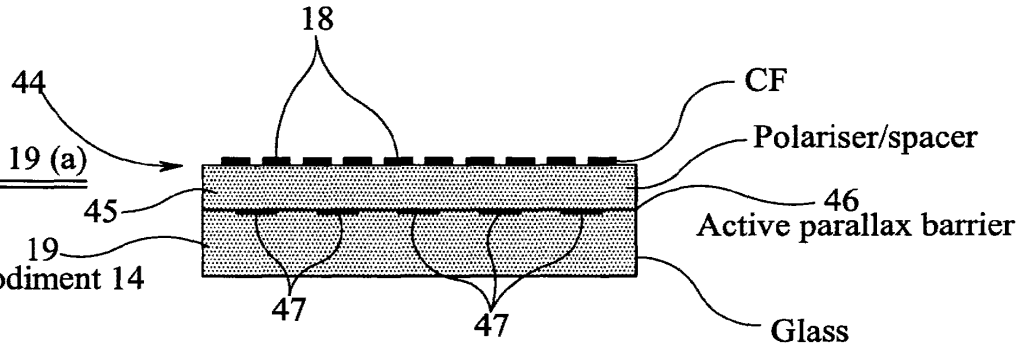


FIG 18 (b)



Embodiment 14

FIG 19 (a)

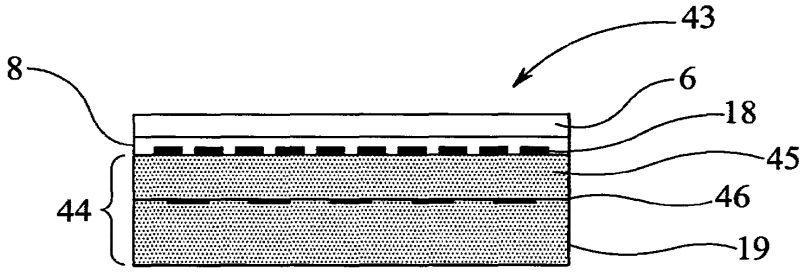


FIG 19 (b)

Microsoft Exhibit 1002 - Page 1053
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

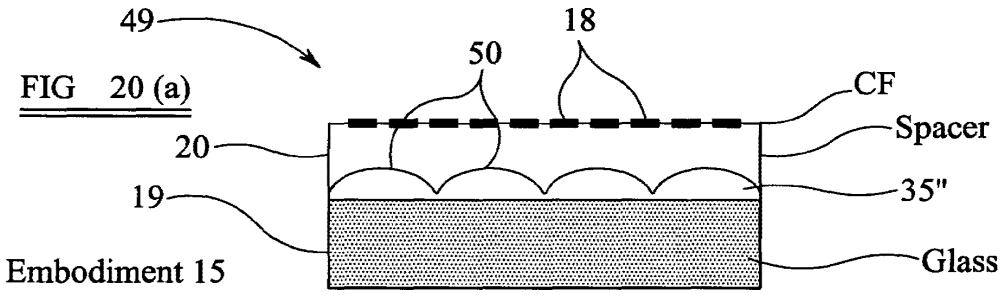


FIG 20 (a)

Embodiment 15

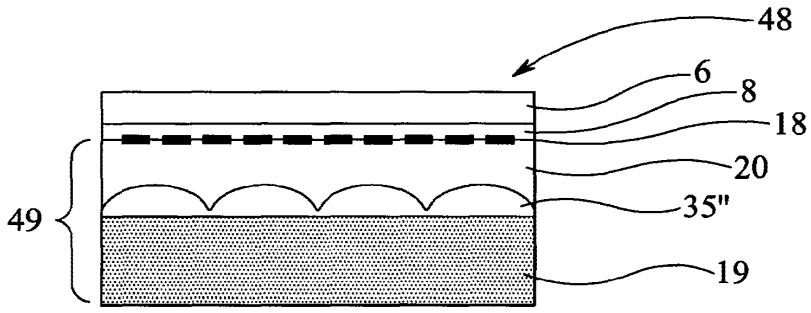


FIG 20 (b)

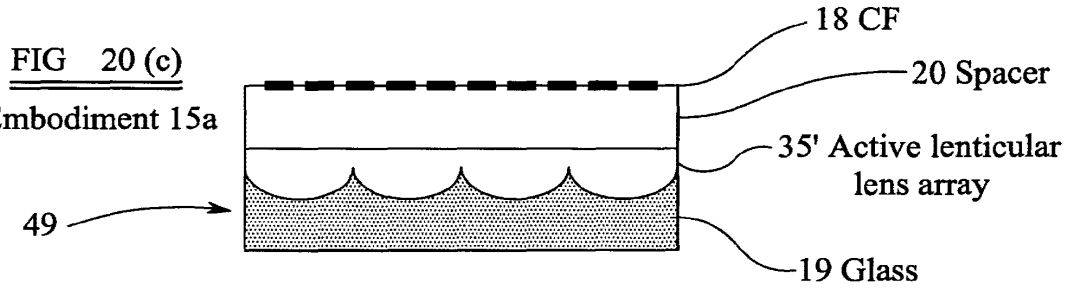


FIG 20 (c)

Embodiment 15a

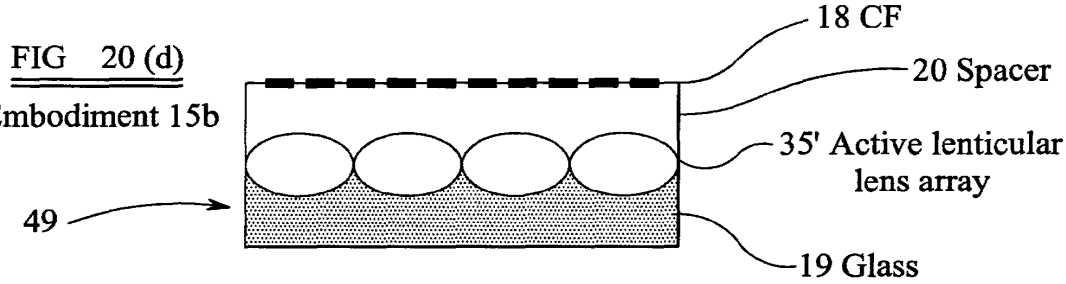
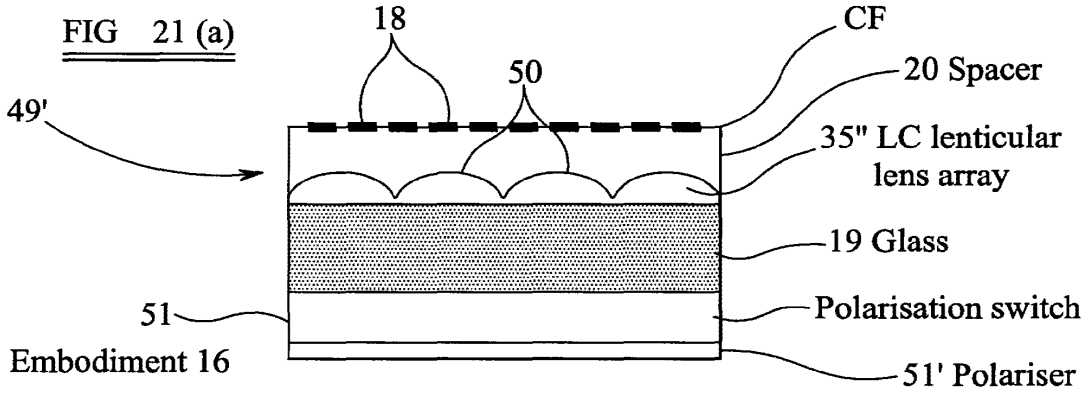


FIG 20 (d)

Embodiment 15b

Microsoft Exhibit 1002 - Page 1054
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG 21 (a)



Embodiment 16

FIG 21 (b)

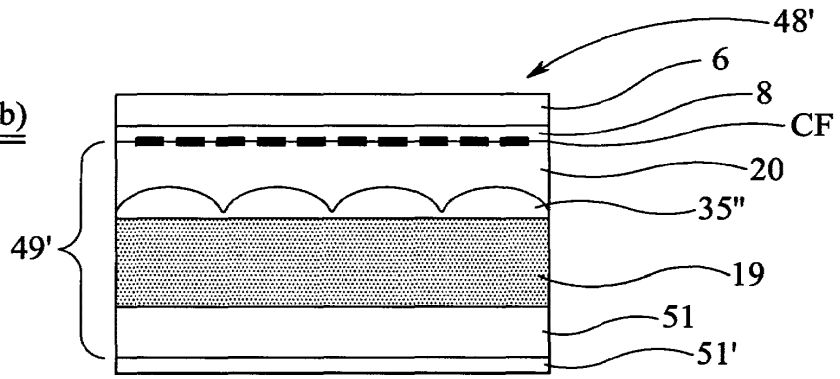
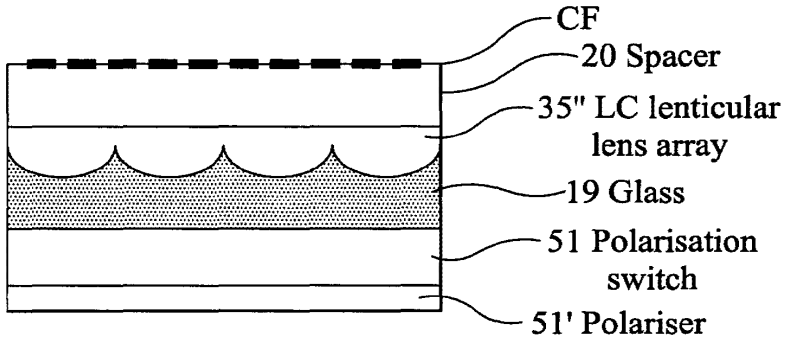


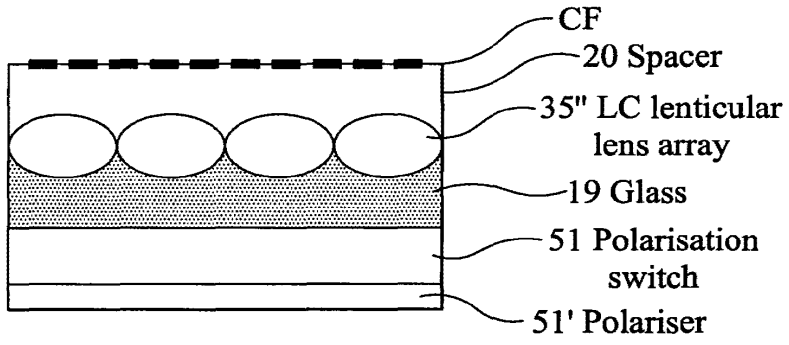
FIG 21 (c)



Embodiment 16a

49'

FIG 21 (d)



Embodiment 16b

49'

Microsoft Exhibit 1002 - Page 1055
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG 22

Embodiment 17

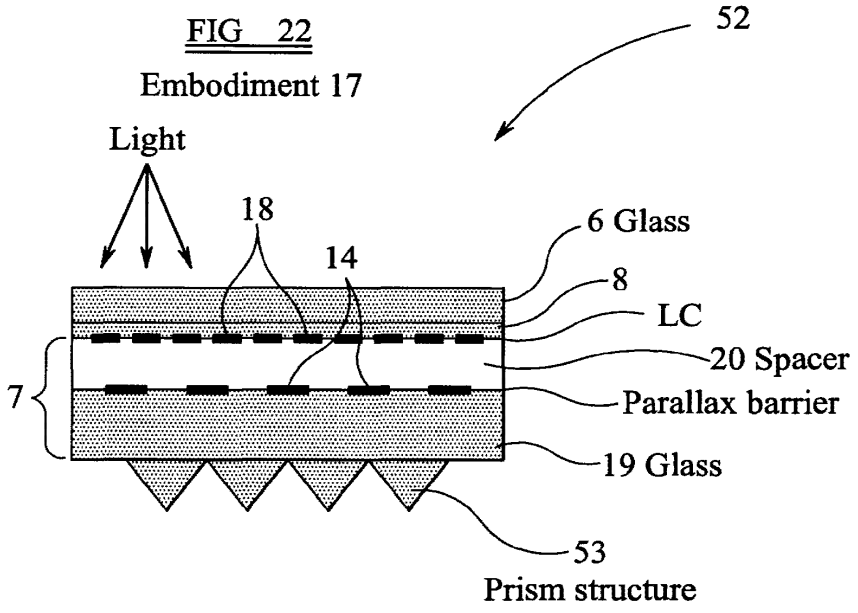
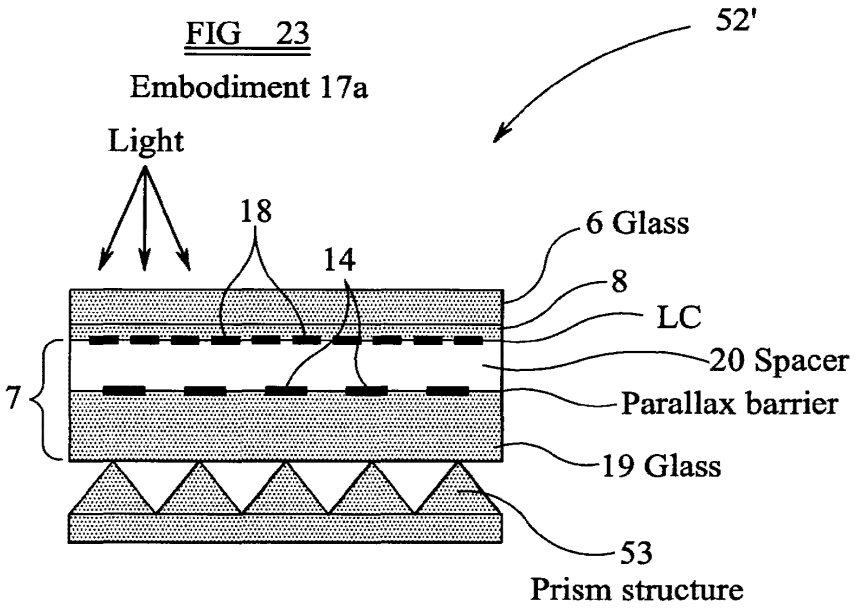


FIG 23

Embodiment 17a



Microsoft Exhibit 1002 - Page 1056
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

FIG 24

Embodiment 18

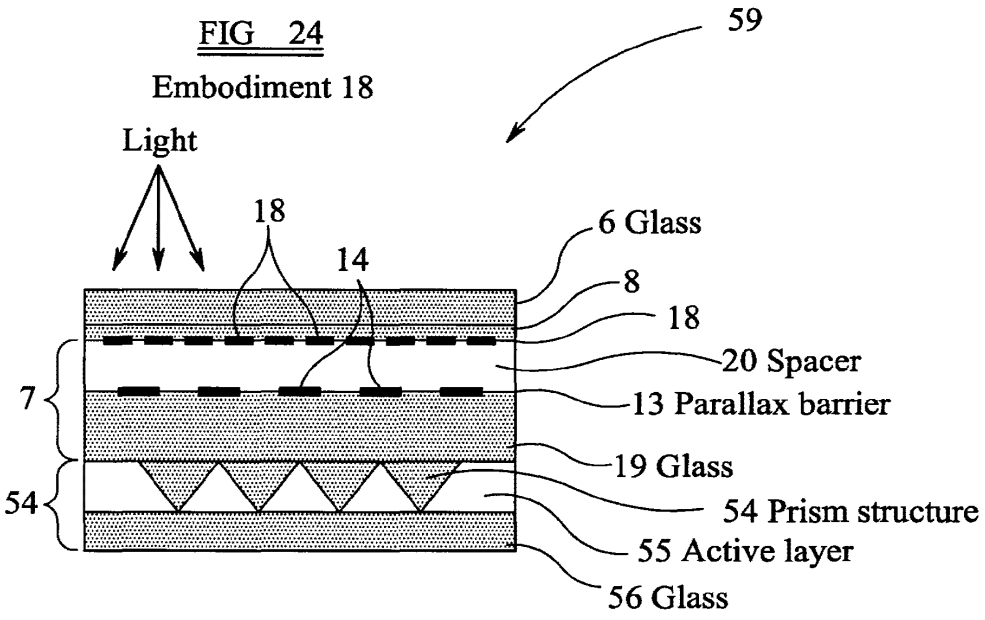
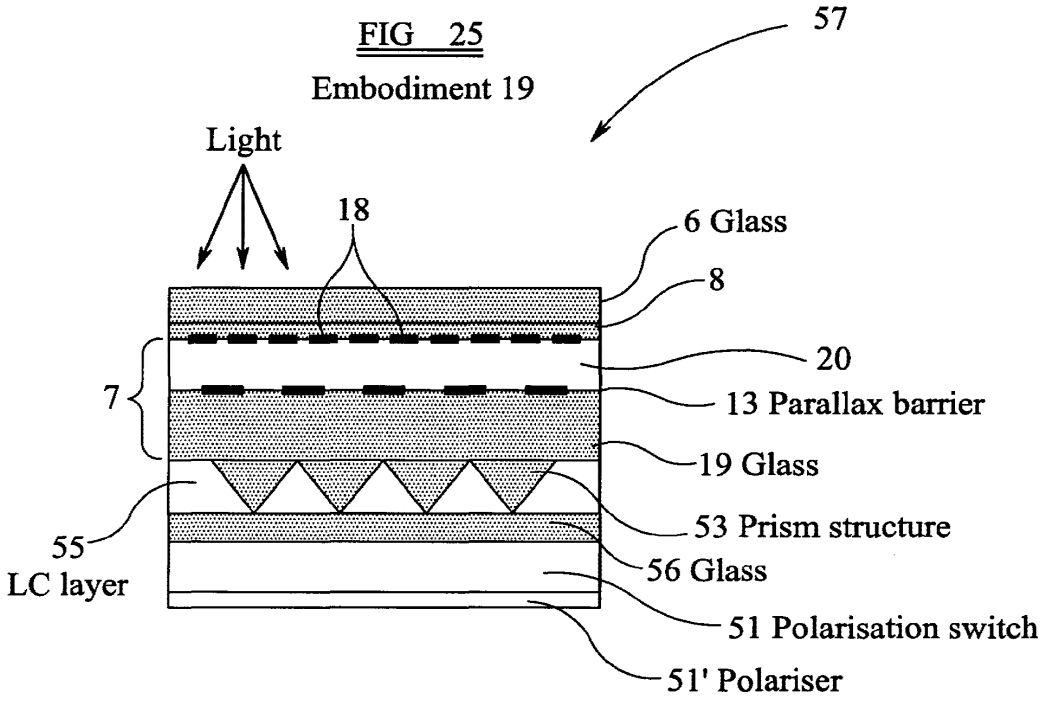


FIG 25

Embodiment 19



Microsoft Exhibit 1002 - Page 1057
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

A Multiple-View Directional Display

The present invention relates to a multiple-view directional display, which displays two or more images such that each image is visible from a different direction. Thus, two observers who view the display from different directions will see different images to one another. Such a display may be used as, for example, an autostereoscopic display device or a dual view display device.

For many years conventional display devices have been designed to be viewed by multiple users simultaneously. The display properties of the display device are made such that viewers can see the same good image quality from different angles with respect to the display. This is effective in applications where many users require the same information from the display – such as, for example, displays of departure information at airports and railway stations. However, there are many applications where it would be desirable for individual users to be able to see different information from the same display. For example, in a motor car the driver may wish to view satellite navigation data while a passenger may wish to view a film. These conflicting needs could be satisfied by providing two separate display devices, but this would take up extra space and would increase the cost. Furthermore, if two separate displays were used in this example it would be possible for the driver to see the passenger's display if the driver moved his or her head, which would be distracting for the driver. As a further example, each player in a computer game for two or more players may wish to view the game from his or her own perspective. This is currently done by each player viewing the game on a separate display screen so that each player sees their own unique perspective on individual screens. However, providing a separate display screen for each player takes up a lot of space and is costly, and is not practical for portable games.

To solve these problems, multiple-view directional displays have been developed. One application of a multiple-view directional display is as a 'dual-view display', which can simultaneously display two or more different images, with each image being visible only in a specific direction – so an observer viewing the display device from one direction will see one image whereas an observer viewing the display device from

Microsoft Exhibit 1002 - Page 1058
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

another, different direction will see a different image. A display that can show different images to two or more users provides a considerable saving in space and cost compared with use of two or more separate displays.

Examples of possible applications of multiple-view directional display devices have been given above, but there are many other applications. For example, they may be used in aeroplanes where each passenger is provided with their own individual in-flight entertainment programmes. Currently each passenger is provided with an individual display device, typically in the back of the seat in the row in front. Using a multiple-view directional display could provide considerable savings in cost, space and weight since it would be possible for one display to serve two or more passengers while still allowing each passenger to select their own choice of film.

A further advantage of a multiple-view directional display is the ability to preclude the users from seeing each other's views. This is desirable in applications requiring security such as banking or sales transactions, for example using an automatic teller machine (ATM), as well as in the above example of computer games.

A further application of a multiple view directional display is in producing a three-dimensional display. In normal vision, the two eyes of a human perceive views of the world from different perspectives, owing to their different location within the head. These two perspectives are then used by the brain to assess the distance to the various objects in a scene. In order to build a display which will effectively display a three dimensional image, it is necessary to re-create this situation and supply a so-called "stereoscopic pair" of images, one image to each eye of the observer.

Three dimensional displays are classified into two types depending on the method used to supply the different views to the eyes. A stereoscopic display typically displays both images of a stereoscopic image pair over a wide viewing area. Each of the views is encoded, for instance by colour, polarisation state, or time of display. The user is required to wear a filter system of glasses that separate the views and let each eye see only the view that is intended for it.

Microsoft Exhibit 1002 - Page 1059
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

An autostereoscopic display displays a right-eye view and a left-eye view in different directions, so that each view is visible only from respective defined regions of space. The region of space in which an image is visible across the whole of the display active area is termed a "viewing window". If the observer is situated such that their left eye is in the viewing window for the left eye view of a stereoscopic pair and their right eye is in the viewing window for the right-eye image of the pair, then a correct view will be seen by each eye of the observer and a three-dimensional image will be perceived. An autostereoscopic display requires no viewing aids to be worn by the observer.

An autostereoscopic display is similar in principle to a dual-view display. However, the two images displayed on an autostereoscopic display are the left-eye and right-eye images of a stereoscopic image pair, and so are not independent from one another. Furthermore, the two images are displayed so as to be visible to a single observer, with one image being visible to each eye of the observer.

For a flat panel autostereoscopic display, the formation of the viewing windows is typically due to a combination of the picture element (or "pixel") structure of the image display unit of the autostereoscopic display and an optical element, generically termed a parallax optic. An example of a parallax optic is a parallax barrier, which is a screen with transmissive regions, often in the form of slits, separated by opaque regions. This screen can be set in front of or behind a spatial light modulator (SLM) having a two-dimensional array of picture elements to produce an autostereoscopic display.

Figure 1 is a plan view of a conventional multiple view directional device, in this case an autostereoscopic display. The directional display 1 consists of a spatial light modulator (SLM) 4 that constitutes an image display device, and a parallax barrier 5. The SLM of Figure 1 is in the form of a liquid crystal display (LCD) device having an active matrix thin film transistor (TFT) substrate 6, a counter-substrate 7, and a liquid crystal layer 8 disposed between the substrate and the counter substrate. The SLM is provided with addressing electrodes (not shown) which define a plurality of independently-addressable picture elements, and is also provided with alignment layers (not shown) for aligning the liquid crystal layer. Viewing angle enhancement films 9

Microsoft Exhibit 1002 - Page 1060
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

and linear polarisers 10 are provided on the outer surface of each substrate 6, 7. Illumination 11 is supplied from a backlight (not shown).

The parallax barrier 5 comprises a substrate 12 with a parallax barrier aperture array 13 formed on its surface adjacent the SLM 4. The aperture array comprises vertically extending (that is, extending into the plane of the paper in Figure 1) transparent apertures 15 separated by opaque portions 14. An anti-reflection (AR) coating 16 is formed on the opposite surface of the parallax barrier substrate 12 (which forms the output surface of the display 1).

The pixels of the SLM 4 are arranged in rows and columns with the columns extending into the plane of the paper in Figure 1. The pixel pitch (the distance from the centre of one pixel to the centre of an adjacent pixel) in the row or horizontal direction being p. The width of the vertically-extending transmissive slits 15 of the aperture array 13 is 2w and the horizontal pitch of the transmissive slits 15 is b. The plane of the barrier aperture array 13 is spaced from the plane of the liquid crystal layer 8 by a distance s.

In use, the display device 1 forms a left-eye image and a right-eye image, and an observer who positions their head such that their left and right eyes are coincident with the left-eye viewing window 2 and the right-eye viewing window 3 respectively will see a three-dimensional image. The left and right viewing windows 2,3 are formed in a window plane 17 at the desired viewing distance from the display. The window plane is spaced from the plane of the aperture array 13 by a distance r_o. The windows 2,3 are contiguous in the window plane and have a pitch e corresponding to the average separation between the two eyes of a human. The half angle to the centre of each window 10, 11 from the normal axis to the display normal is α_s.

The pitch of the slits 15 in the parallax barrier 5 is chosen to be close to an integer multiple of the pixel pitch of the SLM 4 so that groups of columns of pixels are associated with a specific slit of the parallax barrier. Fig. 1 shows a display device in which two pixel columns of the SLM 4 are associated with each transmissive slit 15 of the parallax barrier.

Microsoft Exhibit 1002 - Page 1061
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Figure 2 shows the angular zones of light created from an SLM 4 and parallax barrier 5 where the parallax barrier has a pitch of an exact integer multiple of the pixel column pitch. In this case, the angular zones coming from different locations across the display panel surface intermix and a pure zone of view for image 1 or image 2 (where 'image 1' and 'image 2' denote the two images displayed by the SLM 4) does not exist. In order to address this, the pitch of the parallax barrier is preferably reduced slightly so that it is slightly less than an integer multiple of the pixel column pitch. As a result, the angular zones converge at a pre-defined plane (the "window plane") in front of the display. This effect is illustrated in Figure 3 of the accompanying drawings, which shows the image zones created by an SLM 4 and a modified parallax barrier 5'. The viewing regions, when created in this way, are roughly kite-shaped in plan view.

Figure 4 is a plan view of another conventional multiple view directional display device 1'. This corresponds generally to the display device 1 of Figure 1, except that the parallax barrier 5 is placed behind the SLM 4, so that it is between the backlight and SLM 4. This device may have the advantages that the parallax barrier is less visible to an observer, and that the pixels of the display appear to be closer to the front of the device. Furthermore, although figures 1 and 4 each show a transmissive display device illuminated by a backlight, reflective devices that use ambient light (in bright conditions) are known. In the case of a transflective device, the rear parallax barrier of Figure 4 will absorb none of the ambient lighting. This is an advantage if the display has a 2D mode that uses reflected light.

In the display devices of figures 1 and 4, a parallax barrier is used as the parallax optic. Other types of parallax optic are known. For example, lenticular lens arrays may be used to direct interlaced images in different directions, so as to form a stereoscopic image pair or to form two or more images, each seen in a different direction.

Holographic methods of image splitting are known, but in practice these methods suffer from viewing angle problems, pseudoscopic zones and a lack of easy control of the images.

Microsoft Exhibit 1002 - Page 1062
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Another type of parallax optic is a micropolariser display, which uses a polarised directional light source and patterned high precision micropolariser elements aligned with the pixels of the SLM. Such a display offers the potential for high window image quality, a compact device, and the ability to switch between a 2D display mode and a 3D display mode. The dominant requirement when using a micropolariser display as a parallax optic is the need to avoid parallax problems when the micropolariser elements are incorporated into the SLM.

Where a colour display is required, each pixel of the SLM 4 is generally given a filter-associated with one of the three primary colours. By controlling groups of three pixels, each with a different colour filter, many visible colours may be produced. In an autostereoscopic display each of the stereoscopic image channels must contain sufficient of the colour filters for a balanced colour output. Many SLMs have the colour filters arranged in vertical columns, owing to ease of manufacture, so that all the pixels in a given column have the same colour filter associated with them. If a parallax optic is disposed on such an SLM with three pixel columns associated with each slit or lenslet of the parallax optic, then each viewing region will see pixels of one colour only. Care must be taken with the colour filter layout to avoid this situation. Further details of suitable colour filter layouts are given in EP-A-0 752 610.

The function of the parallax optic in a directional display device such as those shown in figures 1 and 4 is to restrict light transmitted through the pixels of the SLM 4 to certain output angles. This restriction defines the angle of view of each of the pixel columns behind a given element of the parallax optic (such as for example a transmissive slit). The angular range of view of each pixel is determined by the pixel pitch p, the separation s between the plane of the pixels and the plane of the parallax optic, and the refractive index n of the material between the plane of the pixels and the plane of the parallax optic (which in the display of Figure 1 is the substrate 7). H Yamamoto et al. show, in "Optimum parameters and viewing areas of stereoscopic full-colour LED displays using parallax barrier", IEICE Trans. Electron., vol. E83-C, No. 10, p1632

Microsoft Exhibit 1002 - Page 1063
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

(2000), that the angle of separation between images in an autostereoscopic display depends on the distance between the display pixels and the parallax barrier.

The half-angle α of Figure 1 or 4 is given by:

$$\sin\alpha = n\sin\left(\arctan\left(\frac{p}{2s}\right)\right) \qquad (1)$$

One problem with many existing multiple view directional displays is that the angular separation between the two images is too low. In principle, the angle 2α between viewing windows may be increased by increasing the pixel pitch p, decreasing the separation between the parallax optic and the pixels s, or by increasing the refractive index of the substrate n.

Co-pending UK patent application No. 0315171.9 describes a novel pixel structures for use with standard parallax barriers which provides a greater angular separation between the viewing windows of a multiple-view directional display. However, it would be desirable to be able to use a standard pixel structure in a multiple-view directional display.

Co-pending UK patent application Nos. 0306516.6 and 0315170.1 propose increasing the angle of separation between the viewing windows of a multiple-view directional display by increasing the effective pitch of the pixels.

JP-A-7 28 015 propose increasing the pixel pitch and therefore the angular separation between viewing windows of a multiple-view directional display by rotating the pixel configuration such that the colour sub pixels run horizontally rather than vertically. This results in a threefold increase in pixel width and therefore roughly three times increase in viewing angle. This has the disadvantage that the pitch of the parallax barrier pitch must increase as the pixel pitch increases which, in turn, increases the visibility of the parallax barrier to an observer. The manufacture and driving of such a non-standard panel may not be cost effective. In addition there may be applications in

Microsoft Exhibit 1002 - Page 1064
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

which the increase in viewing angle needs to be greater than three times the standard configuration and in these cases simply rotating the pixels will not be sufficient. This is often the case with high resolution panels.

In general, however, the pixel pitch is typically defined by the required resolution specification of the display device and therefore cannot be changed.

It is not always practical or cost effective significantly to change the refractive index of the substrates, which are normally made of glass.

Other attempts at increasing the angular separation between the viewing windows of a multiple-view directional display device have attempted to reduce the separation between the parallax optic and the plane of the pixels of the SLM. However, this has been difficult as will be explained with respect to Figure 5, which is a schematic block view of the display device 1 of Figure 1 with an LCD as the SLM 4.

The LCD panel which forms the SLM 4 is made from two glass substrates. The substrate 6 carries TFT switching elements for addressing the pixels of the SLM, and is therefore known as a "TFT substrate". It will in general also carry other layers for, for example, aligning the liquid crystal layer 8 and allowing electrical switching of the liquid crystal layer. On the other substrate 7 (corresponding to the counter substrate of Figure 1) colour filters 18 are formed, together with other layers for, for example, aligning the liquid crystal layer. The counter substrate 7 is therefore generally known as a "colour filter substrate" or CF substrate. The LCD panel is formed by placing the colour filter substrate opposite to the TFT substrate, and sandwiching the liquid crystal layer 8 between the two substrates. In previous directional displays the parallax optic has been adhered to the completed LCD panel as shown in figure 5. The distance between the LCD pixels and the parallax optic is determined primarily by the thickness of the CF substrate of the LCD. Reducing the thickness of the CF substrate will reduce the distance between the LCD pixels and the parallax optic, but will make the substrate correspondingly weaker. A realistic minimum for LC substrate thickness is about 0.5mm, but the pixel-to-parallax optic separation would still be too large for many applications if a parallax optic were adhered to a substrate of this thickness.

Microsoft Exhibit 1002 - Page 1065
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Japanese Patent No. 9-50 019 discloses a method for increasing the angular separation between the viewing windows of a multiple-view directional display device thereby to decrease viewing distance. This patent proposes reducing the thickness between the LC and barrier. This is done by constructing the stereoscopic LCD panel with the following order of components: LCD panel, parallax barrier, polariser. Previously the order had been: LCD panel, polariser, parallax barrier, as shown in Figure 1. This reduces the separation between the parallax barrier and the pixel plane by the thickness of the polariser, but this results in only a limited increase in the angular separation between the viewing windows of a multiple-view directional display device.

The present invention provides a multiple view directional display having an image display element and a parallax optic; wherein the image display element comprises: a first substrate; a second substrate; and an image display layer sandwiched between the first substrate and the second substrate; and wherein the parallax optic is disposed within the image display element..

Putting the parallax optic within the image display element puts the parallax optic closer to the image display layer, thereby reducing the separation s of equation (1) and increasing the angular separation between two viewing windows produced by the display device. It is not necessary to reduce the thickness of one of the substrates of the image display element, so that the structural strength of the image display element is not affected.

The parallax optic may be disposed between the first substrate and the second substrate. This is a convenient way of placing the parallax optic close to the image display layer.

Alternatively, the parallax optic may be disposed within one of the first substrates or the second substrate. This is another method of enabling the parallax optic to be placed closer to the image display layer without reducing the thickness of the substrates of the image display element.

Microsoft Exhibit 1002 - Page 1066
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

The parallax optic and one of a colour filter array and an array of switching elements may be disposed over a first principal surface of the first substrate.

The parallax optic may be disposed on the first principal surface of the first substrate and the colour filter array or array of switching elements may be disposed over the parallax optic. Alternatively, the colour filter array or array of switching elements may be disposed on the first principal surface of the first substrate and the parallax optic may be disposed over the colour filter array or the or array of switching elements.

The display may further comprise a transparent spacer layer disposed between the parallax optic and the colour filter array or array of switching elements

The display may further comprise another parallax optic disposed between the parallax optic and the colour filter array or array of switching elements.

The parallax optic may comprise a plurality of parallax elements, with each parallax element being disposed in a respective recess in the principal surface of the substrate. Each parallax element may be disposed on a bottom face of a respective recess.

A light-transmissive layer may be disposed over a principal surface of the substrate; a plurality of recesses may be defined in the light-transmissive layer; and the parallax optic may comprise a plurality of parallax elements, each parallax element being disposed in a respective recess in the light-transmissive layer.

The cross-section of a recess, parallel to the surface of the substrate, may decrease with depth.

Each parallax element may substantially fill a respective recess.

One of a colour filter array and an array of switching elements may be disposed over a first principal surface of the first substrate and the parallax optic may be disposed over a second principal surface of the first substrate and.

Microsoft Exhibit 1002 - Page 1067
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

The parallax optic may comprise a plurality of parallax elements, each parallax element being disposed in a respective recess in the second principal surface of the substrate.

The parallax optic may be a parallax barrier, or a lenticular lens array.

The parallax optic may be disableable, and it may be addressable.

A second aspect of the present invention provides a dual-view display device comprising a multiple-view directional display device as defined above.

A third aspect of the present invention provides an auto-stereoscopic display device comprising a multiple-view directional display device as defined above.

A fourth aspect of the present invention provides a parallax optic comprising: a light-transmissive substrate; and a plurality of parallax elements, each parallax element being disposed in a respective recess in a surface of the substrate.

The cross-section of a recess, parallel to the surface of the substrate, may decrease with depth.

Each parallax element may substantially fill a respective recess.

Preferred embodiments of the present invention will now be described by way of illustrative example with reference to the accompanying figures in which:

Figure 1 is a schematic plan view of a conventional auto-stereoscopic display device;
Figure 2 is a schematic illustration of viewing windows provided by a conventional multiple-view display device;
Figure 3 is a schematic plan view of viewing windows produced by another conventional multiple-view directional display device;

Microsoft Exhibit 1002 - Page 1068
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Figure 4 is a schematic plan view of another conventional auto-stereoscopic display device;

Figure 5 is a schematic plan view showing the principle components of a conventional multiple-view directional display device;

Figures 6(a) and 6(b) illustrate a display according to a first embodiment of the present invention;

Figures 6(c) and 6(d) illustrate a display according to a further embodiment of the present invention;

Figures 7(a) and 7(b) illustrate a display according to a further embodiment of the present invention;

Figures 8(a) and 8(b) illustrate a display according to a further embodiment of the present invention;

Figures 9(a) and 9(b) illustrate a display according to a further embodiment of the present invention;

Figures 10(a) and 10(b) illustrate a display according to a further embodiment of the present invention;

Figures 11(a) and 11(b) illustrate a display according to a further embodiment of the present invention;

Figure 12(a) and 12(b) illustrate a display according to a further embodiment of the present invention;

Figure 13(a) and 13(b) illustrate a display according to a further embodiment of the present invention;

Figures 14(a) and 14(b) illustrate a display according to a further embodiment of the present invention;

Figures 15(a) and 15(b) illustrate a display according to a further embodiment of the present invention;

Figures 15(c) and 15(d) illustrate colour filter substrates of displays according to further embodiments of the invention;

Figures 16(a) and 16(b) illustrate a display according to a further embodiment of the present invention;

Figures 17(a) and 17(b) illustrate a display according to a further embodiment of the present invention;

Microsoft Exhibit 1002 - Page 1069
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Figures 18(a) and 18(b) illustrate a display according to a further embodiment of the present invention;

Figures 19(a) and 19(b) illustrate a display according to a further embodiment of the present invention;

Figures 20(a) and 20(b) illustrate a display according to a further embodiment of the present invention;

Figures 20(c) and 20(d) illustrate colour filter substrates of displays according to further embodiments of the invention;

Figures 21(a) and 21(b) illustrate a display according to a further embodiment of the present invention;

Figures 21(c) and 21(d) illustrate colour filter substrates of displays according to further embodiments of the invention;

Figure 22 illustrates a display according to a further embodiment of the present invention;

Figure 23 illustrates a display according to a further embodiment of the present invention;

Figure 24 illustrates a display according to a further embodiment of the present invention; and

Figure 25 illustrates a display according to a further embodiment of the present invention;

Like reference numerals denote like components throughout the drawings.

Figure 6(b) is a schematic plan view of a multiple-view directional display according to a first embodiment of the present invention. The display device 58 comprises a first transparent substrate 6 and a second transparent substrate 7, with an image display layer 8 disposed between the first substrate 6 and the second substrate 7. An array of colour filters 18 is provided on the second substrate 7, and the second substrate will therefore be referred to as a colour filter substrate.

The first substrate 6 is provided with pixel electrodes (not shown) for defining an array of pixels in the image display layer 8, and is also provided with switching elements (not

Microsoft Exhibit 1002 - Page 1070
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

shown) such as thin film transistors (TFTs) for selectively addressing the pixel electrodes. The substrate 6 will be referred to as a 'TFT substrate'.

The image display layer 8 is, in this example, a liquid crystal layer 8. The invention is not limited to this, however, and any transmissive image display layer may be used. Moreover, where the display is used in a "front barrier mode", with the parallax optic disposed between the image display layer and an observer, the display layer may alternatively be an emissive display layer such as a plasma display or an organic light-emitting device (OLED) layer.

The display 58 is assembled such that the colour filters 18 are each substantially opposite a respective pixel of the image display layer 8. Other components such as alignment layers may be disposed on the surfaces of the substrate 6, 7 adjacent to the image display layer, and a counter electrode or electrodes may also be disposed on the CF substrate 7; these components are conventional, and will not be described further. Furthermore, the display 58 may comprise further components such as polarisers, viewing-angle enhancement films, anti-reflection films etc., disposed outside the image display element; these components are also conventional and will not be described further.

The colour filter substrate 7 is shown in more detail in figure 6(a). The colour filter substrate 7 comprises a base substrate 19 made of a light-transmissive material such as glass. A parallax barrier aperture array 13 is disposed on one principle surface of the base substrate 19. In the embodiment of figure 6(a) the parallax barrier aperture array 13 is formed by depositing opaque strips 14 on the surface of the base substrate, thereby defining transmissive slits 15 between the opaque strips.

A spacer layer 20, in this embodiment formed of light-transmissive resin is provided over the parallax barrier aperture array 13. Finally, the colour filters 18 are disposed on the upper surface of the spacer layer 20.

Microsoft Exhibit 1002 - Page 1071
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

In this embodiment, the parallax barrier aperture array 13 is separated from the pixels of the liquid crystal layer 8 by the thickness of the resin spacer layer 20. The resin layer 20 can be made very thin, so that the separation s of equation (1) is small leading to a large angular separation of the viewing windows. Although the resin layer 20 is shown as a single layer, in practice it may be necessary to deposit two or more separate resin layers in order to obtain a spacer layer having the desired thickness. For example, the layer 20 may have a thickness of 50 microns and may comprise polyethylene perephthalate.

Figures 6(d) is a schematic plan views of display 21 according to a further embodiment of the present invention, and Figure 6(c) shows the counter substrate of this display. Only the differences between this embodiment and the previous embodiment will be described.

In this embodiment, the parallax barrier aperture array 13 and the colour filters 18 are both disposed on a first principal surface of the base substrate 19 of the colour filter substrate 7'. The spacer layer 20, again formed of resin, is then disposed over the parallax barrier aperture array 13 and the array of colour filters. Again, the parallax barrier aperture array 13 is separated from the pixels in the liquid crystal layer 8 by the thickness of the resin layer 20, and this can be made small. Providing the parallax barrier and colour filters in the same plane simplifies the manufacture of the display;

Figure 7(b) is a plan view of a display 22 according to a further embodiment of the present invention, and Figure 7(a) shows the colour filter substrate of the display 22. Only the differences between this embodiment and the first embodiment will be described.

In the embodiment of figures 7(a) and 7(b) the parallax barrier aperture array 13 is deposited on a principal surface of the base substrate 19. A spacer layer 20 is placed over the parallax barrier aperture array 13 and the array of colour filters is disposed over the spacer layer 20. In this embodiment, the spacer layer 20 is a glass spacer layer

Microsoft Exhibit 1002 - Page 1072
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

rather than a resin spacer layer. The glass spacer layer is adhered to the parallax barrier, and may be etched in situ to a desired thickness.

Figure 8(b) is a schematic plan-view of a display 23 according to a further embodiment of the present invention, and Figure 8(a) shows the CF substrate of this display. The display 23 of this embodiment corresponds generally to the display of figure 6(b), and only the differences between the embodiments will be described. In the display 23, the spacer layer 20 between the parallax barrier aperture array and the array of colour filters 18 is a layer of a plastics material. The layer of plastics material is adhered to the parallax barrier aperture array 13 by a suitable method such as lamination or gluing. The plastics material 20 may alternatively be printed over the parallax barrier aperture array.

Figure 9(b) is a schematic plan view of a multiple view directional display 24 according to a further embodiment of the present invention, and Figure 9(a) shows the CF substrate 25 of the display. The display 24 again comprises a TFT substrate 6, a colour filter substrate 25, and a liquid crystal layer or other image display layer 8 disposed between the TFT substrate 6 and the colour filter substrate 25.

Figure 9(a) shows the colour filter substrate 25 of the display. As can be seen from the figure, a plurality of recesses 26 is formed in a first principal surface of a base substrate 19. The base substrate 19 may be formed of any suitable light-transmissive material such as, for example, glass, plastic, or glass-reinforced plastic. The recesses 26 may be formed by any suitable process such as, for example, an etching or cutting process. The recesses 26 are preferably in the form of slots that extend across the entire vertical height of the base substrate 19 – that is, they extend into the plane of the paper in Figure 9(a). The recesses 26 preferably have substantially the same depth and width as one another.

A parallax barrier aperture array is defined in the substrate 19 by depositing an opaque material into each recess 26 so that it covers at least the bottom face of each recess. The

Microsoft Exhibit 1002 - Page 1073
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

opaque material thereby defines opaque strips 14 of a parallax barrier aperture array, and light-transmissive regions are defined between the opaque strips 14.

The opaque material that forms the opaque regions of the parallax barrier aperture array may be any suitable opaque material, and may be deposited by any suitable method. For example, an opaque resin may be deposited in the recesses 26 using a spinning process.

Once the opaque material has been deposited, the recesses are then filled with a light-transmissive material in order to planarise the surface of the base substrate 19. For example, a light-transmissive resin may be deposited in the recesses 26 using a spinning process.

Once the surface of the substrate 19 has been made flat, an array of colour filters 18 may be deposited over the substrate 19 to complete the colour filter substrate 25.

In this embodiment, the separation between the parallax barrier aperture array and the liquid crystal layer is approximately equal to the depth d of the recesses 26. The depth d of the recesses can be made small, for example 50 microns, so that a large angular separation between viewing windows can be obtained.

Figure 10(b) shows a display 27 according to a further embodiment of the present invention. The display 27 again comprises a TFT substrate 6, a colour filter substrate 25', and a liquid crystal layer (or other image display layer) 8 disposed between the TFT substrate 6 and the colour filter substrate 25'. This embodiment corresponds generally to the embodiment of figure 9(a) and 9(b), and only the differences between the two embodiments will be described.

Figure 10(a) is a schematic plan view of the colour filter substrate 25' of the display 27. In this embodiment, the colour filters 18 are deposited on a first principal surface of the base substrate 19. Recesses 26 are defined in a second principal surface of the base substrate 19, for example using an etching or cutting technique. An opaque material is

Microsoft Exhibit 1002 - Page 1074
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

then deposited in the recesses, to form the opaque strips 14 of a parallax barrier aperture array. If desired, the recesses may then be filled with a light-transmissive material in order to planarise the second principal surface of the base substrate 19. As in the previous embodiment, any suitable material may be deposited as the opaque material, and may be deposited by any suitable technique. In one preferred embodiment, an opaque resin is deposited into the recesses 26 using a spinning technique.

Compared to the conventional display of figure 5, the separation between the parallax barrier and the liquid crystal layer is reduced by the depth of the recesses, for example 50 microns, so that the angular separation between viewing windows is therefore increased. Since the thickness of the base substrate is reduced only where the recesses are present, the structural strength of the base substrate may be greater than if the entire substrate had been made with a reduced thickness.

Figure 11(b) is a schematic plan view of a multiple-view directional display 28 according to a further embodiment of the present invention. This display again consists of a TFT substrate 6, a colour filter substrate 29, and a liquid crystal layer 8 or other image display layer disposed between the TFT substrate 6 and the colour filter substrate 29.

The colour filter substrate 29 is shown in figure 11(a). As can be seen, the colour filter substrate 29 is generally similar to the colour filter substrate 7 of figure 6(a), except that it is provided with two parallax barriers 13, 13'. The colour filter substrate 29 comprises a base substrate 19 which is made of any suitable light-transmissive material such as, for example, glass. A first parallax barrier aperture array 13 is disposed over a first surface of the base substrate. The parallax barrier aperture array may be formed by, for example, depositing stripes 14 of an opaque material over the substrate to form the opaque portions 14 of a parallax barrier aperture array 13.

A first light-transmissive spacer layer 20 is then deposited over the surface of the substrate 19 on which the parallax barrier aperture array is formed. The first spacer

Microsoft Exhibit 1002 - Page 1075
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

layer may be formed of, for example, a light-transmissive resin, glass, or a transparent plastics material as in the embodiments of figures 6(a), 7(a) and 8(a) described above.

A second parallax barrier aperture array 13' is disposed over the upper surface of the first spacer layer 20. This second parallax barrier aperture array may again be provided by depositing opaque material over the spacer layer 20 in order to form opaque portions 14' of the second parallax barrier aperture array.

A second spacer layer 20' is provided over the second parallax barrier aperture array. The second spacer layer may again be any suitable light-transmissive material such as a light-transmissive resin, a glass layer, glass, or a light-transmissive plastics material.

The colour filters 18 are deposited over the upper surface of the second spacer layer 20'.

This embodiment is not limited to the provision of two parallax barriers on the colour filter substrate. In principle, three or more parallax barrier aperture arrays could be provided over the substrate 19, with each pair of adjacent parallax barrier aperture arrays being separated by a respective spacer layer.

In the embodiment of figure 11(a), it is not necessary for the two spacer layers 20, 20' to be formed of the same material. The two spacer layers may be made of different materials – thus, as an example, the first spacer layer 20 could be a glass layer whereas the second spacer layer 20' could be a light-transmissive resin layer.

In another embodiment (not illustrated), the colour filter substrate is provided with two parallax barrier aperture arrays, one disposed on each side of the base substrate 19. In this embodiment, a first parallax barrier array would be formed on one principal surface of the base substrate 19 and the filters 18 would be provided over the first parallax barrier aperture array with a light-transmissive spacer layer being interposed between the first parallax barrier aperture array and the colour filters 18 as in figure 6(a), 7(a), or 8(a). A second parallax barrier aperture array would be formed on the second principal

Microsoft Exhibit 1002 - Page 1076
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

surface of the base substrate 19, and this would be overlaid by a light-transmissive layer.

Figure 12(a) and 12(b) show a further embodiment of the present invention. Figure 12(b) is a schematic plan view of a multiple-view directional display 30 according to this embodiment of the present invention. The display device again comprises a TFT substrate 6, a colour filter substrate 31, and a liquid crystal layer 8 or other image display layer disposed between the TFT substrate 6 and the colour filter substrate 31.

Figure 12(a) is a schematic plan view of the colour filter substrate 31 of this embodiment of the invention. The colour filter substrate 31 comprises a base substrate 19 which may be made of any suitable light-transmissive material. A plurality of recesses 26 are defined in one surface of the substrate 19, by any suitable process such as etching or cutting. When the substrate 31 is seen in front view, the recesses 26 appear as parallel strips that run from top to bottom of the base substrate 19.

As shown in figure 12(a), in this embodiment the width of a recess, parallel to the surface of the substrate 19, decreases with distance into the substrate. In the embodiment of figure 12(a) the recesses 26 have a triangular cross-section, but the recesses are not limited to this specific cross-section.

A parallax barrier aperture array 13 is formed by depositing an opaque (or reflective) material (or both) into the recesses 26 so as to form opaque portions 14 of the parallax barrier aperture array. The opaque material preferably substantially fills the recesses 26, so as to planarise the upper surface of the base substrate 19. In a preferred embodiment, the opaque material is an opaque resin that is deposited in the recesses 26 by a spinning process – however, in principle, any opaque material may be used.

A light-transmissive spacer layer 20 is deposited over the upper face of the base substrate 19. As described above, this may be a light-transmissive resin layer, a glass layer, a layer of light-transmissive plastics material, etc. The spacer layer may be adhered to the substrate 19 in any suitable manner.

Microsoft Exhibit 1002 - Page 1077
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Finally, the colour filters 18 are deposited on the upper surface of the spacer layer 20 to form the colour filter substrate 31.

In this embodiment, the parallax barrier has a three-dimensional profile, since the opaque elements 14 of the parallax barrier aperture array extend over a finite depth, for example 50 microns, into the substrate. The parallax barrier acts in a similar way to a conventional parallax barrier, such as the parallax barrier of figure 6(a). However, owing to the three-dimensional structure of the parallax barrier, light that is incident on the parallax barrier at high angles to the normal to the plane of the substrate 19 is blocked whereas such rays would be transmitted by a conventional parallax barrier of the type shown in figure 6(a). This may be beneficial in preventing secondary windows.

In the colour filter substrate of figure 12(a), the depth of the recesses may be varied over the substrate 19, in order to vary the depths of the opaque portions of the parallax barrier. Doing this would mean that the cut-off angle, relative to the normal to the plane of the substrate, at which light rays are blocked would vary across the display device.

Figure 13(a) shows a further colour filter substrate 31′ of the present invention, and figure 13(b) shows the colour filter substrate of 13(a) incorporated in a display 30'. These embodiments are generally similar to the embodiments of figures 12(a) and 12(b) respectively, and only the differences will be described here.

In the colour filter substrate 31' of figure 13(a), the recesses 26 are not formed in the base substrate 19. Instead, a light-transmissive spacer layer 32 is provided over the base substrate 19, and the recesses 26 are formed in the spacer layer 32. The spacer layer 32 may be of any suitable material such as, for example, light-transmissive resin, glass, or a light-transmissive plastics material. The recesses 26 may be formed in the spacer layer 32 by any suitable method, such as cutting or etching.

Microsoft Exhibit 1002 - Page 1078
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

An opaque material is deposited in the recesses 26 in the spacer layer 32 to form the opaque portions 14 of a parallax barrier aperture array, as described in connection with figure 12(a) above. Finally, a second spacer layer 20 is deposited over the first spacer layer 32, and colour filters 18 are formed over the upper surface of the second spacer layer 20.

In the embodiments described above, the parallax optic has been constituted by a parallax barrier aperture array. The present invention is not, however, limited to this particular form of parallax optic, but may be employed with other types of parallax optic.

Figures 14(a) and 14(b) illustrate a further embodiment of the present invention, in which the parallax optic is formed by a lenticular lens array.

Figure 14 (b) is a schematic plan view of a multiple-view directional display according to this embodiment of the present invention. The display 33 again comprises a TFT substrate 6, a colour filter substrate 34, and a liquid crystal layer or other image display layer 8 disposed between the colour filter substrate 34 and the TFT substrate 6.

Figure 14(a) shows the colour filter substrate 34 of the display device 33. The colour filter substrate 34 comprises a light-transmissive substrate 19 having an upper surface which is profiled so as to form a lenticular lens array 35. The substrate 19 may be formed in any suitable manner such as, for example, by moulding a light-transmissive plastics material using a suitable mould to provide the lenticular lens array 35 on one surface of the substrate 19. As an alternative, the lens array 35 may be formed by pressing a glass substrate.

A spacer layer 20 is deposited over the lenticular lens array 35. The spacer layer is light-transmissive, and is preferably formed of a resin or plastics material so that the lower surface of the spacer layer can follow the profile of the lenticular lens array 35. Colour filters 18 are deposited on the upper surface of spacer layer 20, which is preferably flat.

Microsoft Exhibit 1002 - Page 1079
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

In this embodiment, the separation between the parallax optic (the lenticular lens array 35) and the liquid crystal layer 8 is equal to the thickness of the spacer layer 20, which must be at least thick enough to planarise the lenses. The spacer layer 20 may be made thin, so that a large angular separation between viewing windows can be obtained.

Figures 15(a) and 15(b) show a further embodiment of the present invention. This embodiment is generally similar to the embodiment of figures 14(a) and 14(b), and only the differences will be described.

In figures 14(a) and 14(b) the lenticular lens array 35 is integral with the base substrate 19, and is obtained by suitably profiling the upper surface of the base substrate 19. In the embodiment of figures 15(a) and 15(b), however, the lenticular lens array 35' is not integral with the base substrate 19. Instead, the base substrate 19 has a substantially flat upper surface, and the lenticular lens array 35' is deposited on the upper surface of the base substrate 19. This may be done by any suitable technique. For example, a layer of light-transmissive resin or light-transmissive plastics material may be deposited over the upper surface of the base substrate 19, and this layer may be pattered to form the lenticular lens array 35'.

Figure 15(c) illustrates a CF substrate 34´´ which differs from the substrate 34´ of Figure 15(a) in that the lenticular lens array 34´´ is "double-sided". In other words, whereas the lenticules of the array 35´ are plano-convex, the lenticules of the array 35´´ are convexo-convex. Although such an arrangement is more difficult to manufacture because recesses have to be formed in the substrate 19, optical performance is improved. For example, a display using the substrate 34´´ of Figure 15(c) has a smaller crosstalk region and wider freedom of viewer movement.

Figure 15(d) illustrates another modified CF substrate 34´´´, which differs from the substrate 34´´ of Figure 15(c) in that the lenticules of the array 34´´´ are spaced apart and are separated by black mask regions 35´´´´. In fact, any embodiment using a lens

Microsoft Exhibit 1002 - Page 1080
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

array as the parallax optic may similarly have the individual lenses or lens elements separated by black mask regions which are non-transmissive to visible light.

The f-number of the lenticular lens array is required to be very low, which makes the array difficult to manufacture. By decreasing the diameter of each lens of the array and keeping the pitch constant (by filling the gaps between the lenses with light-absorbing material or light-reflecting material or both), the f-number of the lenses may be increased. Such an arrangement improves performance, for example in terms of providing a smaller crosstalk region and larger freedom of viewer position.

Figures 16(a) and 16(b) show a further embodiment of the present invention. Figure 16(b) is a schematic plan view through a multiple-view directional display 37 of this embodiment, and figure 16(a) is a schematic plan view of the colour filter substrate 36. This embodiment is generally similar to the embodiment of figure 6(a) and 6(b), and only the differences will be described here.

In the embodiment of figures 16(a) and 16(b), the positions of the parallax barrier aperture array 13 and the colour filters 18 are interchanged compared to their positions in the embodiment of figures 6(a) and 6(b). That is, the colour filters 18 are deposited on a principal surface of the light-transmissive base substrate 19. A spacer layer 20 is deposited over the colour filters 18, and the parallax optic is formed over the upper surface of the spacer layer 20. In the embodiment shown in figures 16(a) and 16(b) a parallax barrier aperture array 13 forms the parallax optic, but this embodiment is not limited to this particular type of parallax optic. The spacer layer 20 may be a light-transmissive resin layer, a glass layer, a light-transmissive layer of plastics material, etc.

In the embodiment of figures 16(a) and 16(b) the parallax barrier array 13 is disposed substantially adjacent to the liquid crystal layer 8. A large angular separation between different viewing windows can therefore be obtained.

Microsoft Exhibit 1002 - Page 1081
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Figures 17(a) and 17(b) illustrate a display 38 according to a further embodiment of the present invention. In this embodiment, the parallax optic is constituted by a reactive mesogen parallax barrier. This embodiment corresponds generally to the embodiment of figure 6(a) and 6(b), and only the differences will be described here.

The RM parallax barrier in this embodiment is formed by strips 40 of a reactive mesogen material disposed over the upper surface of the light-transmissive base substrate 19. A polariser 41 is provided over the upper surface of the base substrate including over the strips 40 of RM material. The strips 40 of RM material and the polariser 41 form a RM parallax barrier 42. The operation of a RM parallax barrier is explained in detail in EP A 0 829 744.

A spacer layer 20 is deposited over the upper surface of the RM parallax barrier 42. Colour filters 18 are deposited on the upper surface of the spacer layer 20. As in previous embodiments, the spacer layer 20 may be, for example, a light transmissive resin layer, a glass layer, a light-transmissive plastic layer, etc. The base substrate 19 may be a glass substrate, a plastics substrate, a glass-reinforced plastics substrate, etc.

In the multiple-view directional display 38 of this embodiment, the separation between the parallax barrier 42 and the liquid crystal layer 8 is again approximately equal to the thickness of the spacer layer 20. The spacer layer may be made thin, so that good angular separation between different viewing windows can be achieved.

This embodiment has the further advantage that the RM parallax barrier is an active parallax barrier, and may be switched (using suitable addressing means, not shown) to put the strips of RM material 40 in a transparent state so that the parallax barrier is disabled or "switched off". If the parallax barrier 42 is disabled, the display device will act as a conventional 2-dimensional or single view display device. Thus, this embodiment provides a display that is operable in either a 2-D display mode or a 3-D or multiple view display mode, and that can provide good angular separation between adjacent viewing windows when operating in the 3-D or multiple view display mode.

Microsoft Exhibit 1002 - Page 1082
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Figure 18(b) illustrates a display 38' according to a further embodiment of the present invention, and Figure 18(a) is a schematic sectional view of the colour filter substrate 39' of the display. The display 38' of this embodiment corresponds essentially to the embodiment of figures 17(a) and 17(b) except that the spacer layer 20 is omitted and the colour filters 18 are disposed directly on the upper surface of the polariser 42. All other features of the display 38' of figure 18(b) correspond to those of the display 38 of figure 17(b) and so will not be described further here.

Figures 19(a) and 19(b) show a further embodiment of the present invention. In this embodiment, the colour filter substrate 44 of the multiple-view directional display 43 is provided with an active parallax barrier 46. Figure 19(b) is a schematic plan view through the display device 43 and figure 19(a) is a schematic sectional view of the colour filter substrate 44.

The active parallax barrier 46 is formed by a plurality of regions 47 of a material whose optical properties are switchable disposed on the surface of the base substrate 19. The regions 47 may be in the form of strips that extend into the plane of the paper in Figure 19(a). The active parallax barrier is formed by the regions 47 in combination with another layer 45 disposed over the regions 47 which may be a linear polariser or a transparent spacer layer depending on the material used for the active strips 47.

In a preferred embodiment the regions 47 are regions of a liquid crystal material and the layer 45 is a linear polariser. As is well known, a liquid crystal material may be addressed so as to either rotate or not rotate the plane of polarisation of linearly polarised light passing through it. Preferably, the regions 47 of liquid crystal material can be switched between a state in which it rotates the plane of polarisation of linearly polarised light by 90° and a state in which it does not rotate the plane of polarisation of linearly polarised light. Thus, the regions 47 of liquid crystal material may be addressed so that light passing through the regions 47 is either transmitted by the linear polariser 45 (in which case the regions 47 define transmissive regions) or is blocked by the linear polariser 45 (in which case the regions 47 define opaque regions).

Microsoft Exhibit 1002 - Page 1083
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

The display 43 is required to be illuminated from the colour filter substrate side by polarised light, either from a light source that emits polarised light or from a polariser disposed in front of a light source. Alternatively, it may be illuminated from the TFT side, in which case a further polariser (not shown) must be disposed beyond the colour filter substrate.

If light that does not pass through the regions 47 of switchable optical properties (i.e., that passes through a gap between adjacent active regions) is passed by the polariser 45, a parallax barrier is formed when light that passes through the regions 47 is blocked by the polariser; in this case, a 3-D or multiple view display mode is obtained. If the regions 47 are switched so that light that passes through a region 47 is transmitted by the polariser 45, then no barrier exists and a 2-D or single view display mode is obtained.

It would in principle also be possible to arrange the transmission direction of the polariser 45 and the polarisation direction of the incident light such that light passing through the gaps between the regions 47 of liquid crystal material is blocked by the polariser 45. In this case a parallax barrier is formed when the regions 47 rotate the plane of polarisation of incident light so that it can pass through the polariser 45. However, when the regions 47 were switched so that light passing through the strips 47 is blocked by the polariser 45, a dark display would be produced as all light would be blocked by the polariser.

The regions of active material 47 are not limited to liquid crystal material. Any material that can be addressed to alter its optical properties can in principle be used. For example, a polymer-dispersed liquid crystal material may be used as the material of the active parallax barrier. As is well-known, a PDLC consists of droplets of liquid crystal material dispersed through a polymer matrix. The refractive index of the liquid crystal droplets can be varied, and the PDLC will transmit light if the refractive index of the liquid crystal droplets is the same as the refractive index of the polymer matrix. However, if the liquid crystal material is switched so that its refractive index is different

Microsoft Exhibit 1002 - Page 1084
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

from the refractive index of the polymer matrix, light passing through the PDLC is scattered.

Another suitable material for the active parallax barrier is a dichroic guest-host material.

This embodiment allows the parallax barrier to be switched on and off, thereby allowing either a 3-D (or multiple view) or a 2-D display mode to be selected. Furthermore, it is possible to arrange the active parallax barrier 46 so that the configuration of transmissive and opaque areas can be altered. For example, the active parallax barrier 46 may be switched so that the opaque regions of the barrier move from one position to another. This effectively causes the barrier to be translated across the area of the display device, and this would alter the position of the viewing windows. Thus, in this embodiment, it is possible to control the position of the viewing windows by suitably addressing the active parallax barrier 46. This embodiment would be particularly useful when combined with an observer tracking device which tracks the observer of the display, as the position of the viewing windows could be controlled on the basis of the position of the observer as determined by the observer-tracking device.

It should be noted that, in this embodiment, the polariser 45 is contained within a liquid crystal display element. The polariser 45 must therefore be able to withstand the harsh processing conditions that occur during manufacture of a liquid crystal panel. Conventional polarisers used on the outside of a liquid crystal display may well not stand the processing conditions, and so cannot be used. This has the possible disadvantage that it may be necessary to use a polariser having a lower contrast ratio than conventional polarisers used outside a liquid crystal panel. If this is the case, the polariser 45 can be oriented so that its poor contrast ratio affects either the contrast ratio of the parallax barrier or the contrast ratio of the pixels of the liquid crystal layer 8.

Where the layer 45 is a spacer layer, it may be treated so that it aligns liquid crystal material, for example of the regions 47, with a particular alignment direction and pre-tilt angle. For example, the spacer layer may be coated with a polyimide layer (not shown)

Microsoft Exhibit 1002 - Page 1085
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

and rubbed and/or exposed to ultraviolet light in a conventional photo-alignment process.

In alternative embodiments, the colour filters may be disposed on the TFT substrate 6 or between the active parallax barrier 46 and the substrate 19.

Figure 20(b) shows a display 48 according to a further embodiment of the present invention, and Figure 20(a) shows the colour filter substrate 49 of the display. This embodiment corresponds generally to the embodiment of Figure 6(a)-6(b) except that in this embodiment, the colour filter substrate 49 of the multiple-view directional display 48 again comprises an active parallax optic 35´´. In this embodiment the active parallax optic 35´´ is an active lenticular lens array. The lenticular lens array can be switched between a mode in which it has substantially no lensing effect (so that no parallax optic exists) and a mode in which it has a lensing effect (so that a parallax optic is formed). The lenticular lens array 35´´ may be addressed by suitable addressing means (not shown).

For example, the lenticules of the lenticular lens array may be made of a liquid crystal material that is addressed by electrodes (not shown) disposed on opposite sides of the lenticules. The liquid crystal material is chosen so that, for some applied voltage across the lens array, its refractive index is as close as possible to the refractive index of the base substrate 19. When the appropriate voltage is applied between the electrodes provided on opposite sides of a lenticule, the refractive index of the liquid crystal material of that lenticule therefore closely matches the refractive index of the spacer layer 20, and the lenticule has substantially no lensing effect. By varying the applied voltage, however, the liquid crystal material of the lenticule may be changed so that its refractive index is made different to the refractive index of the substrate 19. The lenticule therefore acts as a lens, and so forms an element of a parallax optic.

The lenticules 50 of the active lenticular lens array may be arranged as graded refractive (GRIN), or they be arranged as Fresnel lenses.

Microsoft Exhibit 1002 - Page 1086
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Figure 20(c) illustrates a substrate 49 which differs from that shown in Figure 20(a) in that the glass substrate 19 is recessed to accommodate the active lenticular lens array 35''. In this arrangement, the refractive index of the active array should substantially match that of the substrate 19 in the single view or non-directional mode of operation.

Figure 20(d) illustrates a substrate 49 in which the lenses of the active array 35'' are convexo-convex to provide improved performance, such as a smaller crosstalk region and a greater freedom of movement of the viewer. In this case, in the single view mode of operation, the refractive index of the array 35'' should substantially match the refractive indices of the substrate 19 and the spacer 20.

Figure 21(b) shows a display 48' according to a further embodiment of the present invention, and Figure 21(a) shows the colour filter substrate 49' of the display 48'. This embodiment is generally similar to the embodiment of figures 20(a) and 20(b), and only the differences will be described here.

The multiple-view directional display 48' of figure 21(b) has a colour filter substrate 49' that incorporates an active lenticular lens array 35". In this embodiment, however, switching of the lens array is achieved in a different way. In this embodiment, the lenticules 50 are made of liquid crystal material. However, the microscopic structure of the liquid crystal material is fixed, and the liquid crystal material is not addressed in operation of the device.

The switching of the lens array in this embodiment is achieved by making use of the fact that the refractive index of a liquid crystal material is generally dependent on the polarisation state of the light passing through it. The liquid crystal material of the lenticules 50 is chosen such that, for light of one polarisation state, the refractive index of the liquid crystal material is substantially the same as the refractive index of the spacer layer 20. Thus the liquid crystal material has substantially no lensing effect on light of this polarisation state. However, for another polarisation state, in particular for a polarisation state orthogonal to the first polarisation state, the refractive index of the

Microsoft Exhibit 1002 - Page 1087
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

liquid crystal material will not match the refractive index of the layer 20 so that the liquid crystal material has a lensing effect for light of the second polarisation state.

The liquid crystal lenticules 50 are switched on or off by changing the polarisation state of light entering the display 48. This may be done by providing a polarisation switch 51 that can change the polarisation state of light passing through a selected portion of the polarisation switch 51, for example by selecting one of two orthogonal linear polarisations. The polarisation switch 51 may be constituted by, for example, a liquid crystal cell and is followed by a polariser 51′.

Figure 21(c) illustrates another substrate 49′ in which the glass substrate 19 is recessed so as to accommodate the array 35′′. In this case, one of the refractive indices of the material of the array 35′′ must substantially match the refractive index of the glass substrate 19 so as to provide a single view mode of operation.

Figure 21(d) illustrates another form of the colour filter substrate 49′ in which both the spacer 20 and the glass substrate 19 have recesses to accommodate the lens array 35′′, which is convexo-convex. In this case, one of the refractive indices of the material of the array 35′′ is required substantially to match the refractive indices of the spacer 20 and the glass substrate 19 in order to provide a non-directional or single view mode of operation.

Figure 22 is a schematic sectional view of a multiple-view directional display 52 according to a further embodiment of the present invention. This is in many ways similar to the display 58 of figure 6(b), except that a plurality of prisms 53 are provided on the external surface of the base substrate 19 of the colour filter substrate 7. In figure 22 the prisms 53 are shown as having a triangular cross-section. The prisms 53 work in combination with the parallax barrier 13 provided inside the display device. In use, the device is illuminated by a light provided behind the TFT substrate 6, so that the base substrate 19 of the colour filter substrate 7 forms the exit face of the display device. The prism structure varies the angle of separation between the left and right images induced by the parallax barrier.

Microsoft Exhibit 1002 - Page 1088
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

In the embodiment of figure 22, the prisms are arranged so that they reduce the angle of separation between the viewing windows of different images.

Although the prisms are shown as having a triangular cross-section in figure 22, this embodiment is not limited to prisms having a triangular cross-section. In principle, any prism structure that reduces the angle of separation between two viewing windows may be used. Furthermore, where prisms having a triangular cross-section are used, it is not necessary for the prisms to have a cross-section that is an equilateral triangle. In fact, any symmetrical or asymmetrical convergent or divergent element may be used, for example to suit any application of the display.

The embodiment of figure 22 may be of use in, for example, an autostereoscopic display device where the angular separation between the viewing windows of the left-eye image and the right-eye image is required to provide a separation between the left-eye and right-eye windows that is equal to the distance between the two eyes of a human at the desired viewing distance of the display.

Figure 23 shows a display 52' according to a further embodiment of the present invention. This display 52' corresponds generally to the display of figure 22, except that the prisms 53 provided on the surface of the base substrate 19 are intended to increase the angle of separation between the two viewing windows.

Figure 24 illustrates a multiple-view directional display 59 according to a further embodiment of the present invention. The display 59 of this embodiment corresponds generally to the display device 20 of figure 6(b), except that it further comprises switchable means 54 for varying the angle between two viewing windows produced by the device. The switchable means 54 may be switched between a state in which it has substantially no effect on the angular separation between two viewing windows and another state in which it will increase or decrease the angular separation between two viewing windows. In this embodiment the switchable means 54 comprises a plurality of light-transmissive prisms 53 mounted on the external surface of the base substrate 19

Microsoft Exhibit 1002 - Page 1089
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

of the colour filter substrate. An active layer 55 is disposed over the prisms 53 so as to planarise the prisms. The active layer is contained by a transparent plate 56. The prisms and the transparent plate may be formed of glass, transparent resin, transparent plastics material, etc. The active layer 55 may comprise, for example, a liquid crystal layer. The liquid crystal layer is selected such that, when no electric field is applied across the liquid crystal material, the refractive index of the liquid crystal material matches the refractive index of the prisms 53. In this state, the prisms have substantially no effect on the angular separation between two viewing windows produced by the device 54.

The switchable means 54 further comprises electrodes (not shown) that allow an electric field to be applied across the liquid crystal layer 55. By applying a voltage across the electrodes, and thereby applying an electric field across the liquid crystal layer, it is possible to vary the refractive index of the liquid crystal material so that it becomes different from the refractive index of the prisms 53. Light passing through the interface between a prism and the liquid crystal layer therefore undergoes refraction. In consequence, the angular separation between two viewing windows formed by the display device is altered by the prisms 53. This allows the display 59 to switch, for example, between a dual-view display mode and an autostereoscopic display mode.

The switchable means 54 may allow the angular separation between two viewing windows to be controlled continuously by continually varying the electric field applied across the liquid crystal layer. This allows the angular separation between two viewing windows to be tuned to suit a particular use of the display device 54. This embodiment is particularly useful if information about the longitudinal separation between the display and an observer is available, for example from an observer tracking device – in an autostereoscopic display mode the switchable means 54 may control the angular separation between the left-eye and right-eye viewing windows so that the lateral separation at the observer is kept equal to the separation between the two eyes of a human.

Microsoft Exhibit 1002 - Page 1090
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Figure 25 shows a multiple-view directional display 57 according to a further embodiment of the present invention. This display 57 is generally similar to the display 54 of figure 24, and only the differences will be described here.

In the display 57 of figure 25, the switchable means 54 for varying the angular separation between two viewing windows formed by the display comprises prisms 53 disposed on the external surface of the substrate 19 of the colour filter substrate 7. A liquid crystal-layer 55 is placed over the prisms 53, but, in contrast to the embodiment of figure 24, the microscopic structure of the liquid crystal layer is fixed. No means for addressing the liquid crystal layer 55 are therefore required.

The refractive index of the liquid crystal layer 55 is dependent on the state of polarisation of light passing through the liquid crystal layer. The liquid crystal layer is chosen such that its refractive index, for one polarisation state, is substantially equal to the polarisation state of the prisms 53. In this case, light passing through the prisms undergoes substantially no refraction.

For light of another polarisation state, for example a polarisation state orthogonal to the first polarisation state, however, the refractive index of the liquid crystal material 55 is not equal to the refractive index of the prisms 53. For light of this second polarisation state, therefore, refraction occurs at the interface between the prisms and the liquid crystal layer 55, leading to a variation in the angular separation between two viewing windows formed by the display 57.

The refraction effect in this embodiment may be switched on or off by suitably selecting the polarisation state of light entering of leaving the panel. This may be done by providing a polarisation switch 51 and a polariser 51′ between the light source and the observer. In figure 25 the polarisation switch 51 and the polariser 51′ are disposed between the display device and an observer, but they could alternatively be provided between the light source and the display device. The polarisation switch may be, for example, a liquid crystal cell.

Microsoft Exhibit 1002 - Page 1091
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

The embodiments of Figures 24 and 25 may be effected using a prism structure that tends to increase the angular separation between viewing windows, as in figure 23.

Embodiments of the invention have been described above with reference to specific types of parallax optics. The embodiments are not, however, limited to the specific types of parallax optic shown, and may be used with other types of parallax optic.

The present invention allows a substrate on which a parallax optic is mounted to be used as a substrate of an image display element such as, for example, a liquid crystal display element. This has the advantage that the alignment of the parallax optic and the pixels of the display element is carried out during manufacture of the display element. This allows the alignment to be carried out more precisely compared to the conventional case where an external parallax optic is aligned with a complete liquid crystal display element (as in figure 1). Furthermore, eliminating the step of gluing or otherwise adhering a parallax optic to a completed image display element makes the manufacturing process quicker and cheaper.

In the embodiments described above the parallax optic has been disposed on the same substrate as the colour filters. It would alternatively be possible to dispose the parallax optics on the TFT substrate 6 of the display and, for every embodiment described above with a parallax optic provided on the colour filter substrate, there is a corresponding embodiment in which a parallax optic is provided on the TFT substrate. In such modified embodiments, an array of switching elements such as an array of TFTs and the elements of the parallax optics would be disposed over a base substrate of the TFT substrate, possibly with a spacer layer interposed between the parallax optic and the thin film transistors. The separation between the parallax barrier and the image display layer would again be substantially the thickness of the spacer layer (assuming that the spacer layer was disposed over the parallax optic). Moreover, in the embodiments of Figures 22 to 25, the prisms 53 may be disposed on the TFT substrate.

Furthermore, in some liquid crystal panels the colour filters are disposed on the same substrate as the thin film transistors. The invention may then be applied to such a

Microsoft Exhibit 1002 - Page 1092
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

device. For example, a light-transmissive spacer layer (for example a resin, glass or plastics spacer layer) may be disposed over the TFTs (or other switching elements) and the colour filters, and the parallax optic may be disposed over the spacer layer.

The embodiments of the invention, with the exception of those shown in figures 22-25, may be used as either a rear barrier device (as in Figure 4) or as a front barrier device (as in Figure 1).

Where a device of the present invention in which the parallax optic is a parallax barrier is used in the rear-barrier mode of Figure 4, it is preferable if the parallax barrier-elements are reflective on the side facing the back light. Light from the back light that is incident on the opaque regions of the barrier will then be reflected, and can be re-reflected from the back light so that it may pass through the parallax barrier and thus through the display device. This would increase the brightness of the display. The surface of the parallax barrier elements facing away from the backlight is preferably absorbing, to prevent cross-talk.

The invention has been described above with reference to an image display element that comprises a liquid crystal layer. The invention is not, however, limited to this particular image display element and any suitable image display element may be used. As an example, an OLED (organic light-emitting device) image display element may be used.

Microsoft Exhibit 1002 - Page 1093
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

CLAIMS:

1. A multiple view directional display having an image display element and a parallax optic; wherein the image display element comprises: a first substrate; a second substrate; and an image display layer sandwiched between the first substrate and the second substrate; and wherein the parallax optic is disposed within the image display element.

2. A display as claimed in claim 1 wherein the parallax optic is disposed between the first substrate and the second substrate.

3. A display as claimed in claim 1 wherein the parallax optic is disposed within one of the first substrate or the second substrate.

4. A display as claimed in claim 2 wherein the parallax optic and one of a colour filter array and an array of switching elements are disposed over a principal surface of the first substrate.

5. A display as claimed in claim 4 wherein the parallax optic is disposed on the first principal surface of the first substrate and the colour filter array or array of switching elements is disposed over the parallax optic.

6. A display as claimed in claim 4 wherein the colour filter array or array of switching elements is disposed on the first principal surface of the first substrate and the parallax optic is disposed over the colour filter array or the array of switching elements.

7. A display as claimed in claim 5 or 6 and further comprising a transparent spacer layer disposed between the parallax optic and the colour filter array or array of switching elements

Microsoft Exhibit 1002 - Page 1094
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

8. A display as claimed in claim 5, 6 or 7 and further comprising another parallax optic disposed between the parallax optic and the colour filter array or array of switching elements.

9. A display as claimed in claim 4 wherein the parallax optic comprises a plurality of parallax elements, each parallax element being disposed in a respective recess in the principal surface of the substrate.

10. A display as claimed in claim 9 wherein each parallax element is disposed on a bottom face of a respective recess.

11. A display as claimed in claim 4 wherein: a light-transmissive layer is disposed over a principal surface of the substrate; a plurality of recesses are defined in the light-transmissive layer; and the parallax optic comprises a plurality of parallax elements, each parallax element being disposed in a respective recess in the light-transmissive layer.

12. A display as claimed in claim 9 or 11 wherein the cross-section of a recess, parallel to the surface of the substrate, decreases with depth.

13. A display as claimed in claim 12 wherein each parallax element substantially fills a respective recess.

14. A display as claimed in claim 3 wherein one of a colour filter array and an array of switching elements is disposed over a first principal surface of the first substrate and the parallax optic is disposed over a second principal surface of the first substrate.

15. A display as claimed in claim 14 wherein the parallax optic comprises a plurality of parallax elements, each parallax element being disposed in a respective recess in the second principal surface of the substrate.

Microsoft Exhibit 1002 - Page 1095
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

16. A display as claimed in any preceding claim wherein the parallax optic is a parallax barrier.

17. A display as claimed in any preceding claims wherein the parallax optic is a lenticular lens array.

18. A display as claimed in any preceding claim wherein the parallax optic is disableable.

19. A display as claimed in any preceding claim wherein the parallax optic is addressable.

20. A dual-view display comprising a multiple-view directional display as defined in any preceding claim.

21. An autostereoscopic display comprising a multiple-view directional display as defined in any of claims 1 to 19.

22. A parallax optic comprising: a light-transmissive substrate; and a plurality of parallax elements, each parallax element being disposed in a respective recess in a surface of the substrate.

23. A parallax optic as claimed in claim 21 wherein the cross-section of a recess, parallel to the surface of the substrate, decreases with depth.

24. A parallax optic as claimed in claim 22 wherein each parallax element substantially fills a respective recess.

Microsoft Exhibit 1002 - Page 1096
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

The Patent Office
INVESTOR IN PEOPLE

Application No: GB 0320358.5 **Examiner:** Matthew Males
Claims searched: 1 **Date of search:** 9 January 2004

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1 - 3, 17, 20, 21 at least	GB 2278222 A	SHARP - whole document but see abstract; Figs 5,6 & 8.
X	1, 2, 16, 20 at least	US 5831765	NAKAYAMA et al - whole document but see Fig 1; col 5, line 48 - col 7, line 23.
X	1, 2, 20 at least	GB 2296099 A	SHARP - whole document but see abstract; Fig 5.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[W]:

G2J, G5C, H4F

Worldwide search of patent documents classified in the following areas of the IPC[7]:

G02B, G02F, H04N

The following online and other databases have been used in the preparation of this search report:

WPI, EPODOC, JAPIO, INSPEC

Microsoft Exhibit 1002 - Page 1097
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

INVESTOR IN PEOPLE

Application No:	GB0320358.5	**Examiner:**	Matthew Males
Claims searched:	22 - 24	**Date of search:**	2 July 2004

Patents Act 1977
Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular reference
X	22 - 24	US4404471 A WINNEK, MCKEE - see abstract; col 3, lines 30 - 41; Fig 1.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{W} :

G2J; H4F

Worldwide search of patent documents classified in the following areas of the IPC^{07}

G02B; G02F; H04N

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, JAPIO, INSPEC

Microsoft Exhibit 1002 - Page 1098
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

JP 2003-215705 A

Title: ILLUMINATION SYSTEM AND PROJECTION SYSTEM ADOPTING THE SAME

DWPI Abstract

?

Novelty: A light emitting device (10), e.g. light emitting diode (LED), laser diode, organic electro luminescent (EL), or a field emission display (FED) emits a light beam which is to be guided by a wave guide (20) when passed through a diffractive optical element (15). The diffractive optical element varies the optical path of the light beam of the predetermined wavelength.

Use: Illumination system for projection system (claimed).

Advantage: The waveguide maintains reduced cross section of the light beam without any loss. The system volume is reduced thereby providing improved illumination system with enhanced efficiency.

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号
特開2003－215705
（P2003－215705A）
(43)公開日　平成15年７月30日(2003.7.30)

(51)Int.Cl.[7]	識別記号	Ｆ Ｉ		テーマコード（参考）
Ｇ０３Ｂ　21/14		Ｇ０３Ｂ　21/14	Ａ	２Ｈ０４９
Ｇ０２Ｂ　5/32		Ｇ０２Ｂ　5/32		２Ｈ０５２
19/00		19/00		２Ｈ０９９
27/18		27/18	Ｚ	２Ｋ１０３
27/28		27/28	Ｚ	

審査請求　有　　請求項の数69　ＯＬ　（全 14 頁）

(21)出願番号　特願2002－296529(P2002－296529)

(22)出願日　平成14年10月９日(2002.10.9)

(31)優先権主張番号　２００１－０６８８１６

(32)優先日　平成13年11月６日(2001.11.6)

(33)優先権主張国　韓国（ＫＲ）

(71)出願人　390019839
三星電子株式会社
大韓民国京畿道水原市八達区梅灘洞416

(72)発明者　金　成河
大韓民国京畿道水原市八達区遠川洞256－５番地　城東アートビルアパートＢ棟101号

(72)発明者　キリル・セルゲヴィッチ・ソコロフ
大韓民国京畿道水原市八達区梅灘４洞810－４番地　成一アパート206棟1105号

(74)代理人　100064908
弁理士　志賀　正武　（外１名）

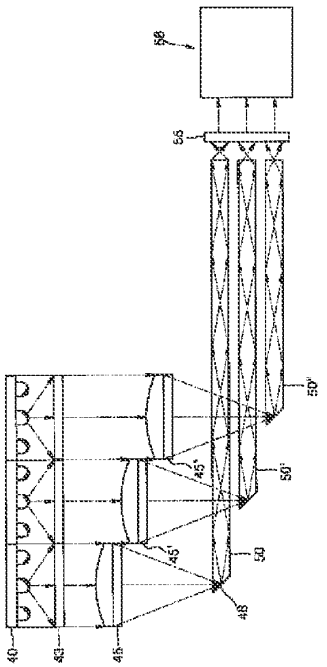
最終頁に続く

(54)【発明の名称】　照明系及びこれを採用したプロジェクションシステム

(57)【要約】

【課題】　カラーホイール無しにカラー画像が具現できる照明系及びこれを採用したプロジェクションシステムを提供する。

【解決手段】　所定波長の光ビームを照射する少なくとも一つの発光素子４０と、前記少なくとも一つの発光素子４０から照射されたビームを集束せしめるフォーカシングレンズ４５と、前記フォーカシングレンズ４５により集束されたビームが入射する所定角度だけ斜めに形成された入射面４８を有する導波路５０とを含むことを特徴とする照明系、及び所定波長の光ビームを照射する少なくとも一つの発光素子と、前記少なくとも一つの発光素子から照射されたビームを集束せしめるフォーカシングレンズと、前記フォーカシングレンズにより集束されたビームが入射する所定角度だけ斜めに形成された入射面を有する導波路と、前記導波路から入射するビームを入力された映像信号に基づき処理して画像を形成するディスプレー素子と、前記ディスプレー素子により形成された画像をスクリーン側に拡大投射せしめる投射レンズユニットとを含むことを特徴とするプロジェクションシステム。



Microsoft Exhibit 1002 - Page 1100
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

【特許請求の範囲】

【請求項１】　所定波長の光ビームを照射する少なくとも一つの発光素子と、
前記少なくとも一つの発光素子から照射されたビームの光路を変える少なくとも一つのホログラム光素子と、
前記ホログラム光素子を通ったビームを案内する導波路とを含むことを特徴とする照明系。

【請求項２】　前記少なくとも一つの発光素子がアレイ構造よりなることを特徴とする請求項１に記載の照明系。

【請求項３】　前記発光素子または発光素子アレイは、発光ダイオード（ＬＥＤ）、レーザダイオード、有機エレクトロルミネセンス（有機ＥＬ）及び電界放出素子（ＦＥＤ）のうち何れか一つよりなることを特徴とする請求項１または２に記載の照明系。

【請求項４】　前記導波路内を進んで出射したビームを一方向に平行ならしめるプリズムアレイをさらに含むことを特徴とする請求項３に記載の照明系。

【請求項５】　前記ホログラム光素子は、
前記導波路の上部または下部に配されることを特徴とする請求項４に記載の照明系。

【請求項６】　前記発光素子または発光素子アレイから照射されたビームを平行ならしめる平行光形成手段がさらに備えられることを特徴とする請求項４または５に記載の照明系。

【請求項７】　前記平行光形成手段は、コリメーティングレンズアレイまたはフレネルレンズアレイであることを特徴とする請求項６に記載の照明系。

【請求項８】　前記プリズムアレイを通ったビームの進路を変える光路変換器をさらに備えることを特徴とする請求項４または５に記載の照明系。

【請求項９】　相異なる波長のビームを照射する複数の前記発光素子または発光素子アレイが水平方向に一列に配されることを特徴とする請求項８に記載の照明系。

【請求項１０】　前記光路変換器は、
前記プリズムアレイを通ったビームを波長に応じて反射または透過せしめるダイクロイックフィルタであることを特徴とする請求項９に記載の照明系。

【請求項１１】　前記光路変換器は、
前記プリズムアレイを通ったビームを偏光方向及び波長に応じて反射または透過せしめるコレステリックバンドモジュレーションフィルタであることを特徴とする請求項９に記載の照明系。

【請求項１２】　前記コレステリックバンドモジュレーションフィルタは、
所定波長のビームに対して左円偏光を反射させて右円偏光を透過せしめる第１の鏡面と、左円偏光を透過させて右円偏光を反射せしめる第２の鏡面とを有することを特徴とする請求項１１に記載の照明系。

【請求項１３】　相異なる波長の光ビームを照射する複数の前記発光素子または発光素子アレイが所定角度にて離隔されて配されることを特徴とする請求項８に記載の照明系。

【請求項１４】　前記光路変換器は、
ＸプリズムまたはＸ型ダイクロイックフィルタであることを特徴とする請求項１３に記載の照明系。

【請求項１５】　前記発光素子または発光素子アレイ、前記ホログラム光素子、前記導波路が複数層構造にてさらに配されることを特徴とする請求項１、２、９及び１３のうち何れか一項に記載の照明系。

【請求項１６】　前記プリズムアレイは、
前記導波路の出射側の端部に該導波路と一体に形成されることを特徴とする請求項４に記載の照明系。

【請求項１７】　相異なる波長の光ビームを照射する発光素子と、
前記発光素子から照射されたビームの光路を変える前記発光素子の各々に対応するホログラム光素子と、
前記ホログラム光素子を介して入射したビームを同方向に案内する導波路とを含むことを特徴とする照明系。

【請求項１８】　前記発光素子がアレイ構造よりなることを特徴とする請求項１７に記載の照明系。

【請求項１９】　前記発光素子または発光素子アレイは、ＬＥＤ、レーザダイオード、有機ＥＬ及びＦＥＤのうち何れか一つよりなることを特徴とする請求項１７又は１８に記載の照明系。

【請求項２０】　前記導波路内を進んで出射したビームを一方向に平行ならしめるプリズムアレイをさらに含むことを特徴とする請求項１９に記載の照明系。

【請求項２１】　前記プリズムアレイは、
前記導波路の出射側の端部に該導波路と一体に形成されることを特徴とする請求項２０に記載の照明系。

【請求項２２】　前記ホログラム光素子は、
前記導波路の上部または下部に配されることを特徴とする請求項１９に記載の照明系。

【請求項２３】　前記発光素子または発光素子アレイから照射されたビームを平行ならしめる平行光形成手段がさらに備えられることを特徴とする請求項２０または２２に記載の照明系。

【請求項２４】　前記平行光形成手段は、コリメーティングレンズアレイまたはフレネルレンズアレイであることを特徴とする請求項２３に記載の照明系。

【請求項２５】　所定波長の光ビームを照射する少なくとも一つの発光素子と、
前記少なくとも一つの発光素子から照射されたビームを集束するフォーカシングレンズと、
前記フォーカシングレンズにより集束されたビームが入射する、所定角度だけ斜めに形成された入射面を有する導波路とを含むことを特徴とする照明系。

【請求項２６】　前記少なくとも一つの発光素子がアレイ構造よりなることを特徴とする請求項２５に記載の照

Microsoft Exhibit 1002 - Page 1101
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

明系。

【請求項２７】　前記発光素子または発光素子アレイは、ＬＥＤ、レーザダイオード、有機ＥＬ及びＦＥＤのうち何れか一つよりなることを特徴とする請求項２５または２６に記載の照明系。

【請求項２８】　前記発光素子または発光素子アレイから照射されたビームを平行ならしめる第１の平行光形成手段がさらに備えられることを特徴とする請求項２７に記載の照明系。

【請求項２９】　前記導波路内を進んで出射したビームを平行ならしめる第２の平行光形成手段をさらに含むことを特徴とする請求項２８に記載の照明系。

【請求項３０】　前記第１及び第２の平行光形成手段は、コリメーティングレンズアレイまたはフレネルレンズアレイであることを特徴とする請求項２８または２９に記載の照明系。

【請求項３１】　前記第２の平行光形成手段を通ったビームを選択的に透過または反射せしめることにより光の進路を変える光路変換器をさらに備えることを特徴とする請求項２９に記載の照明系。

【請求項３２】　相異なる波長のビームを照射する複数の前記発光素子または発光素子アレイが水平方向に一列に配されることを特徴とする請求項３１に記載の照明系。

【請求項３３】　前記光路変換器は、
前記第２の平行光形成手段を通ったビームを波長に応じて反射または透過せしめるダイクロイックフィルタであることを特徴とする請求項３２に記載の照明系。

【請求項３４】　前記光路変換器は、
前記第２の平行光形成手段を通ったビームを偏光方向及び波長に応じて反射または透過せしめるコレステリックバンドモジュレーションフィルタであることを特徴とする請求項３２に記載の照明系。

【請求項３５】　前記コレステリックバンドモジュレーションフィルタは、所定波長のビームに対して左円偏光を反射させて右円偏光を透過せしめる第１の鏡面と、左円偏光を透過させて右円偏光を反射せしめる第２の鏡面とを有することを特徴とする請求項３４に記載の照明系。

【請求項３６】　相異なる波長の光ビームを照射する複数の前記発光素子または発光素子アレイが所定角度にて離隔されて配されることを特徴とする請求項３１に記載の照明系。

【請求項３７】　前記光路変換器は、
Ｘプリズムまたは X 型ダイクロイックフィルタであることを特徴とする請求項３６に記載の照明系。

【請求項３８】　前記発光素子または発光素子アレイ、前記フォーカシングレンズ及び前記導波路が複数層構造にてさらに配されて十分な光量が確保可能であることを特徴とする請求項２５、２６、３２及び３６のうち何れか一項に記載の照明系。

【請求項３９】　前記複数層構造は、対称構造であることを特徴とする請求項３８に記載の照明系。

【請求項４０】　所定波長の光ビームを照射する少なくとも一つの発光素子と、
前記少なくとも一つの発光素子から照射されたビームの光路を変える少なくとも一つの回折光学素子と、
前記回折光学素子を通ったビームを案内する導波路とを含むことを特徴とする照明系。

【請求項４１】　前記少なくとも一つの発光素子は、アレイ構造よりなることを特徴とする請求項４０に記載の照明系。

【請求項４２】　前記発光素子または発光素子アレイは、ＬＥＤ、レーザダイオード、有機ＥＬ及びＦＥＤのうち何れか一つよりなることを特徴とする請求項４０または４１に記載の照明系。

【請求項４３】　前記導波路内を進んで出射したビームを一方向に平行ならしめるプリズムアレイをさらに含むことを特徴とする請求項４２に記載の照明系。

【請求項４４】　前記発光素子または発光素子アレイから照射された光を平行ならしめる平行光形成手段がさらに備えられることを特徴とする請求項４３に記載の照明系。

【請求項４５】　前記平行光形成手段は、コリメーティングレンズアレイまたはフレネルレンズアレイであることを特徴とする請求項４４に記載の照明系。

【請求項４６】　所定波長の光ビームを照射する少なくとも一つの発光素子と、
前記少なくとも一つの発光素子から出射した光ビームの進路を変える少なくとも一つのホログラム光素子と、
前記少なくとも一つのホログラム光素子を通ったビームを案内する導波路と、
前記導波路から入射する光を入力された映像信号に基づき処理して画像を形成するディスプレー素子と、
前記ディスプレー素子により形成された画像をスクリーン側に拡大投射せしめる投射レンズユニットとを含むことを特徴とするプロジェクションシステム。

【請求項４７】　前記少なくとも一つの発光素子は、アレイ構造よりなることを特徴とする請求項４６に記載のプロジェクションシステム。

【請求項４８】　前記発光素子は、ＬＥＤ、レーザダイオード、有機ＥＬ及びＦＥＤのうち何れか一つよりなることを特徴とする請求項４６または４７に記載のプロジェクションシステム。

【請求項４９】　前記導波路内を進んで出射したビームを一方向に平行ならしめるプリズムアレイをさらに含むことを特徴とする請求項４８に記載のプロジェクションシステム。

【請求項５０】　前記プリズムアレイは、
前記導波路の出射側の端部に該導波路と一体に形成され

Microsoft Exhibit 1002 - Page 1102
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

ることを特徴とする請求項４９に記載のプロジェクションシステム。

【請求項５１】　前記プリズムアレイから出射したビームの強度を均一ならしめるフライアイレンズと、該フライアイレンズを通ったビームを前記ディスプレー素子側に集束せしめるリレイレンズとをさらに含むことを特徴とする請求項４９または５０に記載のプロジェクションシステム。

【請求項５２】　前記発光素子または発光素子アレイから照射された光を平行ならしめる平行光形成手段がさらに備えられることを特徴とする請求項５１に記載のプロジェクションシステム。

【請求項５３】　前記平行光形成手段は、コリメーティングレンズアレイまたはフレネルレンズアレイであることを特徴とする請求項５２に記載のプロジェクションシステム。

【請求項５４】　前記プリズムアレイを通ったビームの進路を変える光路変換器をさらに備えることを特徴とする請求項４９または５０に記載のプロジェクションシステム。

【請求項５５】　前記光路変換器から出射したビームの強度を均一ならしめるフライアイレンズと、該フライアイレンズを通ったビームを前記ディスプレー素子側に集束せしめるリレイレンズとをさらに含むことを特徴とする請求項５４に記載のプロジェクションシステム。

【請求項５６】　所定波長の光ビームを照射する少なくとも一つの発光素子と、
前記少なくとも一つの発光素子から照射されたビームを集束せしめるフォーカシングレンズと、
前記フォーカシングレンズにより集束されたビームが入射する所定角度だけ斜めに形成された入射面を有する導波路と、
前記導波路から入射するビームを入力された映像信号に基づき処理して画像を形成するディスプレー素子と、
前記ディスプレー素子により形成された画像をスクリーン側に拡大投射せしめる投射レンズユニットとを含むことを特徴とするプロジェクションシステム。

【請求項５７】　前記少なくとも一つの発光素子は、アレイ構造よりなることを特徴とする請求項５６に記載のプロジェクションシステム。

【請求項５８】　前記発光素子または発光素子アレイは、ＬＥＤ、レーザダイオード、有機ＥＬ及びＦＥＤのうち何れか一つよりなることを特徴とする請求項５７に記載のプロジェクションシステム。

【請求項５９】　前記発光素子または発光素子アレイから照射された光を平行ならしめる第１の平行光形成手段がさらに備えられることを特徴とする請求項５８に記載のプロジェクションシステム。

【請求項６０】　前記導波路内を進んで出射したビームを平行ならしめる第２の平行光形成手段をさらに含むことを特徴とする請求項５９に記載のプロジェクションシステム。

【請求項６１】　前記第２の平行光形成手段から出射したビームの強度を均一ならしめるフライアイレンズと、該フライアイレンズを通ったビームを前記ディスプレー素子側に集束せしめるリレイレンズとをさらに含むことを特徴とする請求項６０に記載のプロジェクションシステム。

【請求項６２】　前記第２の平行光形成手段及び前記フライアイレンズの間に前記第２の平行光形成手段を通ったビームを選択的に透過または反射せしめることにより光の進路を変える光路変換器をさらに備えることを特徴とする請求項５９または６０に記載のプロジェクションシステム。

【請求項６３】　前記第１及び第２の平行光形成手段は、コリメーティングレンズアレイまたはフレネルレンズアレイであることを特徴とする請求項６１に記載のプロジェクションシステム。

【請求項６４】　相異なる波長の光ビームを照射する発光素子と、
前記発光素子から照射されたビームの光路を変える前記発光素子の各々に対応するホログラム光素子と、
前記ホログラム光素子を介して入射したビームを同方向に案内する導波路と、
前記導波路から入射するビームを入力された映像信号に基づき処理して画像を形成するディスプレー素子と、
前記ディスプレー素子により形成された画像をスクリーン側に拡大投射せしめる投射レンズユニットとを含むことを特徴とするプロジェクションシステム。

【請求項６５】　前記少なくとも一つの発光素子は、アレイ構造よりなることを特徴とする請求項６４に記載のプロジェクションシステム。

【請求項６６】　前記発光素子または発光素子アレイは、ＬＥＤ、レーザダイオード、有機ＥＬ及びＦＥＤのうち何れか一つよりなることを特徴とする請求項６５に記載のプロジェクションシステム。

【請求項６７】　前記導波路内を進んで出射したビームを一方向に平行ならしめるプリズムアレイをさらに含むことを特徴とする請求項６４ないし６６のうち何れか一項に記載のプロジェクションシステム。

【請求項６８】　前記プリズムアレイは、
前記導波路の出射側の端部に該導波路と一体に形成されることを特徴とする請求項６７に記載のプロジェクションシステム。

【請求項６９】　前記プリズムアレイから出射したビームの強度を均一ならしめるフライアイレンズと、該フライアイレンズを通ったビームを前記ディスプレー素子側に集束せしめるリレイレンズとをさらに含むことを特徴とする請求項６７に記載のプロジェクションシステム。

【発明の詳細な説明】

Microsoft Exhibit 1002 - Page 1103
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

【０００１】
【発明の属する技術分野】本発明は照明系及びこれを採用したプロジェクションシステムに係り、特に、カラーホイールなしにカラー画像を具現できる照明系及びこれを採用したプロジェクションシステムに関する。
【０００２】
【従来の技術】図１を参照すれば、従来のプロジェクションシステムは、光源１００と、この光源１００から出射したビームを集束せしめる第１のリレイレンズ１０２と、入射光をＲ，Ｇ，Ｂの３色ビームに分離するカラーホイール１０５と、前記カラーホイール１０５を通ったビームを均一ならしめるフライアイレンズ１０７と、前記フライアイレンズ１０７を通ったビームを集束せしめる第２のリレイレンズ１１０と、前記カラーホイール１０５を介して順次に入射するＲ，Ｇ，Ｂの３色によりカラー画像を形成するディスプレー素子１１２及び前記ディスプレー素子１１２により形成された画像をスクリーン１１８に向わせる投射レンズ系１１５とを含んでなる。
【０００３】前記光源１００としては、キセノンランプ、金属ーハロゲンランプ、ＵＨＰランプなどが使われるが、これらのランプは余計な赤外線及び紫外線を多量放出する。これにより多量の熱が生じ、この熱を冷やすための冷却ファンが使われるが、この冷却ファンは騒音発生の原因となる。また、ランプ光源のスペクトル分布を見れば、全波長に亘って広く分布していて狭いカラーガマットを有するためにカラー選択の幅が狭まり、色純度が不良であるだけではなく、寿命が短くランプの安定した使用が限られるといった問題点がある。
【０００４】一方、従来のプロジェクションシステムでは、カラー画像を具現するために前記カラーホイール１０５を駆動モーター（図示せず）により高速回転させてＲ，Ｇ，Ｂを順次前記ディスプレー素子１１２に照明する方式によりカラー画像を具現する。前記カラーホイール１０５はＲ，Ｇ，Ｂの３色フィルタがホイールの全体に亘って等分配置され、１画面が形成される間にカラーホイールが回転し、前記ディスプレー素子１１２の応答速度に応じて前記カラーホイール１０５の回転時に１カラーずつ順次使用するために、２／３の光損失が起こる。また、望ましいカラー具現のために、前記カラーホイール１０５の各カラーの境界部分において所定間隔のギャップが形成されており、この部分でも光損失が起こる。
【０００５】のみならず、前記カラーホイール１０５は高速回転するために騒音が生じ、機械的な運動により安定性にとって不利であるだけではなく、駆動モーターの機械的な限界のために一定以上の速度が得難いためにカラーブレーキアップ現象が招かれる。さらに、カラーホイールそのもののコストが極めて高価であり、これは製造コスト高につながる。
【０００６】
【発明が解決しようとする課題】本発明は前記問題点を解決するためになされたものであり、所定波長の光を照射する発光素子を有する照明系を利用して色純度及びカラーガマットを向上させ、且つ、カラーホイール無しにカラー画像が具現できる照明系及びこれを採用したプロジェクションシステムを提供するところにその目的がある。
【０００７】また、少なくとも一本以上の導波路を備え、光ビームを断面積の縮小された状態でこの導波路を介して光損失なしに案内することにより、コンパクト化でき、且つ、光効率が高められた照明系及びこれを採用したプロジェクションシステムを提供するところにその目的がある。
【０００８】
【課題を解決するための手段】前記目的を達成するために、本発明に係る照明系は、所定波長の光ビームを照射する少なくとも一つの発光素子と、前記少なくとも一つの発光素子から照射されたビームの光路を変える少なくとも一つのホログラム光素子と、前記ホログラム光素子を通ったビームを案内する導波路とを含むことを特徴とする。
【０００９】前記少なくとも一つの発光素子がアレイ構造よりなることを特徴とする。前記発光素子または発光素子アレイは、ＬＥＤ、レーザダイオード、有機ＥＬ及びＦＥＤのうち何れか一つよりなることを特徴とする。前記導波路内を進んで出射したビームを一方向に平行ならしめるプリズムアレイをさらに含むことを特徴とする。前記ホログラム光素子は、前記導波路の上部または下部に配されることを特徴とする。
【００１０】前記発光素子または発光素子アレイから照射されたビームを平行ならしめる平行光形成手段がさらに備えられることを特徴とする。前記平行光形成手段は、コリメーティングレンズアレイまたはフレネルレンズアレイであることを特徴とする。前記プリズムアレイを通ったビームの進路を変える光路変換器をさらに備えることを特徴とする。
【００１１】相異なる波長のビームを照射する複数の発光素子または発光素子アレイが水平方向に一列に配されることを特徴とする。前記光路変換器は、前記プリズムアレイを通ったビームを波長に応じて反射または透過せしめるダイクロイックフィルタであることを特徴とする。前記光路変換器は、前記プリズムアレイを通ったビームを偏光方向及び波長に応じて反射または透過せしめるコレステリックバンドモジュレーションフィルタであることを特徴とする。
【００１２】前記コレステリックバンドモジュレーションフィルタは、所定波長のビームに対して左円偏光を反射させて右円偏光を透過せしめる第１の鏡面と、左円偏光を透過させて右円偏光を反射せしめる第２の鏡面とを

Microsoft Exhibit 1002 - Page 1104
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

有することを特徴とする。前記光路変換器は、Xプリズムまたは X型ダイクロイックフィルタであることを特徴とする。前記発光素子または発光素子アレイ、ホログラム光素子、導波路が複数層構造にてさらに配されることを特徴とする。前記プリズムアレイは、前記導波路の出射側の端部に導波路と一体に形成されることを特徴とする。

【００１３】前記目的を達成するために、本発明に係る照明系は、相異なる波長の光ビームを照射する発光素子と、前記発光素子から照射されたビームの光路を変える前記発光素子の各々に対応するホログラム光素子と、前記ホログラム光素子を介して入射したビームを同方向に案内する導波路とを含むことを特徴とする。

【００１４】前記目的を達成するために、本発明に係る照明系は、所定波長の光ビームを照射する少なくとも一つの発光素子と、前記少なくとも一つの発光素子から照射されたビームを集束するフォーカシングレンズと、前記フォーカシングレンズにより集束されたビームが入射する、所定角度だけ斜めに形成された入射面を有する導波路とを含むことを特徴とする。

【００１５】前記目的を達成するために、本発明に係る照明系は、所定波長の光ビームを照射する少なくとも一つの発光素子と、前記少なくとも一つの発光素子から照射されたビームの光路を変える少なくとも一つの回折光学素子と、前記回折光学素子を通ったビームを案内する導波路とを含むことを特徴とする。

【００１６】前記目的を達成するために、本発明に係るプロジェクションシステムは、所定波長の光ビームを照射する少なくとも一つの発光素子と、前記少なくとも一つの発光素子から出射した光ビームの進路を変える少なくとも一つのホログラム光素子と、前記少なくとも一つのホログラム光素子を通ったビームを案内する導波路と、前記導波路から入射する光を入力された映像信号に基づき処理して画像を形成するディスプレー素子と、前記ディスプレー素子により形成された画像をスクリーン側に拡大投射せしめる投射レンズユニットとを含むことを特徴とする。

【００１７】前記目的を達成するために、本発明に係るプロジェクションシステムは、所定波長の光ビームを照射する少なくとも一つの発光素子と、前記少なくとも一つの発光素子から照射されたビームを集束せしめるフォーカシングレンズと、前記フォーカシングレンズにより集束されたビームが入射する所定角度だけ斜めに形成された入射面を有する導波路と、前記導波路から入射するビームを入力された映像信号に基づき処理して画像を形成するディスプレー素子と、前記ディスプレー素子により形成された画像をスクリーン側に拡大投射せしめる投射レンズユニットとを含むことを特徴とする。

【００１８】前記プリズムアレイまたは光路変換器から出射したビームの強度を均一ならしめるフライアイレンズと、このフライアイレンズを通ったビームを前記ディスプレー素子側に集束せしめるリレイレンズとをさらに含むことを特徴とする。

【００１９】前記目的を達成するために、本発明に係るプロジェクションシステムは、相異なる波長の光ビームを照射する発光素子と、前記発光素子から照射されたビームの光路を変える前記発光素子の各々に対応するホログラム光素子等と、前記ホログラム光素子を介して入射したビームを同方向に案内する導波路と、前記導波路から入射するビームを入力された映像信号に基づき処理して画像を形成するディスプレー素子と、前記ディスプレー素子により形成された画像をスクリーン側に拡大投射せしめる投射レンズユニットとを含むことを特徴とする。

【００２０】

【発明の実施の形態】以下、添付した図面に基づき、本発明の望ましい実施形態について説明する。図２を参照すれば、本発明の第１の実施の形態による照明系は、所定波長の光ビームを照射する少なくとも一つの発光素子１０と、前記少なくとも一つの発光素子１０から照射されたビームの経路を変えるホログラム光素子１５と、前記ホログラム光素子１５を通ったビームを案内する導波路２０とを備える。

【００２１】前記少なくとも一つの発光素子１０としては、ＬＥＤ、レーザダイオード（ＬＤ）、有機ＥＬまたはＦＥＤなどが使用できる。また、前記の如き複数の発光素子が２次元的に配列されたアレイ構造として使用できる。前記少なくとも一つの発光素子または発光素子アレイ１０は相異なる波長のビームを照射するように構成できる。例えば、図４に示されたように、Ｒ波長のビームを照射する第１の発光素子１０ａ、Ｇ波長のビームを照射する第２の発光素子１０ｂ及びＢ波長のビームを照射する第３の発光素子１０ｃを含むことができる。

【００２２】また、前記発光素子または発光素子アレイ１０ａ，１０ｂ，１０ｃから照射される光ビームを平行ならしめるコリメーティングレンズアレイまたはフレネルレンズアレイなどの平行光形成手段１３をさらに備えることができる。そして、前記平行光形成手段１３により平行ならしめられたビームを前記導波路２０内において全反射可能な所定の角度にて入射せしめるホログラム光素子１５が備えられる。前記ホログラム光素子１５は、ビームを前記導波路２０内に入射する時に所定角度だけ回折させて入射せしめることにより、前記導波路２０内におけるビームの断面積を縮小せしめる。すなわち、前記ホログラム光素子１５に入射するビームの断面積に比べて前記ホログラム光素子１５を通った後に前記導波路２０内を進むビームの断面積の方が狭まっているということが分かる。これにより、照明系の全体的な体積を減らせるだけではなく、光損失をも減らせる。

【００２３】前記ホログラム光素子１５は、前記導波路

Microsoft Exhibit 1002 - Page 1105
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

２０の上部または下部に設置可能である。但し、前記ホログラム光素子１５を通った前記導波路２０の一端部から出射したビームが導波路２０の下部面から全反射されて上部面に入射する時、前記ホログラム光素子１５に戻らないように回折角またはホログラムの長さを調節しなければならない。一方、前記ホログラム光素子１５はこれと同じ機能を有する回折光学素子に置き換え可能である。

【００２４】また、前記導波路２０の出射側の端部には導波路２０を通って出射した色々な方向のビームを一方向に平行ならしめるプリズムアレイ２５が配される。すなわち、前記導波路２０内を進むビームは相異なる方向に出射した後、前記プリズムアレイ２５により一方向に集束されつつ平行に進む。ここでは、前記プリズムアレイ２５が前記導波路２０とは別体となっている例を説明したが、これに限定されることなく、前記プリズムアレイを前記導波路２０の出射側の端部に一体に形成しても良い。図３Ａに示されたように、前記導波路２０の出射側の端部に所定角度だけ斜めに形成された傾斜面２６をもたせてプリズムアレイと同じ機能を行わせても良い。あるいは、図３Ｂ及び図３Ｃのように、前記導波路２０の出射側の端部に少なくとも一つのプリズム面２７，２８をもたせてプリズムアレイを構成しても良い。以上のように、前記導波路２０と一体型のプリズムアレイ２６，２７，２８または別体型のプリズムアレイ２５を利用し、前記導波路２０を介して色々な方向に進むビームを一方向に平行ならしめて進める。これにより、前記発光素子１０から照射されたビームの断面積が前記ホログラム光素子１５及び導波路２０により縮小されて前記プリズムアレイ２５，２６，２７，２８を通る。

【００２５】さらに、十分な光量を確保するために、前記発光素子または発光素子アレイ１０を複数備え、これに対応するホログラム光素子１５′及び導波路２０′を複数備えても良い。この時、前記導波路２０，２０′は、隣り合う導波路とは異なる平面に階段状に配されて互いのビームの進路を妨げない。

【００２６】一方、前記プリズムアレイ２５，２６，２７，２８を通ったビームの進路を変える光路変換器３０がさらに備えられても良いが、これについての具体的な例は後述する。

【００２７】本発明の第２の実施の形態による照明系は、図５を参照すれば、前記少なくとも一つの発光素子または発光素子アレイ４０と、ビームの進路を案内する導波路５０と、前記導波路５０の入射側の端部側にビームを集束せしめるフォーカシングレンズ４５とを備えてなる。前記発光素子または発光素子アレイ４０としては、前述の如く、ＬＥＤ、ＬＤ、有機ＥＬまたはＦＥＤなどが使用できる。

【００２８】前記導波路５０の入射側の端部は、前記フォーカシングレンズ４５により集束されたビームが反射して前記導波路５０の内部を全反射するように、所定角度だけ斜めに形成された傾斜面４８を有する。望ましくは、前記傾斜面４８は、略４５° の角度だけ斜めに形成される。ここで、ビームは前記フォーカシングレンズ４５により前記導波路５０の入射側の端部の一点に集束するので、前記導波路５０を一層薄めることができる。従って、前記導波路５０内を進むビームの断面積を一層縮小できる。

【００２９】また、前記発光素子または発光素子アレイ４０は複数備えられて一列に配置できる。ここで、前記複数の発光素子または発光素子アレイの各々に対応するフォーカシングレンズ４５，４５′，４５″が階段状に相異なる平面に配され、前記フォーカシングレンズ４５，４５′，４５″により各々集束されたビームは相異なる平面に配された導波路５０，５０′，５０″を介して各々案内される。これにより、光量が十分に確保できる。前記複数の発光素子または発光素子アレイ４０は一列に配するが、相異なる波長のビームを照射する発光素子または発光素子アレイを前記の如き方式により構成しても良い。

【００３０】前記発光素子または発光素子アレイ４０及びフォーカシングレンズ４５，４５′，４５″の間に前記発光素子または発光素子アレイ４０から照射されたビームを平行ならしめる第１の平行光形成手段４３がさらに備えられても良い。そして、前記導波路５０，５０′，５０″の出射側の端部にも導波路５０，５０′，５０″内を進んで出射したビームを平行ならしめる第２の平行光形成手段５５が備えられる。前記第１及び第２の平行光形成手段４３，５５はコリメーティングレンズアレイまたはフレネルレンズアレイであっても良い。これらに、前記第２の平行光形成手段５５を通ったビームの進路を変える光路変換器５８がさらに備えられても良い。

【００３１】図６ないし図８は、前記光路変換器３０，５８の色々な具体例を示すものである。ここで、光路変換器の例は前記第１の実施の形態及び第２の実施の形態に同一に適用可能であるが、前記第１の実施の形態における図面符号を代表的に使用して説明する。

【００３２】前述の如く、前記発光素子または発光素子アレイ１０は各々Ｒ，Ｇ，Ｂ波長のビームを照射する第１，第２及び第３の発光素子または発光素子アレイ１０ａ，１０ｂ，１０ｃを含むことができ、図６及び図７に示されたように、水平方向に一列に配置できる。また、十分な光量を確保するために、Ｒ，Ｇ，Ｂ波長のビームを照射する第１ないし第３の発光素子または発光素子アレイ１０ａ，１０ｂ，１０ｃを各々複数さらに備えることもできる。複数の発光素子または発光素子アレイを水平方向に平行に配する方法のほかに、上下方向の複数層構造に配しても良い。前記発光素子または発光素子アレイ１０ａ，１０ｂ，１０ｃが複数備えられる場合、各々

Microsoft Exhibit 1002 - Page 1106
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

の発光素子または発光素子アレイに対応するホログラム光素子１５またはフォーカシングレンズ４５、及び導波路２０，５０がそれに対応して複数備えられるということは言うまでもない。前記複数層構造の場合、前記発光素子１０、ホログラム光素子１５またはフォーカシングレンズ４５、及び導波路２０，５０などを備えた層が向かい合いつつ対称に配される。このような水平構造または複数層構造は各波長に対応する発光素子または発光素子アレイ別に同じ構造にて繰り返して構成できる。

【００３３】前記光路変換器３０，５８は、入射光を選択的に透過または反射せしめることにより相異なる光路に入射した光を同じ光路に向わせる。前記光路変換器３０，５８は、図６に示されたように、前記第１ないし第３の発光素子または発光素子アレイ１０ａ，１０ｂ，１０ｃからの光を各々波長に応じて反射または透過せしめる第１，第２及び第３のダイクロイックフィルタ３０ａ，３０ｂ，３０ｃを含むことができる。例えば、前記第１の発光素子または発光素子アレイ１０ａからＲ波長のビームが、第２の発光素子または発光素子アレイ１０ｂからＧ波長のビームが、そして第３の発光素子または発光素子アレイ１０ｃからＢ波長のビームが照射可能である。

【００３４】そして、前記第１のダイクロイックフィルタ３０ａはＲ波長のビームのみ反射し、残りの波長のＧ，Ｂビームは透過させ、前記第２のダイクロイックフィルタ３０ｂはＧ波長のビームのみ反射し、残りの波長のＲ，Ｂビームは透過せしめる。また、前記第３のダイクロイックフィルタ３０ｃは、Ｂ波長のビームは反射し、残りの波長のＲ，Ｇビームは透過せしめる。従って、前記プリズムアレイ２５を通ったビームが前記第１のダイクロイックフィルタ３０ａに入射すれば、図中のＡ方向に反射されて行く。また、前記プリズムアレイ２５を通ったＧビームが前記第２のダイクロイックフィルタ３０ｂに入射すれば、前記第２のダイクロイックフィルタ３０ｂにより反射されて前記第１のダイクロイックフィルタ３０ａを通って図中のＡの方向に直進する。また、前記プリズムアレイ２５を通ったＢビームが前記第３のダイクロイックフィルタ３０ｃに入射すれば、前記第３のダイクロイックミラー３０ｃにより反射され、前記第２及び第１のダイクロイックフィルタ３０ｂ，３０ａを通って図中のＡの方向に直進する。このようにして相異なる経路のＲ，Ｇ，Ｂの３色ビームを同じ経路に進める。

【００３５】これとは異なって、前記光路変換器として、図７に示されたように、入射光の偏光方向に応じて選択的に入射光を反射または透過せしめるコレステリックバンドモジュレーションフィルタ３５を使用できる。前記コレステリックバンドモジュレーションフィルタ３５は、所定波長の光に対し、例えば左円偏光は反射させて右円偏光は透過せしめることにより光路を変えることができ、逆に、左円偏光は透過させて右円偏光は反射せしめることもできる。前記コレステリックバンドモジュレーションフィルタ３５は、Ｒ波長のビーム、Ｇ波長のビーム、Ｂ波長のビームに対して各々円偏光の偏光方向に応じて選択的に透過または反射せしめる第１，第２及び第３のコレステリックバンドモジュレーションフィルタ３５ａ，３５ｂ，３５ｃを含むことができる。

【００３６】一方、前記第１，第２及び第３のコレステリックバンドモジュレーションフィルタ３５ａ，３５ｂ，３５ｃには各々、左円偏光及び右円偏光をどちらも使用可能にして光効率を高めるために、各々のフィルタに対応する波長に対して左円偏光を反射させて右円偏光を透過せしめる第１の鏡面３７と、左円偏光を透過させて右円偏光を反射せしめる第２の鏡面３８とが適宜配される。ここで、左円偏光に対しては＋、右円偏光に対しては－を付けて表記する。例えば、Ｒ＋は左円偏光のＲビームを、Ｒ－は右円偏光のＲビームを表わす。

【００３７】前記発光素子または発光素子アレイ１０を通ったＲ，Ｇ，Ｂビームが各々前記第１，第２及び第３のコレステリックバンドモジュレーションフィルタ３５ａ，３５ｂ，３５ｃに向かう。前記第１，第２及び第３のコレステリックバンドモジュレーションフィルタ３５ａ，３５ｂ，３５ｃは、光が入射する方向から第１の鏡面３７及び第２の鏡面３８が対角線方向に備えられる。ここで、Ｒビームの進路について説明する。前記プリズムアレイ２５を通ったＲビームのうち左円偏光のビームＲ＋が最初に前記第１の鏡面３７に出合えば、この第１の鏡面３７により反射されてから進路上において第２の鏡面３８に出合った時にそのまま透過されて図中のＡ′の方向に進む。一方、Ｒ＋のビームが最初に前記第２の鏡面３８に出合えば、この第２の鏡面３８を透過してから前記第１の鏡面３７により反射されて図中のＡ′の方向に進む。また、前記プリズムアレイ２５を通ったＲビームのうち右円偏光のビームＲ－が最初に前記第１の鏡面３７に出合えば、この第１の鏡面３７を透過し、進路上において第２の鏡面３８に出合った時に反射されてＡ′の方向に進む一方、最初に前記第２の鏡面３８に出合えば、この第２の鏡面３８により反射されてＡ′の方向に向かう。

【００３８】前記の如き作用はＧビームの左円偏光Ｇ＋及び右円偏光Ｇ－、Ｂビームの左円偏光Ｂ＋及び右円偏光Ｂ－に対しても同様に適用され、結局、いずれも同方向（Ａ′）に進められる。前記第１，第２及び第３のコレステリックバンドモジュレーションフィルタ３５ａ，３５ｂ，３５ｃは、各々に対応する波長のビームのみを選択的に透過または反射させ、他の波長のビームに対しては偏光方向に関係なくいずれも透過せしめる。このようにして左円偏光及び右円偏光がどちらも有効に使用可能であるので、光効率の面で極めて有利である。

【００３９】これとは異なって、前記光路変換器は、図

Microsoft Exhibit 1002 - Page 1107
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

８に示されたように、Ｘプリズム６０またはＸ型ダイクロイックフィルタフィルムを含むことができる。この時、前記第１，第２及び第３の発光素子または発光素子アレイ１０ａ，１０ｂ，１０ｃは前記Ｘプリズム６０またはＸ型ダイクロイックフィルタフィルムを中心として所定角度をもって離隔されて配される。前記Ｘプリズム６０は、Ｒ，Ｇ，Ｂ波長のビームを照射する第１，第２及び第３の発光素子または発光素子アレイ１０ａ，１０ｂ，１０ｃ、ホログラム光素子１５及び導波路２０と対向して位置した第１，第２及び第３の入射面６１，６２，６３と、一つの出射面６４とを有する。そして、Ｘ字形に交差されて入射光をその波長に応じて選択的に透過または反射せしめることにより光路を変える第３及び第４の鏡面６０ａ，６０ｂを含む。例えば、前記第３の鏡面６０ａは、Ｒビームを反射させて他の波長のＧ，Ｂビームを透過せしめる一方、前記第４の鏡面６０ｂは、Ｂビームを反射させて他の波長のＲ，Ｇビームを透過せしめる。

【００４０】前記第１ないし第３の発光素子または発光素子アレイ１０ａ，１０ｂ，１０ｃから各々出射されて前記ホログラム光素子１５、導波路２０及びプリズムアレイ２５，２６，２７，２８を通ったＲ，Ｇ，Ｂの３色ビームは各々前記Ｘプリズム６０の対応する第１ないし第３の入射面６１，６２，６３に入射する。このように相異なる経路に入射したＲ，Ｇ，Ｂの３色ビームは前記第３及び第４の鏡面６０ａ，６０ｂを透過またはそこから反射されて前記出射面６４内を同方向に進む。

【００４１】前述の実施の形態により、前記発光素子または発光素子アレイ１０ａ，１０ｂ，１０ｃを各々に配置でき、その配置に見合うように光路変換器３０，３５，６０を選択して構成できる。また、前記実施の形態における少なくとも一つのホログラム光素子１５は同じ機能を有する少なくとも一つの回折光学素子に置き換え可能である。また、前述した第２の実施の形態に対しても前記ダイクロイックフィルタ、コレステリックバンドモジュレーションフィルタ及びＸプリズム、Ｘ型ダイクロイックフィルタフィルムのうち何れか一つが選択されて同様に適用できる。

【００４２】本発明の第３の実施の形態によれば、図９に示されたように、各々Ｒ，Ｇ，Ｂの３色ビームを照射する第４，第５及び第６の発光素子または発光素子アレイ６５，６６，６７と、前記第４ないし第６の発光素子または発光素子アレイ６５，６６，６７から照射されたビームを平行ならしめる平行光形成手段７０と、前記Ｒ，Ｇ，Ｂの３色ビーム各々の光路を所定角度だけ変える第４ないし第６のホログラム光素子７５，７６，７７と、前記ホログラム光素子７５，７６，７７を通って入射したビームを全反射させて進める導波路８０と、前記導波路８０の出射側の端部に設けられたプリズムアレイ８５とを含んでなる。

【００４３】前記平行光形成手段７０は、フレネルレンズアレイまたはコリメーティングレンズアレイであっても良い。前記平行光形成手段７０により平行に出射したＲ，Ｇ，Ｂの３色ビームは各々に対応する第４ないし第６のホログラム光素子７５，７６，７７を介して前記導波路８０内において全反射可能な角度にて入射する。前記プリズムアレイ８５は、前記導波路８０の出射側の端部に一体に形成されており、前記導波路８０を介して相異なる方向に進むビームを一方向に平行に出射せしめる。前記プリズムアレイ８５は、このように前記導波路８０と一体型のものもあれば、前述の如く前記導波路８０と別体型のものもある。また、十分な光量を確保するために、発光素子または発光素子アレイ６５′，６６′，６７′をさらに備えても良い。前記発光素子または発光素子アレイ６５′，６６′，６７′に対応する平行光形成手段７０′、ホログラム光素子７５′，７６′，７７′、導波路８０′及びプリズムアレイ８５′が前述の如き構造にてさらに配される。ここで、前記ホログラム光素子７５′，７６′，７７′及び導波路８０′は、隣り合うホログラム光素子７５，７６，７７及び導波路８０が設けられた平面とは異なる平面に配され、互いの光路が重畳されない。

【００４４】前記第３の実施の形態によれば、前記第４ないし第６の発光素子または発光素子アレイ６５，６６，６７からＲ，Ｇ，Ｂビームが順次オン／オフされて出射することにより、光損失無しにカラー画像が形成可能になる。そして、前記Ｒ，Ｇ，Ｂの３色ビームが前記導波路８０内を同一経路に進むので、別途の光路変換器を備えなくても良い。

【００４５】一方、本発明は、前記の如き照明系を採用したプロジェクションシステムを提供する。本発明に係る照明系を採用したプロジェクションシステムは、図１０に示されたように、光を照射する照明系９０と、この照明系９０から出射したＲ，Ｇ，Ｂの３色ビームを利用して画像を形成するディスプレー素子９５及び前記ディスプレー素子９５により形成された画像をスクリーン９８に向わせる投射レンズユニット９７を含むプロジェクションシステムにおいて、前記照明系９０は、図２に示されたように、所定波長の光ビームを照射する少なくとも一つの発光素子１０と、前記発光素子１０から出射した光ビームの経路を変える少なくとも一つのホログラム光素子１５と、前記少なくとも一つのホログラム光素子１５を介して入射する入射光を案内する導波路２０とを含んでなる。

【００４６】前記照明系は、図２ないし図９を参照して説明した第１ないし第３の実施の形態による照明系のうち一つよりなり、図１０中の９０にて表わされる。図２及び図４を参照すれば、前記発光素子または発光素子アレイ１０としては、ＬＥＤ、ＬＤ、有機ＥＬまたはＦＥＤなどが使用できる。前記発光素子または発光素子アレ

Microsoft Exhibit 1002 - Page 1108
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

イ１０は各々Ｒ，Ｇ，Ｂの３色ビームを出射する第１ないし第３発光素子または発光素子アレイ１０ａ，１０ｂ，１０ｃを含み、十分な光量が確保可能なように発光素子１０ａ，１０ｂ，１０ｃ、ホログラム光素子１５、導波路２０などが同じ構造にて水平方向または上下方向にさらに備えられる。ここで、前記少なくとも一つのホログラム光素子１５は同じ機能を有する回折光学素子に置き換え可能であり、これによっても本発明の目的は達成できる。

【００４７】また、前記導波路２０内を進んで出射したビームを一方向に平行ならしめるプリズムアレイ２５をさらに備えても良い。前記プリズムアレイ２５は、前記導波路２０とは別体型のものもあれば、前記導波路２０の出射側の端部と一体型に形成されるものもある（図３Ａないし図３Ｃ参照）。これに加えて、前記プリズムアレイ２５，２６，２７，２８を介して同方向に進むＲ，Ｇ，Ｂの３色ビームを均一ならしめるフライアイレンズ９２及び前記ディスプレー素子９５側に光を集束せしめるリレイレンズ９３がさらに備えられても良い。これにより、Ｒ，Ｇ，Ｂの３色ビームを利用して前記ディスプレー素子９５によりカラー画像を形成する。前記ディスプレー素子９５は、画像信号に基づきマイクロミラーのオン－オフ切り換え動作によりカラー画像を具現する可動ミラー装置であっても良く、入射光を偏光変調させてカラー画像を具現する液晶表示素子であっても良い。

【００４８】これらに加えて、前記照明系９０は、前記プリズムアレイ２５，２６，２７，２８の後方に相異なる方向から入射するビームの進路を変えて一方向に集束せしめる光路変換器３０をさらに備えても良い。

【００４９】前記光路変換器は、前述の如く、入射光の波長に応じて選択的に透過または反射せしめることによりＲ，Ｇ，Ｂの３色ビームの進路を変える第１ないし第３のダイクロイックフィルタ３０ａ，３０ｂ，３０ｃを含むことができる。前記第１ないし第３のダイクロイックフィルタ３０ａ，３０ｂ，３０ｃ内を同方向に進むＲ，Ｇ，Ｂの３色ビームは、前記フライアイレンズ９２及びリレイレンズ９３により均一に集束されて前記ディスプレー素子９５によりカラー画像を形成する。

【００５０】ここでは、前記光路変換器として第１ないし第３のダイクロイックフィルタ３０ａ，３０ｂ，３０ｃを使用した例を説明したが、これに限定されることなく、前述の如く、入射光の円偏光の方向に応じて透過または反射せしめるコレステリックバンドモジュレーションフィルタ３５を使用しても良い。また、光の波長に応じて入射光を反射または透過せしめることにより相異なる方向から入射するＲ，Ｇ，Ｂの３色ビームが同方向に進むように光路を変えるＸプリズム６０またはＸ型ダイクロイックフィルタが使用できる。この時には、Ｒ，Ｇ，Ｂの３色ビームを照射する第１ないし第３の発光素子または発光素子アレイ１０ａ，１０ｂ，１０ｃが、図８に示されたように、前記Ｘプリズム６０またはＸ型ダイクロイックフィルタを中心として所定角度をもって離隔されて配される。

【００５１】さらに他の実施形態として、前記照明系９０が、図５に示されたように、発光素子または発光素子アレイ４０、前記発光素子または発光素子アレイ４０から照射されたビームを集束せしめるフォーカシングレンズ４５及び前記フォーカシングレンズ４５により集束されたビームが全反射可能に所定角度だけ斜めに形成された反射面４８を有する導波路５０を備えても良い。そして、前記導波路５０内を進んで出射したビームを平行ならしめるコリメーティングレンズまたはフレネルレンズなどの平行光形成手段５５がさらに備えられる。

【００５２】前記平行光形成手段５５により平行ならしめられたビームは前記フライアイレンズアレイ９２により均一になり、前記リレイレンズ９３により前記ディスプレー素子９５に集束する。ここで、前記平行光形成手段５５の後方に前記第１ないし第３のダイクロイックフィルタ３０ａ，３０ｂ，３０ｃ、コレステリックバンドモジュレーションフィルタ３５、Ｘプリズムまたは Ｘ型ダイクロイックフィルタ６０などの光路変換器が挿入可能であるということは前述の通りであるため、これについての詳細な説明は省く。

【００５３】また、本発明に係るプロジェクションシステムは、図９に示されたように、Ｒ，Ｇ，Ｂの３色ビームが前記第４ないし第６のホログラム光素子７５，７６，７７を介して同導波路８０に入射して同方向に進む構造の照明系を採用することができる。この場合には、Ｒ，Ｇ，Ｂの３色ビームが一本の導波路８０を介して同光路に進むので、別途の光路変換器を備えなくても良い。従って、プロジェクションシステムのコンパクト化が可能になる。

【００５４】前記の如き色々な実施の形態による照明系９０から出射されるＲ，Ｇ，Ｂの３色ビームは、前記フライアイレンズ９２及びリレイレンズ９３を通って前記ディスプレー素子９５に入射してカラー画像が形成される。そして、このカラー画像は、前記投射レンズユニット９７により拡大されてスクリーン９８に結像される。

【００５５】

【発明の効果】本発明に係る照明系は、所望の波長帯の狭いスペクトルを有する光を照射する発光素子または発光素子アレイを利用することで色純度が向上し、より広い分布を有するカラーガマットを確保できるだけではなく、ホログラム光素子または回折光学素子、及び導波路によりビームの断面積を縮小せしめることにより照明系をコンパック化でき、しかも光損失を低減できる。また、フォーカシングレンズにより一点に集束されたビームを導波路内に進めることでビームの断面積が一層縮小し、従来のランプ光源に比べて熱の発生が少ないほか、寿命が延びるという利点もある。

Microsoft Exhibit 1002 - Page 1109
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

【００５６】のみならず、本発明に係る照明系を採用したプロジェクションシステムでは、発光素子または発光素子アレイを有する照明系によるタイムシーケンシャル駆動が可能であることから、カラーホイールが不要であり、カラーホイールの回転速度より高速のオンーオフ切り換え作動が可能であることから、高いフレームレートが具現できて電力の消耗も省ける。よって、本発明に係る照明系を採用したプロジェクションシステムは、高鮮明度及び高画質の画面を提供することができる。

【図面の簡単な説明】

【図１】　従来のプロジェクションシステムの概略構成図である。

【図２】　本発明の第１の実施の形態による照明系の正面図である。

【図３Ａ】　本発明の第１の実施の形態による照明系において使われる導波路の色々な実施形態を示す図面である。

【図３Ｂ】　本発明の第１の実施の形態による照明系において使われる導波路の色々な実施形態を示す図面である。

【図３Ｃ】　本発明の第１の実施の形態による照明系において使われる導波路の色々な実施形態を示す図面である。

【図４】　図２の平面図である。

【図５】　本発明の第２の実施の形態による照明系の概略構成図である。

【図６】　本発明の照明系において使われる光路変換器の色々な実施形態を示す図である。

【図７】　本発明の照明系において使われる光路変換器の色々な実施形態を示す図である。

【図８】　本発明の照明系において使われる光路変換器の色々な実施形態を示す図である。

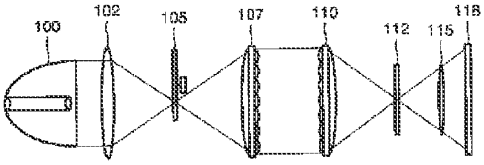
【図９】　本発明の第３の実施の形態による照明系の構成図である。

【図１０】　本発明に係る照明系を採用したプロジェクションシステムの概略構成図である。

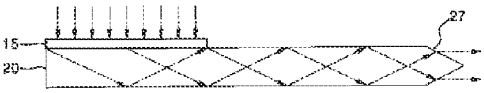
【符号の説明】

１０，４０　　発光素子（発光素子アレイ）
４３　　第１の平行光形成手段
４５，４５′，４５″　　フォーカシングレンズ
４８　　傾斜面（入射面、反射面）
２０，２０′，５０，５０′，５０″，８０，８０′　導波路
５５　　第２の平行光形成手段
３０，３５，５８，６０　　光路変換器
１０，５５，７０，７０′　　平行光形成手段
１５，１５′　　ホログラム光電子
２５～２８，８５，８５′　　プリズムアレイ
３０ａ　　第１のダイクロイックフィルタ（ダイクロイックフィルタ、光路変換器）
３０ｂ　　第２のダイクロイックフィルタ（ダイクロイックフィルタ、光路変換器）
３０ｃ　　第３のダイクロイックフィルタ（ダイクロイックフィルタ、光路変換器）
３５　　コレステリックバンドモジュレーションフィルタ（光路変換器）
３７　　第１の鏡面
３８　　第２の鏡面
６０　　Ｘプリズム（光路変換器）
９０　　照明系
９２，１０７　　フライアイレンズ
９３，１１０　リレイレンズ
９５，１１２　　ディスプレー素子
９７　　投射レンズユニット
９８，１１８　　スクリーン

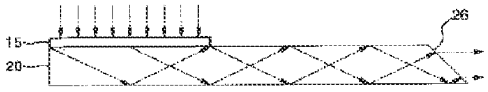
【図１】



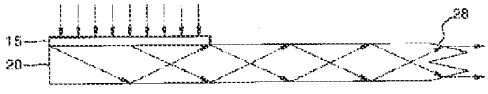
【図３Ｂ】



【図３Ａ】

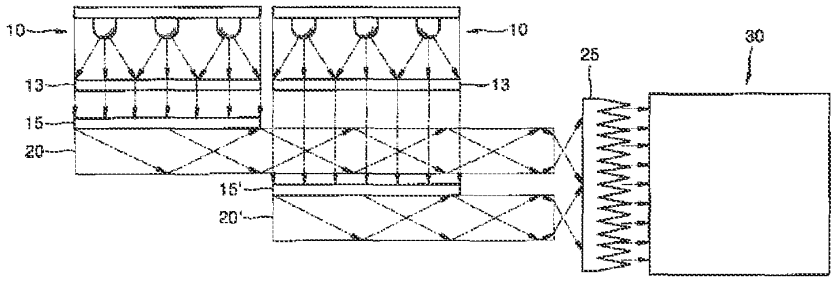


【図３Ｃ】

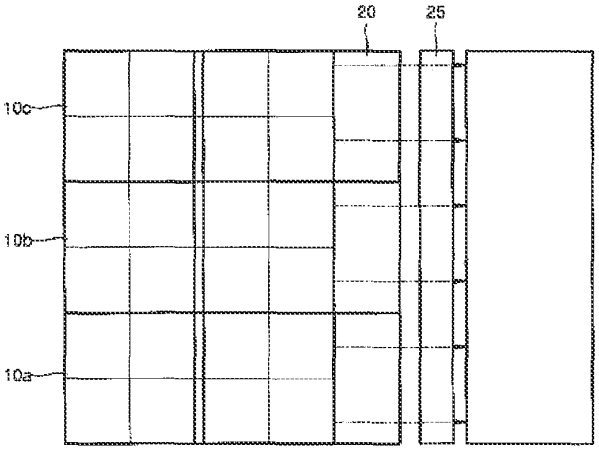


Microsoft Exhibit 1002 - Page 1110
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

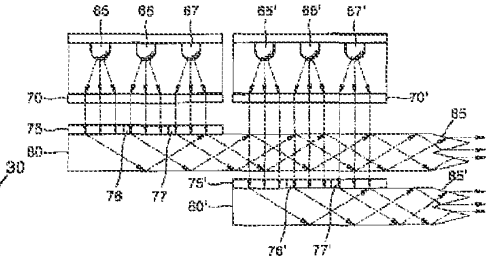
【図２】



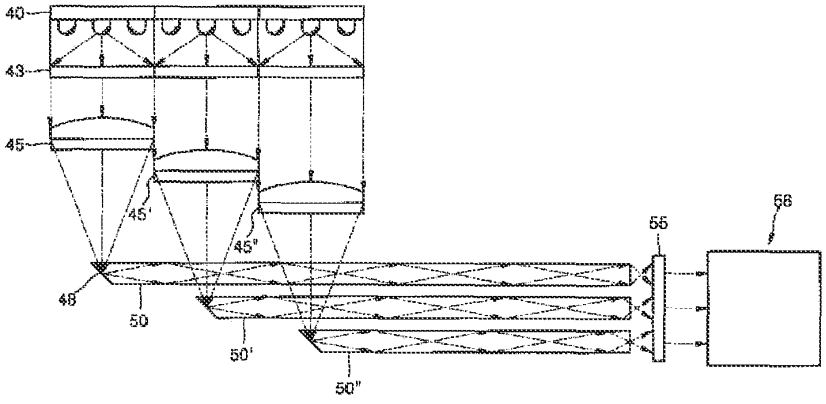
【図４】



【図９】

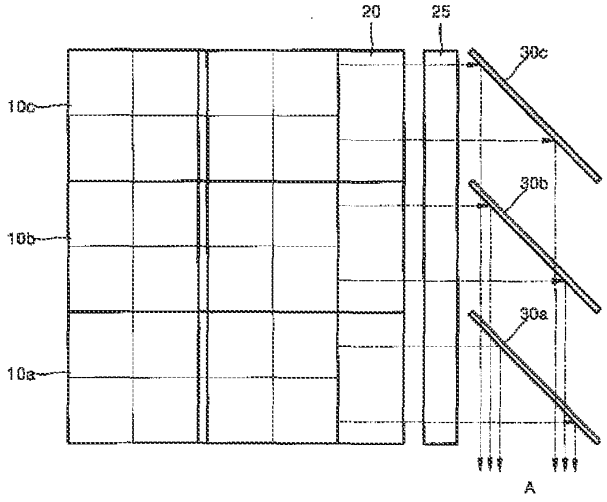


【図５】

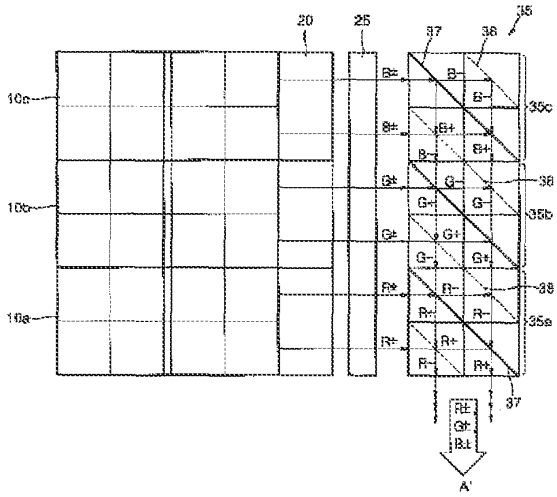


Microsoft Exhibit 1002 - Page 1111
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

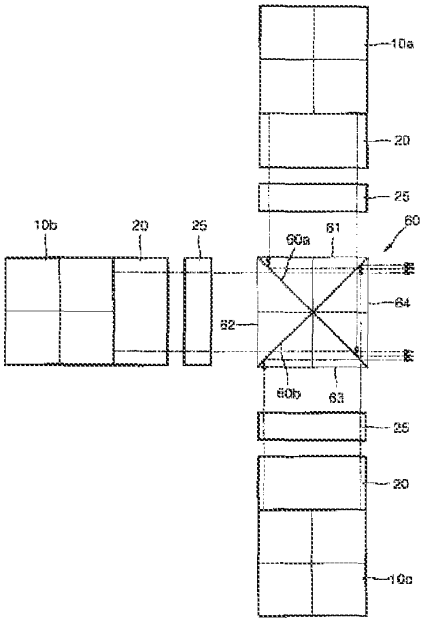
【図６】



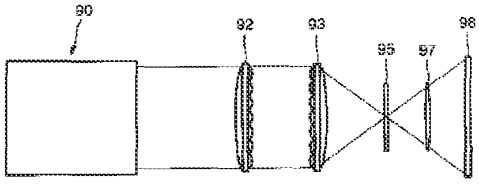
【図７】



【図８】



【図１０】



Microsoft Exhibit 1002 - Page 1112
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

フロントページの続き

Ｆターム(参考)　2H049 CA05 CA09 CA17 CA22
2H052 BA01 BA02 BA03 BA08 BA14
2H099 AA11 BA09 BA17 CA17 DA09
2K103 AA16 BA01 BC01 BC09 BC24
BC26 BC32 BC42 CA46

Microsoft Exhibit 1002 - Page 1113
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

J-PlatPat
Japan Platform to Patent Information
Help desk (9:00-21:00)
(+81)3-6666-8801
Japanese Top page Help (JP) Site map JPO
Patent & Utility Model Design Trademark Trial & Appea
Top page Patent& Utility Model Patent& Utility Model Number Search

Patent & Utility Model Number Search

Back Help Search List

You can retrieve a variety of patent and utility model gazettes by their numbers.

Selected Gazette

Previous Document 10/12 Next Doc

JP,2006-010935,A

PAJ Detail Image
CLAIMS DETAILED DESCRIPTION
DRAWINGS

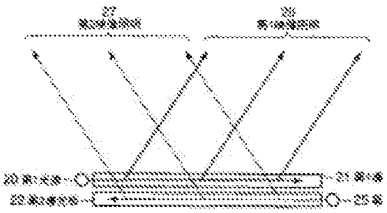
*** NOTICES ***

JPO and INPIT are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[Field of the Invention]
[0001]
The present invention relates to a graphic display device and an in-vehicle graphic display device.
[Background of the Invention]
[0002]
It has one display surface and the graphic display device which the image according to the direction seen, respectively can observe is known conventionally. For example, the Japan Japanese Patent No. 3072866 gazette has disclosed the stereoscopic display device which used matrix form lighting, a lenticular sheet, etc. as technology which switches the directivity of lighting by time sharing in displaying an image according to the direction to see.
[0003]
Fig.19 (A) and (B) is the shown figure one configuration example of the conventional graphic display device, and The light source group 100 which consists of the sources L1, R1-L3, and R3 of split light, such as a stripe shape light source and a matrix form light source, Combination with the lenticular sheet 101 as a light diffusing element which consists of the lenses 1-3 performs time sharing lighting. In Fig.19 (A), the light source of R1-R3 was turned on among L1, R1-L3, and R3, and the light source of L1-L3 is switched off. In Fig.19 (B), the light source of L1-L3 was turned on among L1, R1-L3, and R3, and the light source of R1-R3 is switched off.
[0004]
Since only the light source R is observable if it sees by the lens action of the lenticular sheet 101 from the observer who is in the R side as used in the field of Fig.19, and only the light source L is observable if it sees from the observer who is in the L side, By making the light sources R and L turn on alternately, switching the display of a transmission type display element with the display for the R sides, and the display for the L sides, and displaying it corresponding to it, the R side observer can observe only the R side image, and the L side observer can observe only the L side image.
[0005]
Fig.20 is the figure showing other configuration examples of the conventional graphic display device.
For example, it discloses in news release [by MITSUBISHI DENKI KABUSHIKI KAISHA] (attached on September 30, 2003), and development No.0324.
This composition is the composition for performing a three dimentional display called a scanning backlight system.
The double-sided prism sheet 151 is arranged behind the liquid crystal display element 150, and the light guide plate 153 is arranged back [the].
1st light source 152-1,152-2 is arranged in the both ends of the light guide plate 153. As for the double-sided prism sheet 151, in the front face 151-1, lenticular structure and the rear face 151-2 have prism structure. The light guide plate 153 can switch directivity by ON/OFF of the 1st light source 152-1 and the 2nd light source 152-2. A three dimentional display is realized by entering the illumination light in time sharing by such composition at an observer's right and left eye, and displaying the image (the image 154-1 for right eyes, the image 154-2 for left eyes) corresponding to a right and left eye. In Fig.20, 155-1 is the 1st light source image, and 155-2 is the 2nd light source image.



Representative drawing

Representative drawing | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |

Microsoft Exhibit 1002 - Page 1114
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

[Patent document 1] Japan Japanese Patent No. 3072866 gazette
[Nonpatent literature 1] News release (attached on September 30, 2003) development No.0324 by MITSUBISHI DENKI KABUSHIKI KAISHA
[Description of the Invention]
[Problem to be solved by the invention]
[0006]
However, in the stereoscopic display device of the time sharing lighting system disclosed in the Japan Japanese Patent No. 3072866 gazette, The appropriately observable range was narrow, and when the observation position had been especially shifted more to the R side while the observer of for example, R side observed the image on R side, there was a problem that the L side image which is an image of an opposite direction will be in sight.
[0007]
Below, it describes in detail about this problem. Fig.21 shows the situation when it observes from the outside further from the observation position of Fig.19 (A). Fig.22 is the figure showing what kind of image is in sight by the difference in an observation position in the conventional composition. In Fig.22, although it is an ideal to separate into the 1st (L side) image observation area 602 and the 2nd (R side) image observation area 601 bordering on a center, an observation area, As shown in Fig.21, the region 600 of the 2nd image observation area 601 in which the image for the 1st observer is in sight when it goes outside further exists, and it becomes a cross talk in this region. Conversely, the region 603 of the 1st image observation area 602 in which the image for the 2nd observer is in sight when it goes outside further exists, and it becomes a cross talk in this region.
[0008]
In the optical system using a lenticular sheet, since a focal distance had to be made small, curvature would enlarge dramatically and the influence of aberration would increase with it if it is going to separate a right-and-left image at a big angle, there was also a problem that the influence of a cross talk enlarged as a result.
[0009]
On the other hand, since two light source 152-1,152-2 corresponded to the light guide plate 153 of one sheet and right and left directivity is switched by ON/OFF of each light source 152-1,152-2 in the scanning backlight system, Must make structure of the light guide plate 153 into the given structure or symmetrical structure, and uniform surface treatment A portion near from light source 152-1,152-2, The difference was made to illumination intensity in the portion far from light source 152-1,152-2, it could be seen as illumination unevenness, and there was a problem that the influence will enlarge like a big display screen especially. In order that the light guide plate of the backlight used for the usual display panel may stop illumination unevenness, light guide plate structure has right-and-left asymmetry.
[0010]
With "raster scanning" which is the drive system used for the usual liquid crystal panel and the "hold characteristic" which continues displaying the image of each pixel as display properties of a liquid crystal panel for a fixed time (1 / 60 etc. seconds), If the directivity of the surface light source which are screen size and equivalent size was switched by the package, there was a problem of that emission time is restricted, being easy to generate a cross talk.
[0011]
the present invention is made paying attention to such problem, and comes out.
The object has a cross talk in providing a graphic display device with which few [and] high-definition images with little illumination unevenness are acquired, and an in-vehicle graphic display device.

[Means for solving problem]
[0012]
In order to achieve the above-mentioned object, first invention, The illumination method which is a graphic display device which has one display screen which can display the image corresponding to each of a plurality of observers, and ejects first light flux and second light flux in at least two different directions by time sharing, respectively, The first image that makes the illumination light above-mentioned first light flux ejected from the aforementioned illumination method, Provide the second image which makes above-mentioned second light flux the illumination light, and the transmission type display element which can be displayed by time sharing the aforementioned illumination method, The first light source that ejects the above-mentioned first light flux, and the second light source which ejects the above-mentioned second light flux, The first light guide plate that ejects the first light flux ejected from the above-mentioned first light source only in the direction of a first observer, and the second light guide plate which ejects the second light flux ejected from the above-mentioned second light source only in the direction of a second observer are provided.
[0013]
In the graphic display device which requires second invention for first invention, the above-mentioned first light guide plate is arranged between the aforementioned transmission type display element and the above-mentioned second light guide plate, and the second light flux ejected from the above-mentioned second light guide plate transmits the above-mentioned first light guide plate.
[0014]
In the graphic display device concerning second invention, the 3rd invention in the surface which opposes to the aforementioned transmission type display element of the above-mentioned first light guide plate, and the surface which opposes to the above-mentioned second light guide plate, It is ejected from the above-mentioned second light guide plate, and the flat part is optically provided to the above-mentioned second light flux that transmits the above-mentioned first light guide plate.
[0015]

Microsoft Exhibit 1002 - Page 1115
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

In the graphic display device concerning first invention, the 4th invention in the rear face of the above-mentioned first light guide plate, The plane part for carrying out total internal reflection of the incident light from the above-mentioned first light source, and transmitting to the end face of an opposite side with the above-mentioned first light source of the above-mentioned first light guide plate, Total internal reflection of the incident light from the above-mentioned first light source is carried out, it is made not to fulfill the total reflection condition in the front face of the above-mentioned first light guide plate, and multiple slope parts for making it eject in the above-mentioned first direction of an observer are provided.

[0016]

In the graphic display device concerning first invention, fifth invention in the front face of the above-mentioned first light guide plate, Multiple plane parts for carrying out total internal reflection of the incident light from the above-mentioned first light source, and transmitting to the end face of an opposite side with the above-mentioned first light source of the above-mentioned first light guide plate and projection surfaces for making the incident light from the above-mentioned first light source transmit, and making it eject in the above-mentioned first direction of an observer are provided.

[0017]

In the graphic display device which requires sixth invention for the 4th invention, the angle theta of the aforementioned slope part and the aforementioned plane part to make fulfills the conditions of n-cos2theta<1 (theta< 45 degree), when setting the refractive index of the above-mentioned first light guide plate to n.

[0018]

Multiple rectangular slots are provided by the front face of the above-mentioned first light guide plate in the graphic display device which requires seventh invention for fifth invention.

[0019]

In the graphic display device which requires eighth invention for seventh invention, the above-mentioned rectangular tooth depth is enlarged, so that it keeps away from the above-mentioned first light source.

[0020]

In the graphic display device which requires ninth invention for first invention, the above-mentioned second light guide plate is surface shape with different form from the above-mentioned first light guide plate, or different periodical structure.

[0021]

In the graphic display device which requires tenth invention for first invention, the above-mentioned second light guide plates are the above-mentioned first light guide plate and identical shape, and the above-mentioned first light guide plate and the above-mentioned second light guide plate replace right and left each other, and they are arranged.

[0022]

In the graphic display device concerning tenth invention, the 11th invention regards as the above-mentioned first light source and the above-mentioned second light source from the observer side, and is arranged in a right and left different end-face position.

[0023]

In the graphic display device which requires the 12th invention for first invention, light is emitted periodically at time for the above-mentioned first light source to differ from the above-mentioned second light source, respectively, and the frequency of luminescence of each light source is 24 Hz or more.

[0024]

In the graphic display device which requires the 13th invention for first invention, the component which absorbs light is arranged behind the above-mentioned second light guide plate.

[0025]

In the graphic display device concerning first invention, the 14th invention adjoins the above-mentioned first light guide plate and the above-mentioned second light guide plate along the raster scanning direction of the aforementioned transmission type display element, a plurality of light emitting devices are arranged, and emission control of each light emitting device is carried out separately.

[0026]

In the graphic display device which requires the 15th invention for the 14th invention, each aforementioned light emitting device emits light periodically synchronizing with raster scanning of the aforementioned transmission type display element.

[0027]

In the graphic display device which requires the 16th invention for the 14th invention, the 1st above-mentioned light guide plate and the 2nd above-mentioned light guide plate are divided into a plurality of light guide sections corresponding to each of said plurality of light emitting devices.

[0028]

The 17th invention has one display screen which can display the image corresponding to each of a plurality of observers, The illumination method which is an in-vehicle graphic display device installed in a car, and ejects first light flux and second light flux in at least two different directions by time sharing, respectively, The first image that makes the illumination light above-mentioned first light flux ejected from the aforementioned illumination method, Provide the second image which makes above-mentioned second light flux the illumination light, and the transmission type display element which can be displayed by time sharing the aforementioned illumination method, The first light source that ejects the above-mentioned first light flux, and the second light source which ejects the above-mentioned second light flux, The first light guide plate that ejects the first light flux ejected from the above-mentioned first light source only in the direction of the observer of a drivers side, and the second light guide plate which ejects the second light flux ejected from the above-mentioned second light source only in

Microsoft Exhibit 1002 - Page 1116
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

the direction of the observer of a passenger side are provided.
[Effect of the Invention]
[0029]
According to the present invention, a high-definition image with little illumination unevenness with few { and } cross talks is acquired at low cost.
[Best Mode of Carrying Out the Invention]
[0030]
Hereinafter, with reference to Drawings, the embodiment of the present invention is described in detail. Fig.1 is the figure for describing the example of 1 use of the graphic display device of the present invention. The 1st observer 12-1 who observes the display screen 10 from left-hand side is placed at the method of the forward right of the one display screen 10, and the 2nd observer 12-2 who observes the display screen 10 from right-hand side is placed at the method of the forward left of the display screen 10. Since the 1st observer 12-1 is placed in the 1st image observation area 11-1, respectively and the 2nd observer 12-2 is placed in the 2nd image observation area 11-2 about the 1st image, both can observe the 2nd image simultaneously.
[0031]
Fig.2 is the figure showing the basic constitution of the graphic display device concerning the present invention, and the transmission type display element 24, the light diffusing element 23, the 1st light guide plate 21, and the 2nd light guide plate 22 are arranged sequentially from an observer's position. Thus, according to this embodiment, it has the composition of having piled up doubly the 1st light guide plate 21 and the 2nd light guide plate 22. The end of the 1st light guide plate 21 is adjoined, the 1st light source 20 is arranged, the end of the aforementioned end and opposite side of the 2nd light guide plate 22 is adjoined, and the 2nd light source 25 is arranged. That is, the 1st light source 20 and the 2nd light source 25 are arranged in the asymmetric position with the 1st light guide plate 21 and the 2nd light guide plate 22.
[0032]
The light diffusing element 23 is arranged between the 1st light guide plate 21 and the transmission type display element 24, in order to reduce illumination unevenness etc. Here, since the image is separated so that it may become two directivity horizontally, when the diffusion to a horizontal direction is too strong, there is a possibility that two images may be mixed and it may be visible as a double image. Therefore, it is more preferable than vertical diffusion here to use the light diffusing element which suppressed horizontal diffusion.
[0033]
The 1st light guide plate 21 and the 2nd light guide plate 22 have composition which provided a slot and an inclination special to a transparent component, and the projection, and he is trying to eject the light which entered from the side surface only in a certain direction with directivity. As long as the 1st light source 20 and the 2nd light source 25 are illuminated from the uni directional of the 1st light guide plate 21 and the 2nd light guide plate 22, anything, a pillar-shaped light source like { it is good and } a cold cathode tube may be sufficient as them, and light sources, such as LED, may be put in order and used for them.
[0034]
Fig.3 is a horizontal sectional view of the illumination method of the graphic display device concerning the present invention. The 1st light guide plate 21 and the 2nd light guide plate 22 are arranged in piles. The end (the figure left end) of the 1st light guide plate 21 is adjoined, the 1st light source 20 is arranged, the end of the 1st light guide plate 21 of the 2nd light guide plate 22 (left end) and the end (the figure right end) of an opposite side are adjoined, and the 2nd light source 25 is arranged. Thus, according to this embodiment, the position which arranges the 1st light source 20 and the 2nd light source 25 is differently with the 1st light guide plate 21 and the 2nd light guide plate 22.
[0035]
Below, the direction (the figure above) approaching an observer's position will be considered to be the front. While carrying out total internal reflection of the inside of the 1st light guide plate 21, are transmitted, but the light which entered into the 1st light guide plate 21 from the 1st light source 20. The light ejected from the 1st light guide plate 21 can be illuminated only in the direction of the 1st observer as the 1st image lighting 26 by performing a special surface treatment to the surface of the 1st light guide plate 21, or its part, or making the surface concerned into special form. On the other hand, while carrying out total internal reflection of the inside of the 2nd light guide plate 22, are transmitted, but the light which entered into the 2nd light guide plate 22 from the 2nd light source 25. The light ejected from the 2nd light guide plate 22 can be illuminated only in the direction of the 2nd observer as the 2nd image lighting 27 by performing a special surface treatment to the surface of the 2nd light guide plate 22, or its part, or making the surface concerned into special form. The context on arrangement of the 1st light guide plate 21 and the 2nd light guide plate 22 is arbitrary.
[0036]
Fig.4 is a mimetic diagram showing the specific section structure of the illumination method concerning a 1st embodiment of the present invention. Like the composition of Fig.3, the position which arranges the 1st light source 20 and the 2nd light source 25 is in them differently also here with the 1st light guide plate 121 and the 2nd light guide plate 122 while the 1st light guide plate 121 and the 2nd light guide plate 122 are arranged in piles.
[0037]
Furthermore, a plurality of slope parts 121-1 to 121-3 have extended in the rear face of each light guide plate 121,122 in the shape of a stripe at the predetermined intervals, and form the stair-like portion in it. Although the 1st light guide plate 121 and the 2nd light guide plate 122 are identical shape, they differ in right and left direction. Behind the 2nd light guide plate 122, the light absorption member 28 for absorbing outdoor daylight and unnecessary light is arranged.
[0038]

Microsoft Exhibit 1002 - Page 1117
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

While the light ejected from the 1st light source 20 enters into the 1st light guide plate 121 and total internal reflection is repeated on the front face and rear face, proceed, but. Since the light which carried out total internal reflection in the slope part 121-1 to 121-3 is ahead reflected by an acute angle rather than the light which carried out total internal reflection in the level surface of the 1st light guide plate 121, a total reflection condition is not satisfied in the front face of the 1st light guide plate 121. Therefore, light is illuminated by the 1st observation direction as the 1st image lighting 26.

[0039]

While the light ejected from the 2nd light source 25 enters into the 2nd light guide plate 122 on the other hand and total internal reflection is repeated on the front face and rear face, proceed, but. Since the light which carried out total internal reflection in the slope part 122-1 to 122-3 is ahead reflected by an acute angle rather than the light which carried out total internal reflection in the level surface of the 2nd light guide plate 122, a total reflection condition is not satisfied in the front face of the 1st light guide plate 121. Therefore, light is illuminated as the 2nd image lighting 27 to the 2nd observation direction.

[0040]

Although the 1st light guide plate 121 is passed on the way, the 2nd image lighting 27 originating in the 2nd light source 25, Since it has the same effect as the time of passing a plane-parallel plate in the slope part 121-1 - almost all portions other than 121-3, Moreover the final degree of angle of emergence does not change, change of an angle when the 2nd image lighting 27 enters into the slope part 121-1 to 121-3 of the 1st light guide plate 121, In order to change to an opposite direction, a cross talk etc. are not influenced with the direction which goes outside that of the 2nd observation position, i.e., the 1st observation direction.

[0041]

Since it is typically drawn in the figure, the four or more number of slopes is actually arranged in a predetermined pitch, although only three one side is drawn.

[0042]

Fig.5 is the figure expanding and showing the slope part of the light guide plate described by Fig.4. The conditions for leading the angle theta with a suitable slope part to below are drawn. If based on the light which enters horizontally, since it is a light guide plate illuminated to the 1st observation direction, Fig.5 will serve as a boundary without the cross talk of 3D beam of light which is a boundary of the 1st observation area and the 2nd observation area and which is ejected vertically in the figure. The angle theta of the slope part 31 at that time is 45 degree.

[0043]

Since a beam of light cannot be ejected from a light guide plate if the beam of light reflected in the slope part 31 fulfills a total reflection condition by the front face of a light guide plate, when the angle conditions of the slope part 31 of the limit which sets a refractive index to n and carries out total internal reflection are searched for,

n·sin(90-2theta) <1, i.e., n·cos2theta<1

Incidentally, if n= 1.5, it is set to theta= 24.1 and becomes about 24 degree.

[0044]

As mentioned above, in order for there to be no cross talk and to illuminate the 1st observation direction and the 2nd observation direction efficiently, they are the conditions of the angle theta of the slope part 31,

It turns out that theta<45 degree and n·cos2theta<1 must be filled.

[0045]

Fig.6 is the figure for describing about the angle of visibility at the time of using a constituent of the present invention. Fig.6 shows what kind of image is observed by the difference in an observation position. The observation area is separated into the 1st (L side) observer region 36 and the 2nd (R side) observer region 37 bordering on the center region 35. In the whole region of the 1st observer region 36, the cross talk of the image for the 2nd observer does not exist clearly rather than the center region 35 by comparison with Fig.22, and the cross talk of the image for the 1st observer does not exist in the whole region on the 2nd observer region 37 side rather than the center region 35 further.

[0046]

Fig.7 is the figure showing the modification of composition of having described by Fig.4. In this composition, the angle of the slope part 121-1 to 121-3 of the 1st light guide plate 121 was enlarged as it kept away from the 1st light source 20. Similarly, the angle of the slope part 122-1 to 122-3 of the 2nd light guide plate 122 is enlarged as it keeps away from the 2nd light source 25.

[0047]

Fig.8 is a mimetic diagram showing the specific section structure of the illumination method concerning a 2nd embodiment of the present invention. Like the composition of Fig.3, the position which arranges the 1st light source 20 and the 2nd light source 25 is in them differently also here with the 1st light guide plate 221 and the 2nd light guide plate 222 while the 1st light guide plate 221 and the 2nd light guide plate 222 are arranged in piles. Furthermore, a plurality of slots 221-1 to 221-3 and 222-1 to 222-3 are provided by the front face of each light guide plate 221,222, respectively.

[0048]

The light ejected from the 1st light source 20 enters into 1st light guide plate 221 inside from the end face of the 1st light guide plate 221. Since the total reflection condition is fulfilled by the front face of the 1st light guide plate 21, and the rear face, the light which entered travels to the end-face side of the 1st light source 20 and an opposite side on them, repeating total internal reflection. Since a plurality of slots 221-1 to 221-3 and 222-1 to 222-3 are provided by the front face of the 1st light guide plate 221, to the front face of the 1st light guide plate 21, and a rear face, the light which entered into the approximately perpendicular surface does not fulfill a total reflection condition, but is ejected by the outside of the 1st light guide plate 221. Since light enters only into the vertical plane on the 1st light source 20 side of the groove part

Microsoft Exhibit 1002 - Page 1118
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

121-1 to 121-3, the light ejected does not go to the 2nd observation direction by the 1st light guide plate 221, and turns into illumination light with the directivity which illuminates only the 1st observation direction with it.

[0049]

Although it is as having also described above the operation when the light emitted from the 2nd light source 25 entered into the 2nd light guide plate 222, since the 2nd light guide plate 222 is arranged as symmetrically as the 1st light guide plate 221, it will illuminate only the 2nd observation direction. Although the light ejected from the 2nd light guide plate 222 will pass the 1st light guide plate 221 at this time, the light which entered from the rear face of the 1st light guide plate 221 has the same operation as the case where a plane-parallel plate is transmitted, and even if it is the light which transmitted the 1st light guide plate 221, the 2nd observation direction will be illuminated.

[0050]

Fig.9 is a mimetic diagram showing the specific section structure of the illumination method concerning a 3rd embodiment of the present invention. The 1st light guide plate 121 and the 2nd light guide plate 122 are arranged in piles like the composition of Fig.3 also here. Although not illustrated, a plurality of slots which were described by Fig.8 shall be provided by the front face of each light guide plate 321,322, respectively.

[0051]

First, it describes about the composition about the 1st light guide plate 321. The 1st light guide plate 321 has the operation parallel both and same as the case where a plane-parallel plate is passed, when the light from the 1st light source 20 observes the incident end face 321-1 and the end face of the groove part which light ejects. That is, since the degree of incidence angle and the degree of angle of emergence correspond, light can be more efficiently ejected in a desired position by giving a predetermined angle also about the optic axis of the illumination optical system 40 to the end face 321-1 of the 1st light guide plate 321 in accordance with the degree of angle of emergence.

[0052]

In the 1st light source 20, when the end face 321-2 of the opposite side is vertical to the level surface, the light which arrived to the end face 321-2 concerned may reflect, and it may act as returned light, and may become a cause of a cross talk. Therefore, a cross talk is mitigable by making the end face 321-2 into a wedge shape here, as shown in the figure, and covering the surface by the light absorption member 41.

[0053]

About the composition about the 2nd light guide plate 322, similarly, while giving a predetermined angle for the optic axis of the illumination optical system 43 to the end face 322-2 of the 2nd light guide plate 322 in accordance with the degree of angle of emergence, the end face 322-1 is made into a wedge shape, and the surface is covered by the light absorption member 42.

[0054]

Fig.10 is a mimetic diagram showing the specific section structure of the illumination method concerning a 4th embodiment of the present invention. Although the whole illumination optical system was leaned to the end face of the 1st light guide plate in a 3rd embodiment, At a 4th embodiment, when the beam of light 44 which entered into the light guide plate 421 from the light source 20 by making the end face 421-1 on the incidence side of the light guide plate 421 into fine prism form changes an angle and is ejected from 421 to slot 2 end face by that cause to the front-face side, it can be ejected at a proper angle. As for the vertical angle of prism, supposing he would like to eject perpendicularly in the direction of 30 degree to the light guide plate 421, 10 degrees - about 20 degrees are desirable. The illumination optical system 40 here is [anything] good if it is the prism sheet and diffraction element which condense a collimating lens or the beam of light 44.

[0055]

Fig.11 is the figure showing the modification of composition of having described by Fig.10. It was not vertical and made one wall of a plurality of slots 221-1 to 221-3 of the 1st light guide plate 221, and a plurality of slots 222-1 to 222-3 of the 2nd light guide plate 222 incline in this composition.

[0056]

As mentioned above, although described about the 1st light guide plate and the 2nd light guide plate for every embodiment, the light guide plate of an embodiment which is different in arranging the 1st light guide plate and the 2nd light guide plate may be used. Fig.12 is the example which combined the thing of structure which is different with the 1st light guide plate 121 described with reference to Fig.4 as a 5th embodiment of the present invention, and the 2nd light guide plate 222 described with reference to Fig.7. Although the 1st light guide plate 121 must be the structure which transmits the exit light from the 2nd light guide plate 222, the 2nd light guide plate 222 does not need to be the same as the 1st light guide plate 121, and if it is a light guide plate with which lighting with directivity is obtained, it can be used anything.

[0057]

Fig.13 is the figure showing the modification of composition of having described by Fig.12. In this composition, the angle of the slope part 121-1 to 121-3 of the 1st light guide plate 121 was enlarged as it kept away from the 1st light source 20. He is trying similarly to enlarge as the angle of the slope part 222-1 to 222-3 of the 2nd light guide plate 222 keeps away from the 2nd light source 25.

[0058]

Fig.14 shows the example at the time of mounting in a car by considering the graphic display device of the present invention as the in-vehicle monitor 200. The observation area 203 of the 1st image and the observation area 205 of the 2nd image become settled by setting up so that a driver's seat may be placed at the 1st observer's 201 position in the position of a passenger seat and the 2nd observer 202, and it can observe the image corresponding to each by the

Microsoft Exhibit 1002 - Page 1119
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

passenger and driver sitting in the passenger seat. For example, the passenger sitting in the passenger seat can be simultaneously provided with various images, such as TV image, a DVD image, a game, and variety-of-information search, providing a driver with the image and driving auxiliary image of car navigation. Even if a car is moving, the passenger sitting in the passenger seat can view and listen to the image of TV, a movie, etc., because this provides only for a passenger seat also with the image of TV that viewing and listening under operation is restricted, a movie, etc.

[0059]

Fig.15 (A) and (B) is the figure for describing about the display control of the display screen in consideration of "raster scanning" and the "hold characteristic", when a liquid crystal display element is used as a transmission type display element. Fig.15 (B) shows how the first image displayed on the transmission type display element 24 by raster scanning and a second image change according to a lapse of time (T1-T4). 300-1 is a first image display area, 300-2 is a second image display area, and 300-3 is a boundary part in which a first image and second image are intermingled.

[0060]

When a liquid crystal display element is used, unlike a CRT display, the hold characteristic must be taken into consideration. That is, if a certain pixel is observed, a first image will continue displaying after a first image is displayed on the first image display area 300-1 until a second image is displayed on the second image display area 300-2 next. If a second image is the image after 1 top of a first image, i.e., per second 60 tops, in order to display only one image on one screen, if it is the usual graphic display, the image 60 seconds after one will be displayed. In that case, even if the backlight is always on, when observing an image, there are few problems.

[0061]

However, when switching and seeing the image displayed on one screen like the present invention according to the direction which an observer looks at by time sharing, while displaying the first image and displaying the second image for first image lighting, need second image lighting, but. While displaying the second image, illuminate with the 1st image lighting, or further, Since the difference in a first image and second image is great, the transition period (boundary part 300-3 of Fig.15 (B)) to the following image to which it comes from the speed of a response of a liquid crystal will occur, and it will be the cause of a cross talk with illuminating the portion.

[0062]

So, in the present invention, as shown in Fig.15 (A), it is required to switch the first image illuminated field 301-1 that illuminates a first image, and the second image illuminated field 301-2 which illuminates a second image synchronizing with raster scanning of a transmission type display element. It is more desirable to switch off both of lighting in the portion which hits the boundary part of the first image illuminated field 301-1 and the second image illuminated field 301-2 (putting-out-lights region 301-3).

[0063]

Fig.16 (A) and (B) is the figure showing typically signs that the first image illuminated field 301-1 and the second image illuminated field 301-2 are switched in the putting-out-lights region 301-3. It is shown that the first image illuminated field 301-1 differs in directivity from the second image illuminated field 301-2. Signs that the whole screen including the putting-out-lights region 301-3 shifts according to the lapse of time synchronizing with raster scanning are shown.

[0064]

Although the 1st and a second light source were premised on being a simple substance which has the length corresponding to the dimension of a light guide plate in each above-mentioned embodiment, it is not limited to such composition. For example, it may be the composition which has arranged a plurality of point light sources 500-1 to 500-5, and a plurality of illumination lenses 510-1 to 510-5 at the predetermined intervals over the whole length of the 1st light guide plate 521, and was made into the 1st light source group 500 and the 1st illuminating lens group 510, respectively as shown in Fig.17. Similarly, a plurality of point light sources 501-1 to 501-5 and a plurality of illumination lenses 511-1 to 511-5 are arranged at the predetermined intervals over the whole length of the 2nd light guide plate 522, and the 2nd light source group 501 and the 2nd illuminating lens group 511 are constituted, respectively. In this case, the beam of light emitted, for example from the 1st light source group 500 serves as the illumination light 523 by the 1st illuminating lens group 510, and spreads the inside of the 1st light guide plate 521.

[0065]

Fig.18 is the figure showing the modification of composition of being shown in Fig.17. In this modification, had composition which cuts the 1st light guide plate 521 to a plurality of light guide plates 521-1 to 521-5, and stuck it, multiple light sources 502-1 to 502-5 of the length corresponding to the length of each light guide plate 521-1 to 521-5 were made to adjoin, and it has arranged. In order to carry out total internal reflection of the beam of light from each light source 502-1 to 502-5, the portion pasted together is constituted so that a beam of light may reflect by carrying out mirror coating or arranging a mirror. The light which entered into each light guide plate 521-1 to 521-5 is kept from entering into other light guide plates 521-1 to 521-5. In such composition, a drive as shown in Fig.16 is realizable by switching sequentially each light source 502-1 to 502-5 corresponding to each light guide plate 521-1 to 521-5, and emitting light. Although the example which divided the 1st light guide plate and the 2nd light guide plate into five by a diagram is shown, since the direction which a rate may be sufficient as and was divided finely for how many minutes can respond to raster scanning more, the number to divide can lessen a cross talk.

[0066]

{ Additional remark 1}

Microsoft Exhibit 1002 - Page 1120
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Invention of the following composition can be extracted from the above-mentioned specific embodiment.
[0067]
1. It is a graphic display device which has one display screen which can display the image corresponding to each of a plurality of observers,
The illumination method which ejects first light flux and second light flux in at least two different directions by time sharing, respectively,
It is a transmission type display element which can be displayed by time sharing about the first image that makes the illumination light above-mentioned first light flux ejected from the aforementioned illumination method, and the second image which makes above-mentioned second light flux the illumination light,
It provides,
The aforementioned illumination method,
The first light source that ejects the above-mentioned first light flux,
The second light source which ejects the above-mentioned second light flux,
The first light guide plate that ejects the first light flux ejected from the above-mentioned first light source only in the direction of a first observer,
The second light guide plate which ejects the second light flux ejected from the above-mentioned second light source only in the direction of a second observer,
A providing graphic display device.
[0068]
(The corresponding figure of an embodiment)
The composition of 1 corresponds, for example to Fig.2 and Fig.3.
[0069]
(EFFECT OF THE INVENTION) The illumination light which has the directivity of one direction with one light guide plate is made, by piling up two of them, the lighting system in which time division driving is possible can be realized to a 2-way, and the cross talk in each direction can also be lessened.
[0070]
2. Graphic display device of description to 1, wherein second light flux which the above-mentioned first light guide plate has been arranged between aforementioned transmission type display element and the above-mentioned second light guide plate, and was ejected from the above-mentioned second light guide plate transmits the above-mentioned first light guide plate.
[0071]
(The corresponding figure of an embodiment)
The composition of 2 corresponds, for example to Fig.2 and Fig.3.
[0072]
(EFFECT OF THE INVENTION) When the second light flux ejected from a second light guide plate can transmit a first light guide plate, the light guide plate of two sheets can be used in piles. Thereby, it is possible to take illumination unevenness in each light guide plate, and there is an effect of picture quality enhancement.
[0073]
3. Graphic display device of description to 2, wherein flat part is optically provided by surface which opposes to aforementioned transmission type display element of the above-mentioned first light guide plate, and surface which opposes to the above-mentioned second light guide plate to the above-mentioned second light flux that transmits the above-mentioned first light guide plate.
[0074]
(The corresponding figure of an embodiment)
The composition of 3 corresponds, for example to Fig.4 and Fig.8.
[0075]
(EFFECT OF THE INVENTION.)
Since it has a flat part optically while the second light flux ejected from a second light guide plate can transmit a first light guide plate, the light guide plate of two sheets can be used in piles, maintaining the directivity of each light guide plate. Thereby, while it is possible to take illumination unevenness in each light guide plate, the influence on a cross talk can also be reduced and there is an effect of picture quality enhancement.
[0076]
4. On rear face of the above-mentioned first light guide plate,
The plane part for carrying out total internal reflection of the incident light from the above-mentioned first light source, and transmitting to the end face of an opposite side with the above-mentioned first light source of the above-mentioned first light guide plate,
Total internal reflection of the incident light from the above-mentioned first light source is carried out, it is made not to fulfill the total reflection condition in the front face of the above-mentioned first light guide plate, and the slope part for making it eject in the above-mentioned first direction of an observer,
A graphic display device of the description to 1, wherein more than one are provided.
[0077]
(The corresponding figure of an embodiment)
The composition of 4 corresponds, for example to Fig.4 and Fig.5.
[0078]
(EFFECT OF THE INVENTION.)
Light is ejected from the front face of a light guide plate by total-internal-reflection operation in the slope part which can transmit the light from a light source to the end face of a light guide plate, and are arranged by the total-internal-reflection operation by the plane part provided by the rear face of the first light guide plate at a suitable angle.
[0079]
5. In front face of the above-mentioned first light guide plate,

Microsoft Exhibit 1002 - Page 1121
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

The plane part for carrying out total internal reflection of the incident light from the above-mentioned first light source, and transmitting to the end face of an opposite side with the above-mentioned first light source of the above-mentioned first light guide plate,
The projection surface for making the incident light from the above-mentioned first light source transmit, and making it eject in the above-mentioned first direction of an observer,
A graphic display device of the description to 1, wherein more than one are provided.
[0080]
{The corresponding figure of an embodiment}
The composition of 5 corresponds, for example to Fig.8.
[0081]
{ EFFECT OF THE INVENTION.}
Since it is only the light from the direction in which the light which can enter in a light guide plate in a projection surface has a first light source, the exit light from a projection surface is light with the directivity ejected only to a specific direction, and serves as mitigation of a cross talk.
[0082]
6. When angle theta of aforementioned slope part and aforementioned plane part to make sets refractive index of the above-mentioned first light guide plate to n,
n-cos2theta<1 (theta< 45 degree)
A graphic display device of the description to 4 filling ******.
[0083]
{The corresponding figure of an embodiment}
The composition of 6 corresponds, for example to Fig.5.
[0084]
{ EFFECT OF THE INVENTION.}
A slope part must be a suitable angle in order to eject from a light guide plate at a suitable angle. For example, even if it is the light by which total internal reflection was carried out to the illumination light to eject to the 1st observation direction as theta is 45 degree or more being illuminated by even the 2nd observation direction, and it becoming a cause of a cross talk, and being n-cos2theta>1 in the slope part, Total internal reflection will be carried out in the front face of a light guide plate, and it cannot slip out of a light guide plate. Therefore, the light guide plate with high efficiency for light utilization which has few cross talks is obtained by being referred to as theta<45 degree and n-cos2theta<1.
[0085]
7. Graphic display device of description to 6, wherein multiple slots rectangular in front face of the above-mentioned first light guide plate are provided.
[0086]
{The corresponding figure of an embodiment}
The composition of 7 corresponds, for example to Fig.8 and Fig.9.
[0087]
{ EFFECT OF THE INVENTION.}
It is ejected as lighting with the directivity partial in a certain direction by operation of the slot provided to the light guide plate by entering light from one side of the end face of a light guide plate.
[0088]
8. Graphic display device of description to 7 enlarging the above-mentioned rectangular tooth depth, so that it keeps away from the above-mentioned first light source.
[0089]
{The corresponding figure of an embodiment}
The composition of 8 corresponds, for example to Fig.8 and Fig.9.
[0090]
{ EFFECT OF THE INVENTION.}
If the slot of the side near a light source and the slot of a far side are the same sizes since light is taken out sequentially from the slot of a direction with the light near the light source in a light guide plate from a light source, it will be { near side } brighter and the direction of a far side will look dark. Therefore, lighting uniform on the whole can be obtained by enlarging a slot, so that it keeps away from a light source.
[0091]
9. Graphic display device of description to 1, wherein the above-mentioned second light guide plate is surface shape with different form from the above-mentioned first light guide plate, or different periodical structure.
[0092]
{The corresponding figure of an embodiment}
The composition of 9 corresponds, for example to Fig.12.
[0093]
{ EFFECT OF THE INVENTION.}
Since the second light guide plate which serves as the bottom among the light guide plates made to pile up mutually may not necessarily be the structure of making the incident light from a back surface transmitting, it illuminates only the second direction of an observer, but should just use a backlight system { that it is certain and low cost }. Although the influence of a moire pattern etc. occurs by a case that it is a thing of identical shape, it is also mitigable by changing form or periodical structure with the 1st light guide plate and the 2nd light guide plate.
[0094]
10. A graphic display device of the description to 1 which the above-mentioned second light guide plates are the above-mentioned first light guide plate and identical shape, and is characterized by the above-mentioned first light guide plate and the above-mentioned second light guide plate replacing right and left each other, and arranging them.
[0095]

Microsoft Exhibit 1002 - Page 1122
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

(The corresponding figure of an embodiment)
The composition of 10 corresponds, for example to Fig.4 and Fig.8.
[0096]
(EFFECT OF THE INVENTION.)
although it is the composition which combined two directive different light guide plates -- the 2nd light guide plate -- the 1st light guide plate -- right-and-left ********** -- using with identical shape by things is possible. For this reason, it is not necessary to newly prepare one more kind of light guide plate, and there is an effect of cost reduction.
[0097]
11. A graphic display device of the description to 10 which regarding as the above-mentioned first light source and the above-mentioned second light source from the observer side, and arranging in a right and left different end-face position.
[0098]
(The corresponding figure of an embodiment)
The composition of 11 corresponds, for example to Fig.3, Fig.4, and Fig.8.
[0099]
(EFFECT OF THE INVENTION.)
arranging a light source in an asymmetric position with each light guide plate -- more -- easy -- directivity -- things -- the lighting of a 2-way is realizable. Since right and left direction is only changed the whole light guide plate, the component of common structure can be used with an up-and-down light guide plate.
[0100]
12. A graphic display device of the description to 1 which emits light periodically at the time when the above-mentioned first light source differs from the above-mentioned second light source, respectively, and is characterized by the frequency of luminescence of each light source being 24 Hz or more.
[0101]
(The corresponding figure of an embodiment)
The composition of 12 corresponds, for example to Fig.3.
[0102]
(EFFECT OF THE INVENTION.)
A cross talk is reduced by losing the period both simultaneously turned on in each light source. The influence on the difficulty of seeing by a flicker is mitigable by making a light source drive above 24 Hz.
[0103]
13. A graphic display device of the description to 1, wherein the component which absorbs light is arranged on the rear face of the above-mentioned second light guide plate.
[0104]
(The corresponding figure of an embodiment)
The composition of 13 corresponds, for example to Fig.4.
[0105]
(EFFECT OF THE INVENTION.)
When the light which escapes from a light guide plate to a front direction at the back surface of an opposite side since it is characterized by giving directivity to lighting unlike the usual diffusion type illumination light arises, since it will be further ejected by the viewing side as the surface of a light guide plate in back is a reflection member, it becomes a cause of a cross talk. Then, a cross talk is more mitigable by using the component which absorbs the light which arose in the direction of the back side.
[0106]
Outdoor daylight, such as daylight, can enter into a display screen, and the light reflected on the back side of the light guide plate can also reduce the cross talk by outdoor daylight by arranging a light absorption member under the 2nd light guide plate also from becoming unnecessary light and becoming a cause of a cross talk.
[0107]
14. A graphic display device of the description to 1 by which the above-mentioned first light guide plate and the above-mentioned second light guide plate are adjoined, a plurality of light emitting devices are arranged along the raster scanning direction of the aforementioned transmission type display element, and emission control of each light emitting device is carried out separately.
[0108]
(The corresponding figure of an embodiment)
The composition of 14 corresponds, for example to Fig.17 and Fig.18.
[0109]
(EFFECT OF THE INVENTION.)
Since multiple light emitting devices are arranged along the raster scanning direction of a transmission type display element, the lighting in sync with raster scanning is possible, there are few cross talks, and since emission time can be kept long, the effect of the improvement in luminance is acquired.
[0110]
15. A graphic display device of the description to 14, wherein each aforementioned light emitting device emits light periodically synchronizing with raster scanning of the aforementioned transmission type display element.
[0111]
(The corresponding figure of an embodiment)
The composition of 15 corresponds, for example to Fig.17 and Fig.18.
[0112]
(EFFECT OF THE INVENTION.)
The lighting in sync with raster scanning is possible, there are few cross talks, and since

Microsoft Exhibit 1002 - Page 1123
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

emission time can be kept long, the effect of the improvement in luminance is acquired.
[0113]
16. A graphic display device of the description to 14, wherein the 1st above-mentioned light guide plate and the 2nd above-mentioned light guide plate are divided into a plurality of light guide sections corresponding to each of said plurality of light emitting devices.
[0114]
(The corresponding figure of an embodiment)
The composition of 16 corresponds, for example to Fig.18.
[0115]
(EFFECT OF THE INVENTION.)
In order to prevent becoming a cause of a cross talk when luminescence of one light emitting device leaks to other light emitting devices among a plurality of light emitting devices, a light guide plate is divided for every light emitting device. Thereby, a cross talk is mitigable.
[0116]
17. It is an in-vehicle graphic display device which has one display screen which can display the image corresponding to each of a plurality of observers and which is installed in a car,
The illumination method which ejects first light flux and second light flux in at least two different directions by time sharing, respectively,
It is a transmission type display element which can be displayed by time sharing about the first image that makes the illumination light above-mentioned first light flux ejected from the aforementioned illumination method, and the second image which makes above-mentioned second light flux the illumination light,
It provides,
The aforementioned illumination method,
The first light source that ejects the above-mentioned first light flux,
The second light source which ejects the above-mentioned second light flux,
The first light guide plate that ejects the first light flux ejected from the above-mentioned first light source only in the direction of the observer of a drivers side,
The second light guide plate which ejects the second light flux ejected from the above-mentioned second light source only in the direction of the observer of a passenger side,
A providing in-vehicle graphic display device.
[0117]
(The corresponding figure of an embodiment)
The composition of 17 corresponds, for example to 14.
[0118]
(EFFECT OF THE INVENTION.)
An effect equivalent to the above-mentioned composition 1 is acquired.
[Brief Description of the Drawings]
[0119]
[Drawing 1]It is the figure for describing the example of 1 use of the graphic display device of the present invention.
[Drawing 2]It is the figure showing the basic constitution of the graphic display device concerning the present invention.
[Drawing 3]It is a horizontal sectional view of the illumination method of the graphic display device concerning the present invention.
[Drawing 4]It is a mimetic diagram showing the specific section structure of the illumination method concerning a 1st embodiment of the present invention.
[Drawing 5]It is the figure expanding and showing the slope part of a light guide plate.
[Drawing 6]It is the figure for describing about the angle of visibility at the time of using a constituent of the present invention.
[Drawing 7]It is the figure showing the modification of composition of having described by Fig.4.
[Drawing 8]It is a mimetic diagram showing the specific section structure of the illumination method concerning a 2nd embodiment of the present invention.
[Drawing 9]It is a mimetic diagram showing the specific section structure of the illumination method concerning a 3rd embodiment of the present invention.
[Drawing 10]It is a mimetic diagram showing the specific section structure of the illumination method concerning a 4th embodiment of the present invention.
[Drawing 11]It is the figure showing the modification of composition of having described by Fig.10.
[Drawing 12]It is the figure showing the example which combined the thing of structure which is different with the 1st light guide plate 121 described with reference to Fig.4 as a 5th embodiment of the present invention, and the 2nd light guide plate 222 described with reference to Fig.7.
[Drawing 13]It is the figure showing the modification of composition of having described by Fig.12.
[Drawing 14]It is the figure showing the example at the time of mounting the graphic display device of the present invention as the in-vehicle monitor 200.
[Drawing 15]When a liquid crystal display element is used as the transmission type display element 24, it is the figure for describing about the display control of the display screen in consideration of "raster scanning" and the "hold characteristic."
[Drawing 16]It is the figure showing typically signs that the image illuminated field 301-1 and the second image illuminated field 301-2 of 1 are switched in the putting-out-lights region 301-3.
[Drawing 17]It is the figure showing the modification (the 1) of an illumination method.
[Drawing 18]It is the figure showing the modification (the 2) of an illumination method.
[Drawing 19]It is the figure showing one configuration example of the conventional graphic display device.

Microsoft Exhibit 1002 - Page 1124
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

[Drawing 20]It is the figure showing other configuration examples of the conventional graphic display device.
[Drawing 21]It is the figure showing a situation when it observes from the outside further from the observation position of Fig.19 (A).
[Drawing 22]It is the figure showing what kind of image is in sight by the difference in an observation position in the conventional composition.
[Explanations of letters or numerals]
[0120]
20 -- the 1st light source, 21 -- the 1st light guide plate, 22 -- the 2nd light guide plate, 23 -- light diffusing element, 24 -- transmission type display element, 25 -- the 2nd light source, 26 -- the 1st image lighting, 27 -- the 2nd image lighting, 28 -- light absorption member.

Previous Document 10/12 Next Doc

To return to the top of

Notice on Links Privacy Policy Disclaimers

[Translation done.]

Microsoft Exhibit 1002 - Page 1125
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　JP 2006-10935 A 2006.1.12
(11)特許出願公開番号
特開2006-10935
（Ｐ２００６－１０９３５Ａ）
(43)公開日　平成18年1月12日(2006.1.12)

(51)Int.Cl.			F I			テーマコード(参考)
Ｇ０２Ｂ	27/22	(2006.01)	Ｇ０２Ｂ	27/22		２Ｈ０３８
Ｂ６０Ｒ	11/02	(2006.01)	Ｂ６０Ｒ	11/02	Ｃ	２Ｈ０６９
Ｇ０２Ｂ	6/00	(2006.01)	Ｇ０２Ｂ	6/00	３３１	２Ｈ０８８
Ｇ０２Ｆ	1/13	(2006.01)	Ｇ０２Ｆ	1/13	５０５	２Ｈ０９１
Ｇ０２Ｆ	1/13357	(2006.01)	Ｇ０２Ｆ	1/13357		３Ｄ０２０

審査請求　有　請求項の数17　ＯＬ　（全22頁）　最終頁に続く

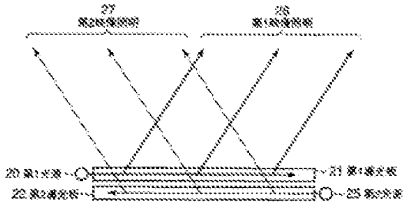
(21)出願番号　特願2004-186286(P2004-186286)
(22)出願日　平成16年6月24日(2004.6.24)

(71)出願人　000000376
オリンパス株式会社
東京都渋谷区幡ヶ谷２丁目４３番２号
(74)代理人　100058479
弁理士　鈴江　武彦
(74)代理人　100091351
弁理士　河野　哲
(74)代理人　100088683
弁理士　中村　誠
(74)代理人　100108855
弁理士　蔵田　昌俊
(74)代理人　100075672
弁理士　峰　隆司
(74)代理人　100109830
弁理士　福原　淑弘

最終頁に続く

(54)【発明の名称】映像表示装置及び車載用映像表示装置

(57)【要約】
【課題】低コストで、クロストークが少なくかつ照明ムラの少ない高画質の映像が得られる映像表示装置を提供する。
【解決手段】複数の観察者のそれぞれに対応する映像を表示可能な一つの表示画面を有する映像表示装置であって、時分割で少なくとも２つの異なる方向にそれぞれ第１の光束及び第２の光束を射出する照明手段と、照明手段から射出された第１の光束を照明光とする第１の映像と、第２の光束を照明光とする第２の映像とを時分割で表示可能な透過型表示素子と、を具備し、照明手段は、第１の光束を射出する第１光源２０と、第２の光束を射出する第２光源２５と、第１光源２０から射出された第１の光束を第１の観察者の方向のみに射出する第１導光板２１と、第２光源２５から射出された第２の光束を第２の観察者の方向のみに射出する第２導光板２２とを具備する。
【選択図】　図３



Microsoft Exhibit 1002 - Page 1126
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

【特許請求の範囲】
【請求項１】
複数の観察者のそれぞれに対応する映像を表示可能な一つの表示画面を有する映像表示装置であって、
時分割で少なくとも２つの異なる方向にそれぞれ第１の光束及び第２の光束を射出する照明手段と、
前記照明手段から射出された前記第１の光束を照明光とする第１の映像と、前記第２の光束を照明光とする第２の映像とを時分割で表示可能な透過型表示素子と、
を具備し、
前記照明手段は、
前記第１の光束を射出する第１の光源と、
前記第２の光束を射出する第２の光源と、
前記第１の光源から射出された第１の光束を第１の観察者の方向のみに射出する第１の導光板と、
前記第２の光源から射出された第２の光束を第２の観察者の方向のみに射出する第２の導光板と、
を具備することを特徴とする映像表示装置。
【請求項２】
前記第１の導光板は、前記透過型表示素子と前記第２の導光板との間に配置され、前記第２の導光板から射出された第２の光束は、前記第１の導光板を透過することを特徴とする請求項１に記載の映像表示装置。
【請求項３】
前記第１の導光板の、前記透過型表示素子に対向する面と、前記第２の導光板に対向する面には、前記第２の導光板から射出され、前記第１の導光板を透過する前記第２の光束に対して光学的に平坦な部位が設けられていることを特徴とする請求項２に記載の映像表示装置。
【請求項４】
前記第１の導光板の後面には、
前記第１の光源からの入射光を全反射させて前記第１の導光板の前記第１の光源とは反対側の端面に伝えるための平面部と、
前記第１の光源からの入射光を全反射させて前記第１の導光板の前面での全反射条件を満たさなくし、前記第１の観察者方向に射出させるための斜面部とが、
複数設けられていることを特徴とする請求項１に記載の映像表示装置。
【請求項５】
前記第１の導光板の前面には、
前記第１の光源からの入射光を全反射させて前記第１の導光板の前記第１の光源とは反対側の端面に伝えるための平面部と、
前記第１の光源からの入射光を透過させて、前記第１の観察者方向に射出させるための射出面とが、
複数設けられていることを特徴とする請求項１に記載の映像表示装置。
【請求項６】
前記斜面部と前記平面部とのなす角θは、前記第１の導光板の屈折率をｎとするとき、
ｎ・ｃｏｓ２θ＜１（θ＜４５度）
の条件を満たすことを特徴とする請求項４に記載の映像表示装置。
【請求項７】
前記第１の導光板の前面には、
矩形の溝が複数設けられていることを特徴とする請求項５に記載の映像表示装置。
【請求項８】
前記矩形の溝の深さは、前記第１の光源から遠ざかるほど大きくなることを特徴とする請求項７に記載の映像表示装置。

Microsoft Exhibit 1002 - Page 1127
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

【請求項９】
前記第２の導光板は、前記第１の導光板と異なる形状または異なる周期構造をもつ表面形状であることを特徴とする請求項１に記載の映像表示装置。
【請求項１０】
前記第２の導光板は、前記第１の導光板と同一形状であり、前記第１の導光板と、前記第２の導光板とは、互いに左右を入れ替えて配置されていることを特徴とする請求項１に記載の映像表示装置。
【請求項１１】
前記第１の光源と、前記第２の光源とは、観察者側から見て左右の異なる端面位置に配置されていることを特徴とする請求項１０に記載の映像表示装置。
【請求項１２】
前記第１の光源と前記第２の光源とは、それぞれ異なる時間に周期的に発光し、各光源の発光の周波数は２４Ｈｚ以上であることを特徴とする請求項１に記載の映像表示装置。
【請求項１３】
前記第２の導光板の後方には光を吸収する部材が配置されていることを特徴とする請求項１に記載の映像表示装置。
【請求項１４】
前記透過型表示素子のラスタ走査方向に沿って、前記第１の導光板及び前記第２の導光板に隣接して複数の発光素子が配置され、各発光素子は個々に発光制御されることを特徴とする請求項１に記載の映像表示装置。
【請求項１５】
前記各発光素子は、前記透過型表示素子のラスタ走査に同期して、周期的に発光することを特徴とする請求項１４に記載の映像表示装置。
【請求項１６】
前記第１導光板および前記第２導光板は、前記複数の発光素子の各々にに対応して複数の導光部に分割されていることを特徴とする請求項１４に記載の映像表示装置。
【請求項１７】
複数の観察者のそれぞれに対応する映像を表示可能な一つの表示画面を有する、車内に設置される車載用映像表示装置であって、
時分割で少なくとも２つの異なる方向にそれぞれ第１の光束及び第２の光束を射出する照明手段と、
前記照明手段から射出された前記第１の光束を照明光とする第１の映像と、前記第２の光束を照明光とする第２の映像とを時分割で表示可能な透過型表示素子と、
を具備し、
前記照明手段は、
前記第１の光束を射出する第１の光源と、
前記第２の光束を射出する第２の光源と、
前記第１の光源から射出された第１の光束を運転席側の観察者の方向のみに射出する第１の導光板と、
前記第２の光源から射出された第２の光束を助手席側の観察者の方向のみに射出する第２の導光板と、
を具備することを特徴とする車載用映像表示装置。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は映像表示装置及び車載用映像表示装置に関するものである。
【背景技術】
【０００２】
１つの表示面を有し、それぞれ見る方向に応じた映像が観察可能な映像表示装置が従来より知られている。例えば、日本国特許第３０７２８６６号公報には、見る方向に応じて

Microsoft Exhibit 1002 - Page 1128
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

映像を表示するにあたって、照明の指向性を時分割で切り換える技術としてマトリクス状照明とレンチキュラ等を利用した立体表示装置が開示されている。

【０００３】

図１９（Ａ）、（Ｂ）は、従来の映像表示装置の一構成例を示す図であり、ストライプ状光源やマトリクス状光源などの分割光源Ｌ１、Ｒ１～Ｌ３，Ｒ３からなる光源群１００と，レンズ１～３からなる光拡散素子としてのレンチキュラ１０１との組み合わせにより時分割照明を行うようになっている。図１９（Ａ）では、Ｌ１、Ｒ１～Ｌ３，Ｒ３のうち、Ｒ１～Ｒ３の光源は点灯し、Ｌ１～Ｌ３の光源は消灯している。また、図１９（Ｂ）では、Ｌ１，Ｒ１～Ｌ３，Ｒ３のうち、Ｌ１～Ｌ３の光源は点灯し、Ｒ１～Ｒ３の光源は消灯している。

【０００４】

レンチキュラ１０１のレンズ作用により、図１９でいうＲ側にいる観察者から見ると、光源Ｒしか観察することができず、Ｌ側にいる観察者から見ると、光源Ｌしか観察することができないため、光源ＲとＬを交互に点灯させ、それに対応して透過型表示素子の表示をＲ側用表示、Ｌ側用表示と切り換えて表示させることにより、Ｒ側観察者はＲ側映像のみ観察することができ、Ｌ側観察者はＬ側映像のみ観察することができるというものである。

【０００５】

図２０は、従来の映像表示装置の他の構成例を示す図であり、例えば、三菱電機株式会社によるニュースリリース（２００３年９月３０日付け）、開発Ｎｏ．０３２４、に開示されている。この構成は、スキャンバックライト方式と呼ばれる立体表示を行うための構成であり、液晶表示素子１５０の背後に両面プリズムシート１５１を配置し、その背後に導光板１５３を配置したものである。導光板１５３の両端には第１光源１５２－１，１５２－２が配置されている。両面プリズムシート１５１は、前面１５１－１がレンチキュラ構造、後面１５１－２がプリズム構造となっている。導光板１５３は、第１光源１５２－１，第２光源１５２－２のＯＮ／ＯＦＦにより指向性を切り換えることができる。このような構成により観察者の左右の目に照明光を時分割に入射させ、左右の目に対応した映像（右目用画像１５４－１，左目用映像１５４－２）を表示させることで立体表示を実現したものである。図２０において、１５５－１は第１光源像、１５５－２は第２光源像である。

【特許文献１】日本国特許第３０７２８６６号公報

【非特許文献１】三菱電機株式会社によるニュースリリース（２００３年９月３０日付け）　　開発Ｎｏ．０３２４

【発明の開示】

【発明が解決しようとする課題】

【０００６】

しかしながら、日本国特許第３０７２８６６号公報に開示された時分割照明方式の立体表示装置では、適切に観察できる範囲が狭く、特に例えばＲ側の観察者がＲ側の映像を観察中に，よりＲ側に観察位置をずらしてしまった場合には、逆方向の映像であるＬ側映像が見えてしまうという問題があった。

【０００７】

以下に、この問題について詳細に説明する。図２１は、図１９（Ａ）の観察位置よりさらに外側から観察したときの様子を示している。図２２は、従来の構成において観察位置の違いによってどのような映像が見えるかを示す図である。図２２において、観察領域は、中央を境に第１（Ｌ側）映像観察領域６０２と第２（Ｒ側）映像観察領域６０１とに分離されるのが理想であるが、図２１に示すように第２映像観察領域６０１のさらに外側にいくと第１観察者用映像が見える領域６００が存在しこの領域ではクロストークとなる。逆に第１映像観察領域６０２のさらに外側にいくと第２観察者用映像が見える領域６０３が存在しこの領域ではクロストークとなる。

【０００８】

Microsoft Exhibit 1002 - Page 1129
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

また、レンチキュラを使った光学系では、大きな角度で左右映像を分離しようとすると、焦点距離を小さくしなければならず、曲率が非常に大きくなり、それとともに収差の影響が増大してしまうため、結果的にクロストークの影響が大きくなるという問題もあった。

【０００９】

一方、スキャンバックライト方式では、１枚の導光板１５３に２つの光源１５２－１，１５２－２が対応し、それぞれの光源１５２－１，１５２－２のＯＮ／ＯＦＦによって左右の指向性を切り換えているために、導光板１５３の構造を一様な表面加工を施した構造または左右対称構造としなければならず、光源１５２－１，１５２－２から近い部分と、光源１５２－１，１５２－２から遠い部分とで照明強度に差ができ、それが照明ムラとして見えてしまい、特に大きな表示画面ほどその影響は大きくなってしまうという問題があった。また、通常の表示パネルに使用されるバックライトの導光板は照明ムラを抑えるために導光板構造が左右非対称になっている。

【００１０】

また、通常の液晶パネルに用いられている駆動方式である「ラスタ走査」と、液晶パネルの表示特性として各画素の映像は一定期間（１/６０秒など）表示し続ける，「ホールド特性」により、画面サイズと同等サイズである面光源の指向性を一括で切り換えたのでは、発光時間が制限される、クロストークが発生しやすいなどの問題があった。

【００１１】

本発明は、このような課題に着目してなされたものであり、その目的とするところは、低コストで、クロストークが少なくかつ照明ムラの少ない高画質の映像が得られる映像表示装置及び車載用映像表示装置を提供することにある。

【課題を解決するための手段】

【００１２】

上記の目的を達成するために、第１の発明は、複数の観察者のそれぞれに対応する映像を表示可能な一つの表示画面を有する映像表示装置であって、時分割で少なくとも２つの異なる方向にそれぞれ第１の光束及び第２の光束を射出する照明手段と、前記照明手段から射出された前記第１の光束を照明光とする第１の映像と、前記第２の光束を照明光とする第２の映像とを時分割で表示可能な透過型表示素子と、を具備し、前記照明手段は、前記第１の光束を射出する第１の光源と、前記第２の光束を射出する第２の光源と、前記第１の光源から射出された第１の光束を第１の観察者の方向のみに射出する第１の導光板と、前記第２の光源から射出された第２の光束を第２の観察者の方向のみに射出する第２の導光板と、を具備する。

【００１３】

また、第２の発明は、第１の発明に係る映像表示装置において、前記第１の導光板は、前記透過型表示素子と前記第２の導光板との間に配置され、前記第２の導光板から射出された第２の光束は、前記第１の導光板を透過する。

【００１４】

また、第３の発明は、第２の発明に係る映像表示装置において、前記第１の導光板の，前記透過型表示素子に対向する面と、前記第２の導光板に対向する面には、前記第２の導光板から射出され、前記第１の導光板を透過する前記第２の光束に対して光学的に平坦な部位が設けられている。

【００１５】

また、第４の発明は、第１の発明に係る映像表示装置において、前記第１の導光板の後面には、前記第１の光源からの入射光を全反射させて前記第１の導光板の前記第１の光源とは反対側の端面に伝えるための平面部と、前記第１の光源からの入射光を全反射させて前記第１の導光板の前面での全反射条件を満たさなくし、前記第１の観察者方向に射出させるための斜面部とが、複数設けられている。

【００１６】

また、第５の発明は、第１の発明に係る映像表示装置において、前記第１の導光板の前

Microsoft Exhibit 1002 - Page 1130
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

面には、前記第１の光源からの入射光を全反射させて前記第１の導光板の前記第１の光源とは反対側の端面に伝えるための平面部と、前記第１の光源からの入射光を透過させて、前記第１の観察者方向に射出させるための射出面とが、複数設けられている。

【００１７】

また、第６の発明は、第４の発明に係る映像表示装置において、前記斜面部と前記平面部とのなす角θは、前記第１の導光板の屈折率をｎとするとき、ｎ・ｃｏｓ２θ＜１（θ＜４５度）の条件を満たす。

【００１８】

また、第７の発明は、第５の発明に係る映像表示装置において、前記第１の導光板の前面には、矩形の溝が複数設けられている。

【００１９】

また、第８の発明は、第７の発明に係る映像表示装置において、前記矩形の溝の深さは、前記第１の光源から遠ざかるほど大きくなる。

【００２０】

また、第９の発明は、第１の発明に係る映像表示装置において、前記第２の導光板は、前記第１の導光板と異なる形状または異なる周期構造をもつ表面形状である。

【００２１】

また、第１０の発明は、第１の発明に係る映像表示装置において、前記第２の導光板は、前記第１の導光板と同一形状であり、前記第１の導光板と、前記第２の導光板とは、互いに左右を入れ替えて配置されている。

【００２２】

また、第１１の発明は、第１０の発明に係る映像表示装置において、前記第１の光源と、前記第２の光源とは、観察者側から見て左右の異なる端面位置に配置されている。

【００２３】

また、第１２の発明は、第１の発明に係る映像表示装置において、前記第１の光源と前記第２の光源とは、それぞれ異なる時間に周期的に発光し、各光源の発光の周波数は２４Ｈｚ以上である。

【００２４】

また、第１３の発明は、第１の発明に係る映像表示装置において、前記第２の導光板の後方には光を吸収する部材が配置されている。

【００２５】

また、第１４の発明は、第１の発明に係る映像表示装置において、前記透過型表示素子のラスタ走査方向に沿って、前記第１の導光板及び前記第２の導光板に隣接して複数の発光素子が配置され、各発光素子は個々に発光制御される。

【００２６】

また、第１５の発明は、第１４の発明に係る映像表示装置において、前記各発光素子は、前記透過型表示素子のラスタ走査に同期して、周期的に発光する。

【００２７】

また、第１６の発明は、第１４の発明に係る映像表示装置において、前記第１導光板および前記第２導光板は、前記複数の発光素子の各々に対応して複数の導光部に分割されている。

【００２８】

また、第１７の発明は、複数の観察者のそれぞれに対応する映像を表示可能な一つの表示画面を有する、車内に設置される車載用映像表示装置であって、時分割で少なくとも２つの異なる方向にそれぞれ第１の光束及び第２の光束を射出する照明手段と、前記照明手段から射出された前記第１の光束を照明光とする第１の映像と、前記第２の光束を照明光とする第２の映像とを時分割で表示可能な透過型表示素子と、を具備し、前記照明手段は、前記第１の光束を射出する第１の光源と、前記第２の光束を射出する第２の光源と、前記第１の光源から射出された第１の光束を運転席側の観察者の方向のみに射出する第１の導光板と、前記第２の光源から射出された第２の光束を助手席側の観察者の方向のみに射

Microsoft Exhibit 1002 - Page 1131
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

出する第２の導光板と、を具備する。

【発明の効果】

【００２９】

本発明によれば、低コストで、クロストークが少なくかつ照明ムラの少ない高画質の映像が得られる。

【発明を実施するための最良の形態】

【００３０】

以下、図面を参照して本発明の実施形態を詳細に説明する。図１は、本発明の映像表示装置の一使用例を説明するための図である。１つの表示画面１０の右前方には表示画面１０を左側から観察する第１観察者１２－１が位置し、表示画面１０の左前方には表示画面１０を右側から観察する第２観察者１２－２が位置している。それぞれ第１観察者１２－１は第１映像観察範囲１１－１内に位置しているので第１映像を、第２観察者１２－２は第２映像観察範囲１１－２内に位置しているので第２映像を、両者が同時に観察することができる。

【００３１】

図２は、本発明に係る映像表示装置の基本構成を示す図であり、観察者の位置から順に、透過型表示素子２４、光拡散素子２３、第１導光板２１、第２導光板２２が配置されている。このように本実施形態では、第１導光板２１と第２導光板２２とを二重に重ねた構成となっている。また、第１導光板２１の一端に隣接して第１光源２０が配置され、第２導光板２２の、前記一端と反対側の端部に隣接して第２光源２５が配置されている。すなわち、第１光源２０と第２光源２５とは、第１導光板２１と第２導光板２２とで左右異なる位置に配置されている。

【００３２】

光拡散素子２３は、照明ムラなどを軽減するために第１導光板２１と透過型表示素子２４の間に配置される。ここでは水平方向に２つの指向性となるように映像を分離しているため、水平方向への拡散が強すぎると、２つの映像が混ざってしまい２重の映像として見えてしまう恐れがある。よって、ここでは垂直方向の拡散よりも水平方向の拡散を抑えた光拡散素子を用いるのが好ましい。

【００３３】

また、第１導光板２１、第２導光板２２は、透明な部材に特別な溝や傾斜、突起を設けた構成となっており、側面から入射した光を指向性をもったある方向のみに射出するようにしている。第１光源２０，第２光源２５は、第１導光板２１、第２導光板２２の片方向から照明されればなんでもよく、冷陰極管のような柱状光源でもよいし、ＬＥＤなどの光源を並べて使用してもよい。

【００３４】

図３は、本発明に係る映像表示装置の照明手段の水平断面図である。第１導光板２１と第２導光板２２とは重ねて配置されている。第１導光板２１の一端（図では左端）に隣接して第１光源２０が配置され、第２導光板２２の、第１導光板２１の一端（左端）と反対側の端部（図では右端）に隣接して第２光源２５が配置されている。このように本実施形態では、第１光源２０と第２光源２５を配置する位置を、第１導光板２１と第２導光板２２とで異ならせている。

【００３５】

以下では、観察者の位置に近づく方向（図では上方向）を前方と考えることにする。第１光源２０から第１導光板２１に入射した光は、第１導光板２１内を全反射しながら伝わっていくが、第１導光板２１の表面またはその一部に特殊な表面処理を施すか、あるいは当該表面を特殊な形状とすることで、第１導光板２１から射出される光が第１映像照明２６として第１観察者方向のみに照明されるようにすることができる。一方、第２光源２５から第２導光板２２に入射した光は、第２導光板２２内を全反射しながら伝わっていくが、第２導光板２２の表面またはその一部に特殊な表面処理を施すか、あるいは当該表面を特殊な形状とすることで、第２導光板２２から射出される光が第２映像照明２７として第

Microsoft Exhibit 1002 - Page 1132
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

２観察者方向のみに照明されるようにすることができる。第１導光板２１と第２導光板２２の配置上の前後関係は任意である。

【００３６】

図４は、本発明の第１実施形態に係る照明手段の具体的な断面構造を示す模式図である。ここでも図３の構成と同様に、第１導光板１２１と第２導光板１２２とは重ねて配置されるとともに、第１光源２０と第２光源２５を配置する位置を、第１導光板１２１と第２導光板１２２とで異ならせている。

【００３７】

さらに各導光板１２１，１２２の後面には、複数の斜面部１２１－１～１２１－３が所定の間隔でスジ状に延在しており、階段状部分を形成している。第１導光板１２１と第２導光板１２２とは同一形状であるが、左右の向きが異なっている。第２導光板１２２の後方には外光や不要光を吸収するための光吸収部材２８が配置されている。

【００３８】

第１光源２０から射出された光は第１導光板１２１に入射し、その前面および後面で全反射を繰り返しながら進んでいくが、斜面部１２１－１～１２１－３で全反射した光は、第１導光板１２１の水平面で全反射した光よりも急角度で前方に反射されるため、第１導光板１２１の前面では全反射条件が成立しない。したがって、光は第１映像照明２６として第１観察方向に照明される。

【００３９】

一方、第２光源２５から射出された光は第２導光板１２２に入射し、その前面および後面で全反射を繰り返しながら進んでいくが、斜面部１２２－１～１２２－３で全反射した光は、第２導光板１２２の水平面で全反射した光よりも急角度で前方に反射されるため、第１導光板１２１の前面では全反射条件が成立しない。したがって、光は第２映像照明２７として第２観察方向へ照明される。

【００４０】

第２光源２５に由来する第２映像照明２７は、途中第１導光板１２１を通過するが、斜面部１２１－１～１２１－３以外のほとんどの部分において、平行平面板を通過するときと同じ効果をもつため、最終的な射出角度は変化しない。また、第２映像照明２７が第１導光板１２１の斜面部１２１－１～１２１－３に入射した場合の角度の変化は、第２観察位置のより外側へ向かう方向、つまり、第１観察方向とは逆方向へ変化するため、クロストークなどに影響することはない。

【００４１】

図中では模式的に描かれているため、斜面の数が片側３本しか描かれていないが、実際には所定のピッチで４本以上配置される。

【００４２】

図５は、図４で説明した導光板の斜面部を拡大して示す図である。以下に、斜面部の適切な角度θを導くための条件を導く。水平に入射してくる光を基準とすると、図５は第１観察方向へ照明する導光板となっているから、第１観察領域と第２観察領域の境界である、図中の垂直に射出する光線３０がクロストークのない境界となる。そのときの斜面部３１の角度θは４５度である。

【００４３】

また、斜面部３１で反射した光線が導光板の前面で全反射条件を満たしてしまうと、光線は導光板から射出できないので、屈折率をｎとして，全反射してしまう限界の斜面部３１の角度条件を求めると、

$$n \cdot \sin(90-2\theta) < 1, \text{ つまり、} n \cdot \cos 2\theta < 1$$

ちなみに、ｎ＝１．５とするとθ＝２４．１となり、約２４度となる。

【００４４】

以上より、クロストークがなく、かつ効率良く第１観察方向と第２観察方向とを照明するためには、斜面部３１の角度θの条件は，

$$\theta < 45\text{度}, \quad n \cdot \cos 2\theta < 1$$

Microsoft Exhibit 1002 - Page 1133
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

を満たさなければならないことがわかる。

【００４５】

図６は、本発明の構成を用いた場合の視野角について説明するための図である。図６は、観察位置の違いによってどのような映像が観察されるかを示している。観察領域は、中央領域３５を境にして第１（Ｌ側）観察者領域３６と第２（Ｒ側）観察者領域３７に分離されている。図２２との比較により明らかなように、中央領域３５よりも第１観察者領域３６の全領域において第２観察者用映像のクロストークは存在せず、さらに中央領域３５よりも第２観察者領域３７側の全領域においても第１観察者用映像のクロストークは存在しない。

【００４６】

図７は、図４で説明した構成の変形例を示す図である。この構成では、第１導光板１２１の斜面部１２１－１～１２１－３の角度を第１光源２０から遠ざかるに従って大きくしたことを特徴とする。同様にして、第２導光板１２２の斜面部１２２－１～１２２－３の角度は、第２光源２５から遠ざかるに従って大きくなっている。

【００４７】

図８は、本発明の第２実施形態に係る照明手段の具体的な断面構造を示す模式図である。ここでも図３の構成と同様に、第１導光板２２１と第２導光板２２２とは重ねて配置されるとともに、第１光源２０と第２光源２５を配置する位置を、第１導光板２２１と第２導光板２２２とで異ならせている。さらに各導光板２２１，２２２の前面には複数の溝２２１－１～２２１－３及び２２２－１～２２２－３がそれぞれ設けられている。

【００４８】

第１光源２０から射出された光は第１導光板２２１の端面から第１導光板２２１内部へ入射する。第１導光板２１の前面、後面では全反射条件が満たされているため，入射した光は全反射を繰り返しながら、第１光源２０と反対側の端面側へ進行する。第１導光板２２１の前面には複数の溝２２１－１～２２１－３及び２２２－１～２２２－３が設けられているため、第１導光板２１の前面、後面に対して、略垂直の面に入射した光は全反射条件を満たさず、第１導光板２２１の外部に射出される。第１導光板２２１では、光は溝部１２１－１～１２１－３の第１光源２０側の垂直面にしか入射しないため、射出される光は第２観察方向に行くことはなく、第１観察方向のみを照明する指向性をもった照明光となる。

【００４９】

第２光源２５から出射された光が第２導光板２２２に入射したときの作用も上記したとおりであるが、第２導光板２２２は第１導光板２２１と左右対称に配置されているため，第２観察方向のみを照明することになる。このとき、第２導光板２２２から射出された光は第１導光板２２１を通過することとなるが，第１導光板２２１の後面から入射した光は平行平面板を透過した場合と同様の作用があり、第１導光板２２１を透過した光であっても第２観察方向を照明することとなる。

【００５０】

図９は、本発明の第３実施形態に係る照明手段の具体的な断面構造を示す模式図である。ここでも図３の構成と同様に、第１導光板１２１と第２導光板１２２とは重ねて配置されている。図示しないが、各導光板３２１，３２２の前面には図８で説明したような複数の溝がそれぞれ設けられているものとする。

【００５１】

まず、第１導光板３２１に関する構成について説明する。第１導光板３２１は、第１光源２０からの光が入射する端面３２１－１と、光が射出する溝部の端面とに注目すると、どちらも平行であり，平行平面板を通過した場合と同様の作用をもつ。つまり入射角度と射出角度が一致するため、照明光学系４０の光軸についても、射出角度に合わせて第１導光板３２１の端面３２１－１に対して所定の角度をもたせることで、光をより効率よく所望の位置に射出することができる。

【００５２】

Microsoft Exhibit 1002 - Page 1134
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

また、第１光源２０とは反対側の端面３２１－２が水平面に対して垂直になっていると、当該端面３２１－２までたどり着いた光が反射して戻り光として作用し、クロストークの原因となることがある。したがってここでは図のように端面３２１－２を楔形状にして、その表面を光吸収部材４１で覆うことで、クロストークを軽減することができる。

【００５３】

第２導光板３２２に関する構成についても、同様にして、照明光学系４３の光軸を射出角度に合わせて第２導光板３２２の端面３２２－２に対して所定の角度をもたせるとともに、端面３２２－１を楔形状にして、その表面を光吸収部材４２で覆う。

【００５４】

図１０は、本発明の第４実施形態に係る照明手段の具体的な断面構造を示す模式図である。第３実施形態では照明光学系全体を第１導光板の端面に対して傾けたが、第４実施形態では、導光板４２１の入射側の端面４２１－１を細かいプリズム形状とすることで、光源２０から導光板４２１に入射した光線４４は前面側へ角度を変え、それにより溝４２１－２端面から射出される際に適正な角度で射出することができる。導光板４２１に対して垂直方向から３０°方向に射出したいとすると、プリズムの頂角は１０°～２０°位が望ましい。ここでの照明光学系４０とはコリメータレンズあるいは光線４４を集光するようなプリズムシート、回折素子ならなんでもよい。

【００５５】

図１１は、図１０で説明した構成の変形例を示す図である。この構成では、第１導光板２２１の複数の溝２２１－１～２２１－３と、第２導光板２２２の複数の溝２２２－１～２２２－３の一方の壁を垂直ではなく傾斜させたことを特徴とする。

【００５６】

以上、各実施形態ごとに第１導光板と第２導光板について説明したが、第１導光板と第２導光板とを配置するにあたって異なる実施形態の導光板を用いても良い。図１２は、本発明の第５実施形態として、図４を参照して説明した第１導光板１２１と、図７を参照して説明した第２導光板２２２とで異なる構造のものを組み合わせた例である。第１導光板１２１は第２導光板２２２からの射出光を透過する構造でなければならないが、第２導光板２２２は第１導光板１２１と同一である必要はなく、指向性をもった照明が得られる導光板ならばなんでも利用できる。

【００５７】

図１３は、図１２で説明した構成の変形例を示す図である。この構成では、第１導光板１２１の斜面部１２１－１～１２１－３の角度を第１光源２０から遠ざかるに従って大きくしたことを特徴とする。同様にして、第２導光板２２２の斜面部２２２－１～２２２－３の角度が第２光源２５から遠ざかるに従って大きくなるようにしている。

【００５８】

図１４は、本発明の映像表示装置を車載モニター２００として車内に搭載した場合の例を示している。第１観察者２０１の位置に助手席、第２観察者２０２の位置に運転席が位置するように設定することで第１映像の観察範囲２０３と第２映像の観察範囲２０５とが定まり、助手席への搭乗者と運転手とでそれぞれに対応した映像を観察することができる。例えば、運転手にはカーナビゲーションの映像やドライビング補助映像を提供しながら、同時に助手席の搭乗者にはＴＶ映像やＤＶＤ映像、ゲーム、各種情報検索など様々な映像を提供することができる。これにより、運転中の視聴が規制されているようなＴＶや映画などの映像でも、助手席にのみ提供することで、助手席の搭乗者は車が移動中であってもＴＶや映画などの映像を視聴することができる。

【００５９】

図１５（Ａ）、（Ｂ）は、透過型表示素子として液晶表示素子を用いた場合において、「ラスタ走査」と「ホールド特性」を考慮した表示画面の表示制御について説明するための図である。図１５（Ｂ）は、ラスタ走査により透過型表示素子２４に表示される第１の映像と第２の映像が時間の経過（Ｔ１～Ｔ４）に従ってどのように変化するかを示している。３００－１は第１の映像表示領域、３００－２は第２の映像表示領域、３００－３は

Microsoft Exhibit 1002 - Page 1135
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

第１の映像と第２の映像とが混在する境界部である。

【００６０】

液晶表示素子を用いた場合にはＣＲＴディスプレイとは異なり、そのホールド特性を考慮しなければならない。すなわち、ある画素に注目すると、第１の映像表示領域３００－１に第１の映像が表示されてから次に第２の映像表示領域３００－２に第２の映像が表示されるまでの間ずっと第１の映像が表示し続けることとなる。通常の映像表示であれば、１つの画面で１つの映像しか表示しないために、第２の映像は第１の映像の１コマ後の映像、つまり毎秒６０コマであれば、１／６０秒後の映像が表示されることとなる。その場合、バックライトが常時点灯していても映像を観察する上で問題は少ない。

【００６１】

しかし、本発明のように、観察者の見る方向に応じて１つの画面に表示される映像を時分割で切り換えて見る場合においては、第１の映像を表示しているときには第１の映像照明を、第２の映像を表示しているときには第２の映像照明を必要とするが、第２の映像を表示しているときに第１映像照明で照明してしまったり、さらには、第１の映像と第２の映像の違いが大きいことから、液晶の応答の速度からくる次の映像への移行期間（図１５（Ｂ）の境界部３００－３）が発生し、その部分を照明してしまうことでクロストークの原因となってしまう。

【００６２】

そこで本発明では、図１５（Ａ）に示すように、透過型表示素子のラスタ走査に同期して、第１の映像を照明する第１の映像照明領域３０１－１と、第２の映像を照明する第２の映像照明領域３０１－２とを切り換えることが必要である。さらに、第１の映像照明領域３０１－１と第２の映像照明領域３０１－２の境界部にあたる部分では両方の照明を消灯するほうが望ましい（消灯領域３０１－３）。

【００６３】

図１６（Ａ），（Ｂ）は、第１の映像照明領域３０１－１と、第２の映像照明領域３０１－２とを消灯領域３０１－３で切り換える様子を模式的に示す図である。第１の映像照明領域３０１－１と、第２の映像照明領域３０１－２とで指向性が異なることが示されている。また、消灯領域３０１－３を含む画面全体がラスタ走査に同期して時間の経過にしたがってシフトしていく様子を示している。

【００６４】

なお、前記した各実施形態では、第１及び第２の光源が導光板の寸法に対応する長さを有する単体であることを前提にしたが、このような構成に限定されることはない。例えば、図１７に示すように複数の点光源５００－１～５００－５と複数の照明レンズ５１０－１～５１０－５とを第１導光板５２１の長さ全体に渡って所定の間隔で配置してそれぞれ第１光源群５００、第１照明レンズ群５１０とした構成であってもよい。同様にして、複数の点光源５０１－１～５０１－５と複数の照明レンズ５１１－１～５１１－５とを第２導光板５２２の長さ全体に渡って所定の間隔で配置してそれぞれ第２光源群５０１、第２照明レンズ群５１１を構成する。この場合、例えば第１光源群５００から出射した光線は第１照明レンズ群５１０により照明光５２３となって第１導光板５２１内を伝播する。

【００６５】

図１８は、図１７に示す構成の変形例を示す図である。この変形例では、第１導光板５２１を複数の導光板５２１－１～５２１－５に切断して貼り合せた構成とし、各導光板５２１－１～５２１－５の長さに対応する長さの光源５０２－１～５０２－５を複数隣接させて配置したことを特徴とする。貼り合わせた部分は各光源５０２－１～５０２－５からの光線を全反射するためにミラーコーティングするか、あるいはミラーを配置することで光線が反射するように構成する。また、各導光板５２１－１～５２１－５に入射した光が他の導光板５２１－１～５２１－５に入射しないようにする。このような構成において、各導光板５２１－１～５２１－５に対応した各光源５０２－１～５０２－５を順次切り換えて発光することにより、図１６に示すような駆動が実現できる。なお、図では第１導光板、第２導光板とも５つに分割した例を示しているが、分割する数は何分割でもよく、細

Microsoft Exhibit 1002 - Page 1136
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

かく分割した方がよりラスタ走査に対応できるためクロストークを少なくすることができる。

【００６６】

（付記１）

上記した具体的な実施形態から以下のような構成の発明を抽出することができる。

【００６７】

１．　複数の観察者のそれぞれに対応する映像を表示可能な一つの表示画面を有する映像表示装置であって、

時分割で少なくとも２つの異なる方向にそれぞれ第１の光束及び第２の光束を射出する照明手段と、

前記照明手段から射出された前記第１の光束を照明光とする第１の映像と、前記第２の光束を照明光とする第２の映像とを時分割で表示可能な透過型表示素子と、

を具備し、

前記照明手段は、

前記第１の光束を射出する第１の光源と、

前記第２の光束を射出する第２の光源と、

前記第１の光源から射出された第１の光束を第１の観察者の方向のみに射出する第１の導光板と、

前記第２の光源から射出された第２の光束を第２の観察者の方向のみに射出する第２の導光板と、

を具備することを特徴とする映像表示装置。

【００６８】

（対応する実施形態の図）

１の構成は、例えば図２、図３に対応する。

【００６９】

（効果）　１つの導光板で１方向の指向性をもつ照明光を作り、それを２枚重ねることで、２方向に時分割駆動が可能な照明装置が実現でき、それぞれの方向でのクロストークも少なくすることができる。

【００７０】

２．　前記第１の導光板は、前記透過型表示素子と前記第２の導光板との間に配置され、前記第２の導光板から射出された第２の光束は、前記第１の導光板を透過することを特徴とする１に記載の映像表示装置。

【００７１】

（対応する実施形態の図）

２の構成は、例えば図２、図３に対応する。

【００７２】

（効果）　第２の導光板から射出される第２の光束が第１の導光板を透過できることにより、２枚の導光板を重ねて使用することができる。これにより、それぞれの導光板において照明ムラを取ることが可能であり、画質向上の効果がある。

【００７３】

３．　前記第１の導光板の、前記透過型表示素子に対向する面と、前記第２の導光板に対向する面には、前記第１の導光板を透過する前記第２の光束に対して光学的に平坦な部位が設けられていることを特徴とする２に記載の映像表示装置。

【００７４】

（対応する実施形態の図）

３の構成は、例えば図４、図８に対応する。

【００７５】

（効果）

第２の導光板から射出される第２の光束が第１の導光板を透過できるとともに、光学的に平坦な部位を有することから、それぞれの導光板の指向性を保ちながら２枚の導光板を

Microsoft Exhibit 1002 - Page 1137
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

重ねて使用することができる。これにより、それぞれの導光板において照明ムラを取ることが可能であるとともに、クロストークへの影響も軽減でき、画質向上の効果がある。

【００７６】

４．　前記第１の導光板の後面には、

前記第１の光源からの入射光を全反射させて前記第１の導光板の前記第１の光源とは反対側の端面に伝えるための平面部と、

前記第１の光源からの入射光を全反射させて前記第１の導光板の前面での全反射条件を満たさなくし、前記第１の観察者方向に射出させるための斜面部とが、

複数設けられていることを特徴とする１に記載の映像表示装置。

【００７７】

（対応する実施形態の図）

４の構成は、例えば図４、図５に対応する。

【００７８】

（効果）

第１の導光板の後面に設けられた平面部での全反射作用により、光源からの光を導光板の端面まで伝えることが出来、また、複数配置されている斜面部での全反射作用により、光は導光板の前面から適切な角度で射出される。

【００７９】

５．　前記第１の導光板の前面には、

前記第１の光源からの入射光を全反射させて前記第１の導光板の前記第１の光源とは反対側の端面に伝えるための平面部と、

前記第１の光源からの入射光を透過させて、前記第１の観察者方向に射出させるための射出面とが、

複数設けられていることを特徴とする１に記載の映像表示装置。

【００８０】

（対応する実施形態の図）

５の構成は、例えば図８に対応する。

【００８１】

（効果）

導光板内において射出面に入射できる光は、第１の光源がある方向からの光のみなので、射出面からの射出光は特定方向のみへ射出する指向性を持った光であり、クロストークの軽減となる。

【００８２】

６．　前記斜面部と前記平面部とのなす角θは、前記第１の導光板の屈折率をｎとするとき、

ｎ・ｃｏｓ２θ＜１（θ＜４５度）

の条件を満たすことを特徴とする４に記載の映像表示装置。

【００８３】

（対応する実施形態の図）

６の構成は、例えば図５に対応する。

【００８４】

（効果）

適切な角度で導光板から射出するためには斜面部が適切な角度でなければならず、例えば、θが４５度以上であると第１観察方向に射出したい照明光が第２観察方向にまで照明されクロストークの原因となり、また、ｎ・ｃｏｓ２θ＞１であると、斜面部で全反射された光であっても、導光板の前面で全反射されてしまい、導光板から抜け出すことができない。よって、θ＜４５度　、ｎ・ｃｏｓ２θ＜１とすることで、クロストークが少なく、光利用効率の高い導光板が得られる。

【００８５】

７．　前記第１の導光板の前面には、

Microsoft Exhibit 1002 - Page 1138
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

矩形の溝が複数設けられていることを特徴とする５に記載の映像表示装置。
【００８６】
（対応する実施形態の図）
７の構成は、例えば図８、図９に対応する。
【００８７】
（効果）
導光板に設けた溝の作用によって、導光板の端面の一方から光を入射させることにより、ある方向に偏った指向性をもった照明として射出される。
【００８８】
８．　前記矩形の溝の深さは、前記第１の光源から遠ざかるほど大きくなることを特徴とする７に記載の映像表示装置。
【００８９】
（対応する実施形態の図）
８の構成は，例えば図８，図９に対応する。
【００９０】
（効果）
光源からの光が、導光板内の光源に近い方の溝から順に光が取り出されていくため、光源に近い側の溝と遠い側の溝が同じ大きさであれば、近い側の方が明るく、遠い側の方が暗く見えてしまう。そのため、光源から遠ざかるほど溝を大きくすることで、全体的に均一な照明を得ることができる。
【００９１】
９．　前記第２の導光板は、前記第１の導光板と異なる形状または異なる周期構造をもつ表面形状であることを特徴とする１に記載の映像表示装置。
【００９２】
（対応する実施形態の図）
９の構成は、例えば図１２に対応する。
【００９３】
（効果）
重ね合わせている導光板のうち下側となる第２の導光板は必ずしも裏面からの入射光を透過させる構造でなくてもよいことから、第２の観察者方向のみを照明するもっとも確実で低コストなバックライト方式を利用すればよい。また、同一形状のものであると、場合によりモアレ縞等の影響が発生するが、第１導光板と第２導光板とで形状または周期構造を変えることで軽減することもできる。
【００９４】
１０．　前記第２の導光板は，前記第１の導光板と同一形状であり、前記第１の導光板と，前記第２の導光板とは、互いに左右を入れ替えて配置されていることを特徴とする１に記載の映像表示装置。
【００９５】
（対応する実施形態の図）
１０の構成は、例えば図４、図８に対応する。
【００９６】
（効果）
指向性の異なる２つの導光板を組み合わせた構成であるが、第２導光板は第１導光板を左右ひっくり返すことにより、同一形状で利用することが可能である。このため新たにもう１種類の導光板を用意しなくてもよくコスト削減の効果がある。
【００９７】
１１．　前記第１の光源と、前記第２の光源とは、観察者側から見て左右の異なる端面位置に配置されていることを特徴とする１０に記載の映像表示装置。
【００９８】
（対応する実施形態の図）

Microsoft Exhibit 1002 - Page 1139
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

１１の構成は、例えば図３、図４、図８に対応する。

【００９９】

（効果）

それぞれの導光板で左右異なる位置に光源を配置することで、より容易に指向性のことなる２方向の照明を実現することができる。さらに、導光板ごと左右の向きを変えるだけであるため、上下の導光板で共通構造の部材を利用することができる。

【０１００】

１２．　前記第１の光源と前記第２の光源とは、それぞれ異なる時間に周期的に発光し、各光源の発光の周波数は２４Ｈｚ以上であることを特徴とする１に記載の映像表示装置。

【０１０１】

（対応する実施形態の図）

１２の構成は、例えば図３に対応する。

【０１０２】

（効果）

各光源において同時に両方点灯する期間をなくすことで、クロストークが軽減される。また、光源を２４Ｈｚ以上で駆動させることによりフリッカによる見づらさへの影響を軽減することができる。

【０１０３】

１３．　前記第２の導光板の後面には光を吸収する部材が配置されていることを特徴とする１に記載の映像表示装置。

【０１０４】

（対応する実施形態の図）

１３の構成は、例えば図４に対応する。

【０１０５】

（効果）

通常の拡散型の照明光と違い、照明に指向性を持たせることを特徴としているため、導光板から正面方向とは反対側の裏面に抜ける光が生じた場合に導光板の背後の面が反射部材であると、それがさらに観察側に射出されてしまうためクロストークの原因となる。そこで、裏側方向に生じた光を吸収する部材を用いることで、よりクロストークを軽減することができる。

【０１０６】

さらに、表示画面に日光などの外光が入射し、導光板の裏側で反射した光は不要光となりクロストークの原因となることからも、第２導光板の下に光吸収部材を配置することで、外光によるクロストークも軽減することができる。

【０１０７】

１４．前記透過型表示素子のラスタ走査方向に沿って、前記第１の導光板及び前記第２の導光板に隣接して複数の発光素子が配置され、各発光素子は個々に発光制御される１に記載の映像表示装置。

【０１０８】

（対応する実施形態の図）

１４の構成は、例えば図１７、図１８に対応する。

【０１０９】

（効果）

発光素子が透過型表示素子のラスタ走査方向に沿って複数配置されているのでラスタ走査に同期した照明が可能であり、クロストークが少なく、かつ発光時間を長く保てるため、輝度向上の効果が得られる。

【０１１０】

１５．　前記各発光素子は、前記透過型表示素子のラスタ走査に同期して、周期的に発光することを特徴とする１４に記載の映像表示装置。

【０１１１】

Microsoft Exhibit 1002 - Page 1140
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

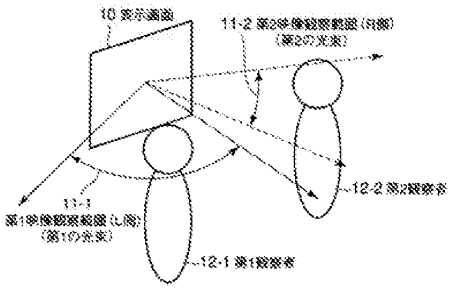
（対応する実施形態の図）
１５の構成は、例えば図１７、図１８に対応する。
【０１１２】
（効果）
ラスタ走査に同期した照明が可能であり、クロストークが少なく、かつ発光時間を長く保てるため、輝度向上の効果が得られる。
【０１１３】
１６．前記第１導光板および前記第２導光板は、前記複数の発光素子の各々に対応して複数の導光部に分割されていることを特徴とする１４に記載の映像表示装置。
【０１１４】
（対応する実施形態の図）
１６の構成は、例えば図１８に対応する。
【０１１５】
（効果）
複数の発光素子のうち１つの発光素子の発光が他の発光素子に漏れることによりクロストークの原因となることを防ぐために、導光板を各発光素子ごとに分割する。これにより、クロストークを軽減することができる。
【０１１６】
１７．　複数の観察者のそれぞれに対応する映像を表示可能な一つの表示画面を有する、車内に設置される車載用映像表示装置であって、
時分割で少なくとも２つの異なる方向にそれぞれ第１の光束及び第２の光束を射出する照明手段と、
前記照明手段から射出された前記第１の光束を照明光とする第１の映像と、前記第２の光束を照明光とする第２の映像とを時分割で表示可能な透過型表示素子と、
を具備し、
前記照明手段は、
前記第１の光束を射出する第１の光源と、
前記第２の光束を射出する第２の光源と、
前記第１の光源から射出された第１の光束を運転席側の観察者の方向のみに射出する第１の導光板と、
前記第２の光源から射出された第２の光束を助手席側の観察者の方向のみに射出する第２の導光板と、
を具備することを特徴とする車載用映像表示装置。
【０１１７】
（対応する実施形態の図）
１７の構成は、例えば１４に対応する。
【０１１８】
（効果）
上記の構成１と同等の効果が得られる。
【図面の簡単な説明】
【０１１９】
【図１】本発明の映像表示装置の一使用例を説明するための図である。
【図２】本発明に係る映像表示装置の基本構成を示す図である。
【図３】本発明に係る映像表示装置の照明手段の水平断面図である。
【図４】本発明の第１実施形態に係る照明手段の具体的な断面構造を示す模式図である。
【図５】導光板の斜面部分を拡大して示す図である。
【図６】本発明の構成を用いた場合の視野角について説明するための図である。
【図７】図４で説明した構成の変形例を示す図である。
【図８】本発明の第２実施形態に係る照明手段の具体的な断面構造を示す模式図である。
【図９】本発明の第３実施形態に係る照明手段の具体的な断面構造を示す模式図である。

Microsoft Exhibit 1002 - Page 1141
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

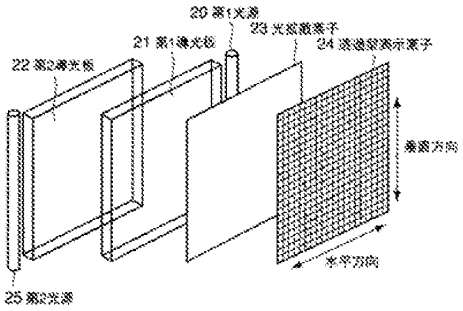
【図１０】本発明の第４実施形態に係る照明手段の具体的な断面構造を示す模式図である。
【図１１】図１０で説明した構成の変形例を示す図である。
【図１２】本発明の第５実施形態として、図４を参照して説明した第１導光板１２１と、図７を参照して説明した第２導光板２２２とで異なる構造のものを組み合わせた例を示す図である。
【図１３】図１２で説明した構成の変形例を示す図である。
【図１４】本発明の映像表示装置を車載モニター２００として搭載した場合の例を示す図である。
【図１５】透過型表示素子２４として液晶表示素子を用いた場合において、「ラスタ走査」と「ホールド特性」を考慮した表示画面の表示制御について説明するための図である。
【図１６】１の映像照明領域３０１－１と、第２の映像照明領域３０１－２とを消灯領域３０１－３で切り換える様子を模式的に示す図である。
【図１７】照明手段の変形例（その１）を示す図である。
【図１８】照明手段の変形例（その２）を示す図である。
【図１９】従来の映像表示装置の一構成例を示す図である。
【図２０】従来の映像表示装置の他の構成例を示す図である。
【図２１】図１９（Ａ）の観察位置よりさらに外側から観察したときの様子を示す図である。
【図２２】従来の構成において観察位置の違いによってどのような映像が見えるかを示す図である。
【符号の説明】
【０１２０】
２０…第１光源、２１…第１導光板、２２…第２導光板、２３…光拡散素子、２４…透過型表示素子、２５…第２光源、２６…第１映像照明、２７…第２映像照明、２８…光吸収部材。

Microsoft Exhibit 1002 - Page 1142
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

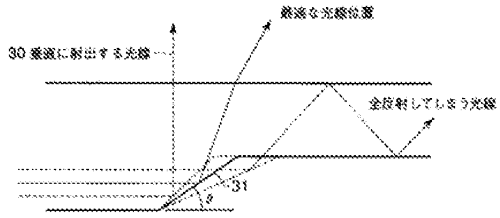
【図１】



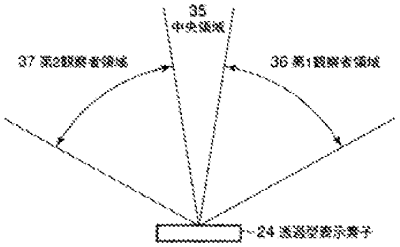
【図２】



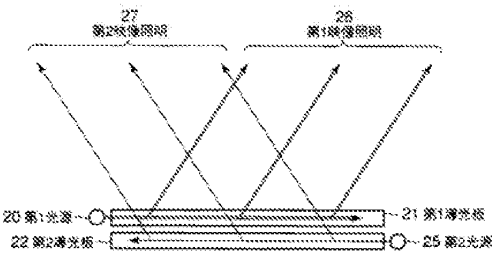
【図５】



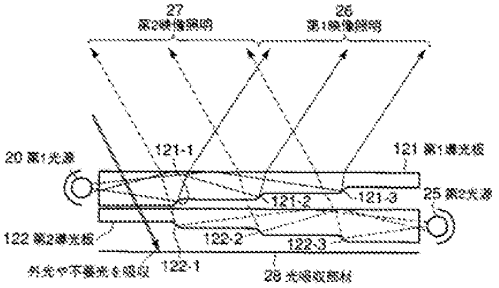
【図６】



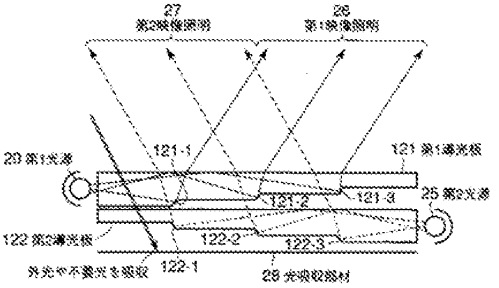
【図３】



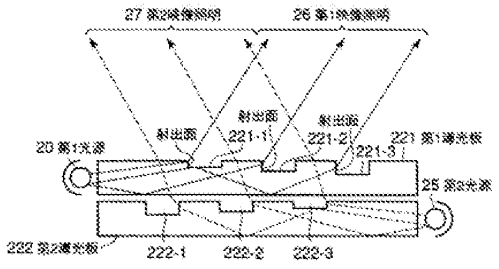
【図４】



【図７】

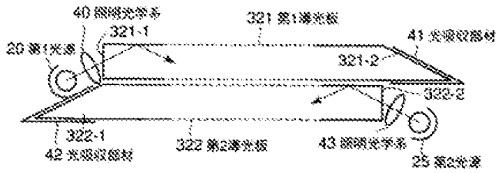


【図８】

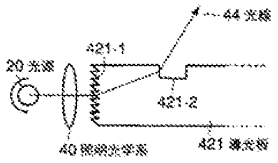


Microsoft Exhibit 1002 - Page 1143
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

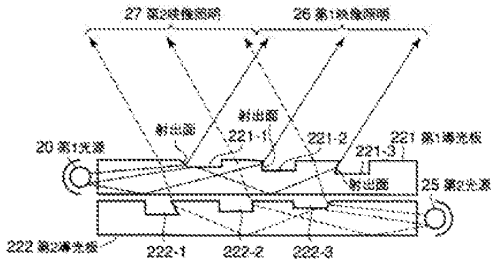
【図９】



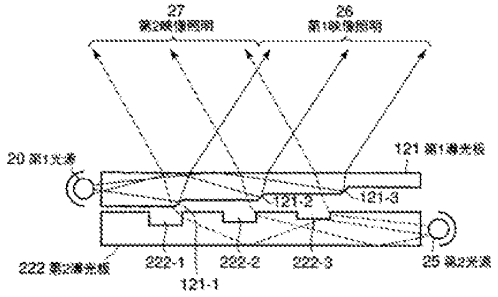
【図１０】



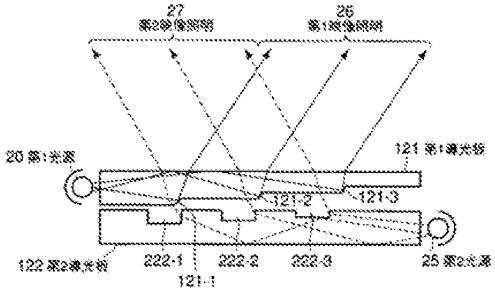
【図１１】



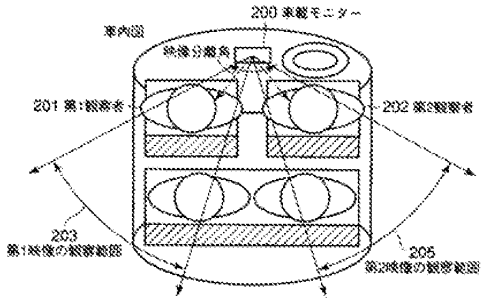
【図１２】



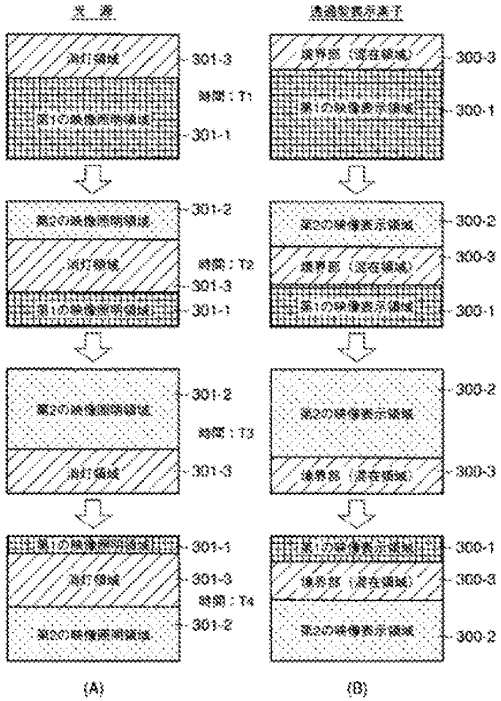
【図１３】



【図１４】

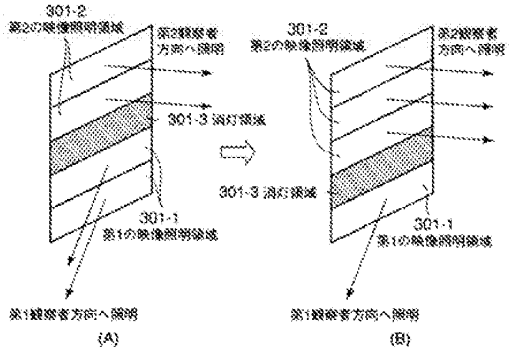


【図１５】

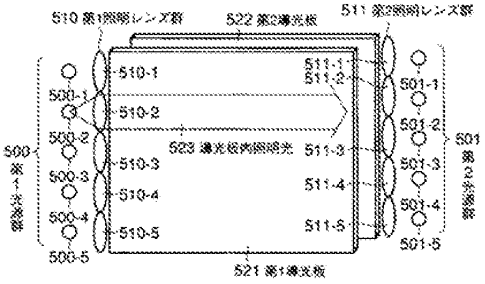


Microsoft Exhibit 1002 - Page 1144
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

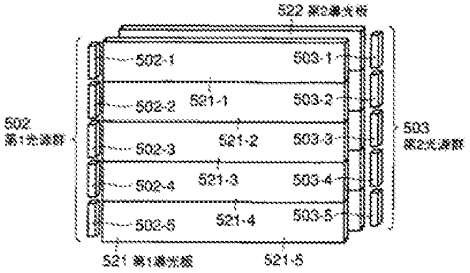
【図１６】



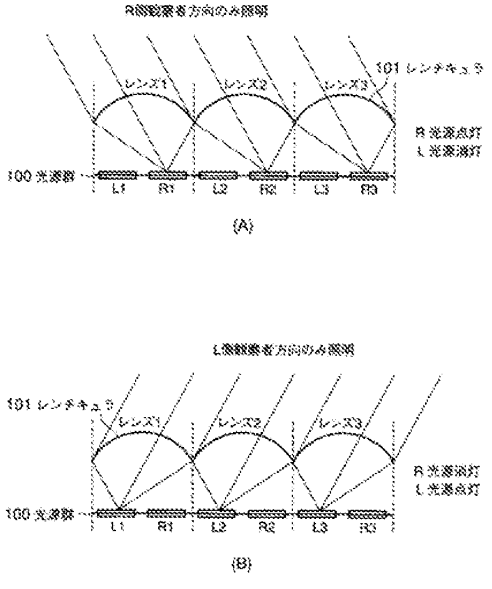
【図１７】



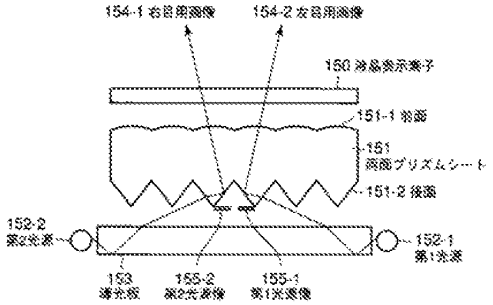
【図１８】



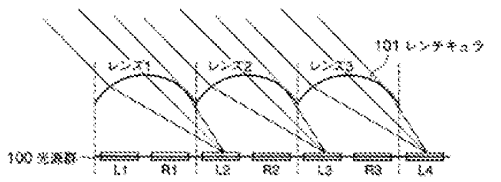
【図１９】



【図２０】

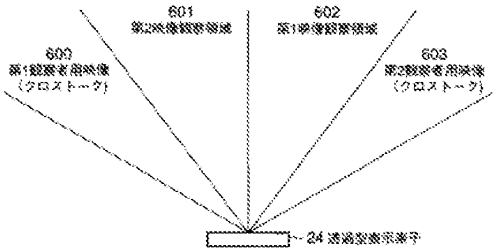


【図２１】



Microsoft Exhibit 1002 - Page 1145
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

【図２２】



Microsoft Exhibit 1002 - Page 1146
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

フロントページの続き

(51)Int.Cl.		F I			テーマコード（参考）
G03B 35/26	*(2006.01)*	G03B	35/26		5C435
G09F 9/00	*(2006.01)*	G09F	9/00	336J	
		G09F	9/00	362	

(74)代理人 100084618
弁理士 村松 貞男
(74)代理人 100092196
弁理士 橋本 良郎
(72)発明者 杉原 良平
東京都渋谷区幡ヶ谷２丁目４３番２号 オリンパス株式会社内
(72)発明者 井場 陽一
東京都渋谷区幡ヶ谷２丁目４３番２号 オリンパス株式会社内

Ｆターム(参考) 2H038 AA55 BA06
2H059 AB13
2H088 EA05 HA28 MA01 MA20
2H091 FA23Z FA41Z LA16 LA30 MA01 MA03
3D020 BA04 BC02 BE03
5C435 AA01 BB12 CC09 EE25 FF02 FF08 FF12 GG06 HH02

Microsoft Exhibit 1002 - Page 1147
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Espacenet

Bibliographic data: JP2007109255 (A) — 2007-04-26

WAVELET-BASED FACIAL MOTION CAPTURE FOR ANIMATING OBJECT IMPARTED WITH HUMAN APPEARANCE

Inventor(s): MAURER THOMAS; ELAGIN EGOR VALERIEVICH; AGOSTINO NOCERA LUCIANO PASQUA; STEFFENS JOHANNESS BERNHARD; NEVEN HARTMUT ± (MAURER THOMAS, ; ELAGIN EGOR VALERIEVICH, ; AGOSTINO NOCERA LUCIANO PASQUALE, ; STEFFENS JOHANNESS BERNHARD, ; NEVEN HARTMUT)

Applicant(s): EYEMATIC INTERFACES INC ± (EYEMATIC INTERFACES INC)

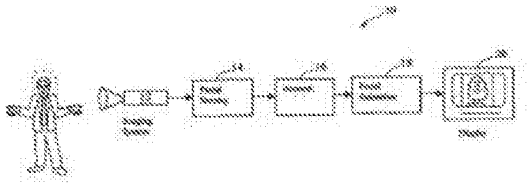
Classification: - international: ***G06K9/00; G06T7/20;*** *G06T17/40*
- cooperative: **G06K9/00228**; **G06K9/00248**; **G06K9/00362**; **G06K9/4619**; **G06K9/469**; **G06T7/246**; **G06T7/262**; G06T2207/20064

Application number: JP20060329956 20061206 Global Dossier

Priority number(s): US19980081615P 19980413 ; US19980188079 19981106

Also published as: AT248409 (T) AU3639699 (A) BR9909611 (A) BR9909611 (B1) CA2327304 (A1) more

Abstract of JP2007109255 (A)



PROBLEM TO BE SOLVED: To track a natural property of a person without being accompanied by an unnatural element capable of disturbing or blocking the natural property of the person, in a device for detecting motion, a characteristic, and properties or the like of a face of the person, generating an image of an object imparted with human appearance on the basis of detection of the face, and animating it. ;SOLUTION: Image processing technology based on a bunch graph and a model graph efficiently expressing a characteristic of the image as a jet is used. The jet comprises a wavelet transform processed by a landmark location or a node of the image corresponding to the easily identifiable characteristic. The node is acquired and

Microsoft Exhibit 1002 - Page 1148
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

tracked, and the object imparted with the human appearance is animated according to the facial motion of the person. In the detection of the face, by finding the characteristic and the properties of the face of the person by use of jet similarity, the natural property of the person can be tracked without being accompanied by the unnatural element capable of disturbing or blocking the natural property of the person. ;COPYRIGHT: (C) 2007,JPO&INPIT

Microsoft Exhibit 1002 - Page 1149
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2007-109255
(P2007-109255A)
(43)公開日　平成19年4月26日(2007.4.26)

(51)Int.Cl.		F I			テーマコード（参考）
G06T 7/20	***(2006.01)***	G06T	7/20	300B	5B050
G06T 17/40	*(2006.01)*	G06T	17/40	A	5L096

審査請求 有　請求項の数 1　OL　（全 21 頁）

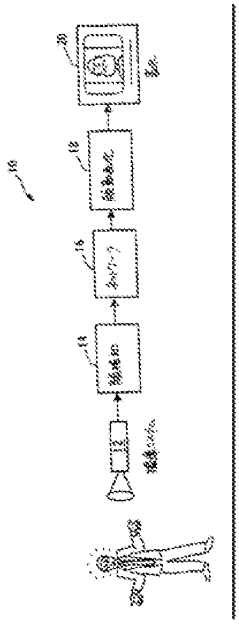
(21)出願番号　特願2006-329956 (P2006-329956)
(22)出願日　平成18年12月6日 (2006.12.6)
(62)分割の表示　特願2000-543930 (P2000-543930)の分割
原出願日　平成11年4月12日 (1999.4.12)
(31)優先権主張番号　60/081,615
(32)優先日　平成10年4月13日 (1998.4.13)
(33)優先権主張国　米国 (US)
(31)優先権主張番号　09/188,079
(32)優先日　平成10年11月6日 (1998.11.6)
(33)優先権主張国　米国 (US)

(71)出願人　500475100
アイマティック・インターフェイシズ・インコーポレイテッド
アメリカ合衆国、９０４０４　カリフォルニア州、サンタ・モニカ、コロラド・ブールバード、２８０１－２８０３
(74)代理人　100064746
弁理士　深見　久郎
(74)代理人　100085132
弁理士　森田　俊雄
(74)代理人　100083703
弁理士　仲村　義平
(74)代理人　100096781
弁理士　堀井　豊

最終頁に続く

(54)【発明の名称】人間の姿を与えたものを動画化するためのウェーブレットに基づく顔の動きの捕捉

(57)【要約】
【課題】人物の顔の動き、特徴、および特性などを検知し、顔の検知に基づいて、人間の姿を与えたものの画像を生成しかつ動画化するための装置において、人物の自然な特性を、その人物の自然な特性を妨害または阻止し得る不自然な要素を伴なわずに、追跡する。
【解決手段】画像の特徴をジェットとして効率的に表現するモデルグラフおよびバンチグラフに基づいた画像処理技術を用いる。ジェットは、容易に識別可能な特徴に対応する。画像のノードまたはランドマークロケーションで処理されたウェーブレット変換からなる。ノードを獲得し追跡して、人物の顔の動きに従い、人間の姿を与えたものを動画化する。また顔の検知では、ジェット類似度を用いて人物の顔の特徴および特性を求めることにより、人物の自然な特性を、その人物の自然な特性を妨害または阻止し得る不自然な要素を伴なわずに、追跡することができる。
【選択図】図１



Microsoft Exhibit 1002 - Page 1150
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

【特許請求の範囲】
【請求項1】
画像フレームのシーケンスに対する特徴検知のための方法であって、
ウェーブレット変換を用いて各画像フレームを変換し、変換された画像フレームを生成するためのステップと、
モデルグラフのノードを、前記変換された画像フレームのロケーションに初期化するためのステップとを含み、各ノードは特徴に特有のウェーブレットジェットに関連し、前記初期化するステップは、前記モデルグラフを前記変換された画像フレームを横切るように動かし、前記モデルグラフを前記変換された画像フレームを横切るように動かす際に求められた前記ノードのウェーブレットジェットと前記変換された画像フレームのロケーションとの間のジェット類似度が最大である前記変換された画像フレームのロケーションに、前記モデルグラフを配置することにより行なわれ、さらに、
画像フレーム間で前記モデルグラフの１以上のノードのロケーションを追跡するためのステップを含み、
前記方法がさらに、追跡されたノードのロケーションを、前記追跡されたノードのロケーションが画像フレーム間の予め定められた位置制約を超えてずれた場合に、再初期化するためのステップを含むことを特徴とする、特徴検知のための方法。

【発明の詳細な説明】
【技術分野】
【0001】
本発明は、動的な顔の特徴の検知に関し、より具体的には、顔の特徴をリアルタイムで発見、追跡、かつ分類して、人の姿を与えたもの（avatar、分身）を動画化するグラフィックスエンジンに入力する、視覚に基づく動き捕捉システムに関する。
【背景技術】
【0002】
仮想空間を人間の姿を与えたもので満たすことは、共有環境を経験できるようにするには魅力的な方法である。しかしながら、一般的に、既存の共有環境では、ユーザを具体化するすなわちユーザの表情またはジェスチャーをそのユーザの分身に与えユーザに似たものにするのに十分な質で顔の特徴は検知されていない。高品質で顔の特徴を検知することは非常に有利である。なぜなら、顔によるジェスチャーは、コミュニケーションの根本的手段であるからである。したがって、ユーザを具体化することによって、仮想空間の魅力は増大する。
【発明の開示】
【発明が解決しようとする課題】
【0003】
典型的に、顔の特徴を検知する既存の方法は、人物の顔に固定されるマーカを用いる。顔の動きを捕捉するためにマーカを使用することは煩わしいもので、一般的にはマーカの使用によって顔の動き捕捉の用途は映画の制作といったコストのかかる応用に限定されてきた。
【0004】
したがって、現在非常に必要なのは、好都合でかつ効率的な顔の特徴検知を実現する、視覚に基づく動き捕捉システムである。本発明はこの必要を満たす。
【課題を解決するための手段】
【0005】
本発明は、人物の顔の動き、特徴または特性を検知するための装置および関連の方法において実施される。顔の検知の結果を用いて、人間の姿を与えたもの（分身）の画像を動画化することができる。この分身装置は、モデルグラフおよびバンチグラフに基づく画像処理技術を使用する。このモデルグラフおよびバンチグラフは、画像の特徴を、容易に識別可能な特徴に対応する顔の画像のランドマークにおけるウェーブレット変換からなるジェットとして、効率的に表現する。この検知システムにより、ある人物の自然な特性を、

Microsoft Exhibit 1002 - Page 1151
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

その人物の自然な特性を妨害する不自然な要素を伴なわずに追跡することができる。
【0006】
特徴検知プロセスは、画像フレームのシーケンスに対して働き、ウェーブレット変換を用いて各画像フレームを変換し、変換された画像フレームを生成する。変換された画像フレームへの、モデルグラフのウェーブレットジェットに関連するノードロケーションの初期化は、モデルグラフを変換された画像フレームを横切るように動かし、モデルグラフを、ノードロケーションのウェーブレットジェットと変換された画像フレームとの間のジェット類似度が最大である、変換された画像フレームにおけるあるロケーションに配置することによって行なわれる。モデルグラフの１以上のノードロケーションのロケーションを画像フレーム間で追跡する。追跡されたノードは、そのノードの位置が画像フレーム間の予め定められた位置制約を超えてずれた場合に、再初期化される。
【0007】
本発明のある実施例において、顔の特徴の発見は、頭モデルを個別化するための弾性バンチグラフマッチングに基づき得る。また、顔の画像の解析のためのモデルグラフは、人間の顔の目立つ特徴に関連する複数のロケーションノード（たとえば１８）を含み得る。
【0008】
本発明の他の特徴および利点は、好ましい実施例についての以下の記載を、添付の図面と関連づけて検討することにより明らかになるはずであり、この図面は例として本発明の原理を示している。
【発明を実施するための最良の形態】
【0009】
本発明は、人物の顔の動き、特徴、および特性などを検知し、その顔検知に基づいて、人間の姿を与えたもの（分身）の画像を生成しかつ動画化するための装置および関連の方法において実施される。この分身装置は、画像の特徴をジェットとして効率的に表現するモデルグラフおよびバンチグラフに基づく画像処理技術を利用する。このジェットはウェーブレット変換からなり、容易に識別可能な特徴に対応する画像のノードまたはランドマークロケーションにおいて処理される。ノードを獲得して追跡し、人物の顔の動きに従って、人間の姿を与えたものの画像を動画化する。また、顔の検知では、ジェット類似度を用いて人物の顔の特徴および特性を判断するので、人物の自然な特性を、その人物の自然な特性を妨害し得る不自然な要素を伴なわずに、追跡することができる。
【0010】
図１に示すように、本発明の分身動画化システム１０は、撮像システム１２と、顔検知プロセス１４と、データ通信ネットワーク１６と、顔動画化プロセス１８と、分身ディスプレイ２０とを含む。撮像システムは、ある人物のライブビデオ画像信号を獲得しデジタル化することによって、画像フレームに組織されるデジタル化されたビデオデータのストリームを生成する。デジタル化されたビデオ画像データは、顔検知プロセスに与えられ、このプロセスは、各フレームにおける、その人物の顔および対応する顔の特徴の場所を求める。顔検知プロセスはまた、フレームからフレームへと顔の特徴の位置および特性を追跡する。追跡情報をネットワークを介して１以上の遠隔場所に送り、この遠隔場所においてその情報を受信し、グラフィックスエンジンを用いて分身ディスプレイに動画化された顔の画像を生成することができる。動画化された顔の画像は、その人物の写真のように写実的なモデル、漫画のキャラクター、またはユーザに全く無関係の顔に基づき得る。
【0011】
撮像システム１２および顔検知プロセス１４を図２および３においてさらに詳細に示す。撮像システムは、ビデオ画像フレームのストリームを発生するデジタルビデオカメラ２２を用いて人物の画像を捕捉する。ビデオ画像フレームは、処理のためにビデオランダムアクセスメモリ（ＶＲＡＭ）２４に転送される。Matrox（登録商標）から入手可能なMatrox Meteor IIは、申し分ない撮像システムであり、これは、従来のＣＣＤカメラによって生成されたデジタル化画像を発生し、この画像をリアルタイムでフレームレート３０Ｈｚでメモリに転送する。画像フレームは、ＶＲＡＭおよびランダムアクセスメモリＲＡＭ３

Microsoft Exhibit 1002 - Page 1152
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

０に結合された中央処理装置（ＣＰＵ）２８を備える画像プロセッサ２６によって処理される。ＲＡＭは、プログラムコードおよびデータを記憶し、顔検知および分身動画化プロセスを実現する。

【0012】

顔特徴プロセスは、デジタル化された画像に対して働き、人物の顔の特徴を発見し（ブロック３２）、その特徴を追跡し（ブロック３４）、必要に応じて特徴追跡を再初期化する。顔の特徴を分類してもよい（ブロック３６）。顔特徴プロセスは、顔の特徴の位置および分類に関連するデータを生成し、これが、顔動画化プロセスとのインターフェイスに与えられる（ブロック３８）。

【0013】

顔の特徴の場所は、図４に示す弾性グラフマッチングを用いて求めることができる。この弾性グラフマッチング技術では、捕捉された画像（ブロック４０）を、図５を参照して以下でさらに詳細に説明するウェーブレット変換を用いて、ガボール空間に変換する（ブロック４２）。変換された画像（ブロック４４）は、当初の画像の各画素につき、ウェーブレット成分を表わす４０の複素値によって表現される。次に、図７を参照して以下できらに詳細に説明するモデルグラフのハードコピーを、変換された画像の上の、変化するモデルノード位置に位置決めし、最適類似度の位置を発見する（ブロック４６）。最適類似度の探索は、モデルグラフを画像の左上隅に位置決めし、ノードにあるジェットを抽出し、画像グラフとモデルグラフとの間の類似度を求めることによって行なうことができる。この探索は、モデルグラフを、画像の左上隅から始めて左から右へとスライドさせることによって続けられる（ブロック４８）。顔のおおよその位置がわかると（ブロック５０）、ノードを個別に動かして弾性グラフ歪みを導入する（ブロック５２）。うまくマッチングする場所を求めるために、位相の影響を受けない類似度関数を用いる（ブロック５４）。次に、位相の影響を受ける類似度関数を用いて、正確にジェットの場所を求める。その理由は、位相がジェットの小さな変位の影響を大きくうけるからである。位相の影響を受けない類似度関数および位相の影響を受ける類似度関数については、図５－８を参照して以下で説明する。なお、図４では当初の画像に関するグラフが示されているが、モデルグラフの移動およびマッチングは、実際には変換された画像に対して行なわれる。

【0014】

ウェーブレット変換について図５を参照して説明する。当初の画像をガボールウェーブレットを用いて処理すると畳込みの結果が生じる。ガボールに基づくウェーブレットは、ガウスエンベロープにより変調された２次元の複合波フィールドからなる。

【0015】

【数1】

$$\psi_{\vec{k}}(x) = \frac{k^2}{\sigma^2} e^{-x^2 \frac{k^2}{2\sigma^2}} \left\{ e^{i\vec{k}\vec{x}} - e^{\frac{-\sigma^2}{2}} \right\} \qquad (1)$$

【0016】

ウェーブレットは、ガウス窓により制限される、波数ベクトルｋ→（記号→は本来ｋの上に示されるものである。以下の表記も同様。）の平面波であり、波長に対するその大きさは、σによりパラメータ化される。括弧内の項はＤＣ成分を除去する。波数ベクトルｋの振幅は以下のようにして選択できる。式中νは所望の空間解像度に関連する。

【0017】

【数2】

Microsoft Exhibit 1002 - Page 1153
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

$$k_\nu = 2^{-\frac{\nu+2}{2}}\pi, \nu = 1, 2, \ldots \qquad (2)$$

画像位置 $\vec{x}$ を中心とするウェーブレットを用いてグレーレベル分布 $I(\vec{x})$ の画像からウェーブレット成分 J_k を抽出する。

$$J_k(\vec{x}) = \int d\vec{x}' I(\vec{x}') \Psi_k(\vec{x} - \vec{x}') \qquad (3)$$

【0018】

典型的には、波数ベクトルｋ→の空間を、解像度レベルが５（２分の１オクターブずつ異なる）および各解像度レベルでの配向が８の離散階層構造において（例として図８参照）サンプリングすることにより、サンプリングされた画像ポイント各々に対し４０の複素値を生成する。（実成分および虚成分は平面波の正弦および余弦相を指す。）ｋ一空間におけるサンプルは、インデックスｊ＝１、…、４０で指定され、１つの画像ポイントを中心とするすべてのウェーブレット成分は、図６に示すジェット６０と呼ばれるベクトルとみなされる。各ジェットは、ｘ→を囲む領域の局所的な特徴を記述する。サンプリングの際の密度が十分であれば、画像を、サンプリングされた周波数によりカバーされる帯域内のジェットから再構成できる。このように、あるジェットの各成分は、画像のポイント（ｘ、ｙ）で抽出されたガボールウェーブレットのフィルタ応答である。

【0019】

図６に示す６２で示した画像グラフを用いて物体の外観を記述する（このコンテクストでは顔）。この番号で示されたグラフのノード６４は、物体上のポイントを指し、ジェット６０として示される。グラフのエッジ６６は、ノード間の距離ベクトルで示される。ノードおよびエッジはグラフトポロジーを定める。トポロジーが等しいグラフを比較することができる。２つのジェットの絶対成分の正規化ドット積が、ジェット類似度を定める。この値はコンラストの変化と無関係である。２つのグラフ間の類似度を計算するために、グラフ間の対応するジェットの類似度に対して和を取り入れる。

【0020】

画像において人間の顔を発見するために具体的に指定されるモデルグラフ６８を図７に示す。グラフにおいて数字がつけられたノードは以下のロケーションを有する。

【0021】

０　右の瞳
１　左の瞳
２　鼻の上端
３　右眉の右隅
４　右眉の左隅
５　左眉の右隅
６　左眉の左隅
７　右の鼻孔
８　鼻尖
９　左の鼻孔
１０　口の右隅
１１　上唇の中心
１２　口の左隅
１３　下唇の中心
１４　右耳の下部
１５　右耳の上部
１６　左耳の上部

Microsoft Exhibit 1002 - Page 1154
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

１７　左耳の下部
顔を表わすために、バンチグラフ７０（図６）と呼ばれるデータ構造を用いる。これは上記のグラフと似ているが、各ノードに対しジェットを１つだけ設ける代わりに、ジェットのバンチ（束）全体７２（バンチジェット）を各ノードに設ける。各ジェットは異なる顔の画像から得られる。バンチグラフを形成するために、顔の画像のコレクション（バンチグラフギャラリー）を、顔の規定された位置のノードロケーションでマークする。この規定された位置はランドマークと呼ばれる。バンチグラフと画像とのマッチングの際、画像から抽出されたジェットを、バンチグラフに添付された対応するバンチにおけるすべてのジェットと比較し、最もよくマッチングしているもの１つを選択する。このマッチングプロセスは、弾性バンチグラフマッチングと呼ばれる。バンチグラフは、慎重に選択したギャラリーを用いて構成されると、局所的性質が大きく異なる多岐にわたる顔、たとえば、男性および女性の顔のサンプルならびに年齢または人種の異なる人々のサンプルをカバーする。

【0022】
再び、画像における顔を発見するために、グラフが最もよくマッチングしている場所が見つかるまで、グラフを移動させ、スケーリングし、歪ませる（バンチジェット内で最も適合するジェットは、ノードの現在の位置で画像から抽出されたジェットに最も類似する）。顔の特徴は顔ごとに異なるため、グラフはこのタスクに対してより一般的に作成される。たとえば、各ノードには、１０から１００の個々の顔から取り入れた、対応するランドマークのジェットが割当てられる。

【0023】
異なるまたは相補的でさえある２つのタスクに対して異なる２つのジェット類似度関数が用いられる。ジェットJ一の成分が振幅および位相ϕ_jを用いた形式で書かれる場合、２つのジェットJ→およびJ′一の類似度に対する一方の形式は、以下のような、振幅ベクトルの正規化されたスカラ積である。

【0024】
【数3】

$$S(\vec{J},\vec{J}') = \frac{\sum a_j a'_j}{\sqrt{\sum a_j^2 \sum a'^2_j}} \qquad (4)$$

他方の類似度関数は以下の形式である。

$$S(\vec{J},\vec{J}') = \frac{\sum a_j a'_j \cos(\phi_j - \phi'_j - \vec{d}\vec{k}_j)}{\sqrt{\sum a_j^2 \sum a'^2_j}} \qquad (5)$$

【0025】
この関数は、２つのジェットが指す画像ポイント間の相対移動ベクトルを含む。グラフマッチング中に２つのジェットを比較するとき、これらの類似度をdに関して最大化し、ジェット位置の正確な判断を行なう。双方の類似度関数を用いるが、最初にグラフのマッチングを行なうときには位相の影響を受けない方（これは相対的位置とともに滑らかに変化する）が好まれることが多く、ジェットを正確に位置決めするときには位相の影響を受ける方が好まれることが多い。

【0026】
顔の特徴の位置を発見した後、顔の特徴を、図９に示すように連続フレームにわたって追跡する。本発明の追跡技術により、ある特徴またはノードの追跡に失敗したかどうかを検出しそのノードに対する追跡プロセスを再初期化する追跡修正方法を用いることによって、長いフレームシーケンスにわたって強力な追跡を行なうことができる。

【0027】

Microsoft Exhibit 1002 - Page 1155
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

画像シーケンスの画像Ｉ＿ｎにおける１つのノードの位置Ｘ＿ｎは、上記のランドマーク発見方法（ブロック８０）を用いて画像Ｉ＿ｎでランドマークを発見する、または、追跡プロセスを用いて画像Ｉ＿（ｎ－１）からＩ＿ｎへとノードを追跡することによりわかる。次にこのノードを、いくつかの技術のうち１つによって、画像Ｉ＿（ｎ＋１）における対応する位置Ｘ＿（ｎ＋１）まで追跡する（ブロック８２）。以下で説明する追跡法により、有利に高速な動きに対処することができる。

【0028】

第１の追跡技術は線形動き予測を含む。新規の画像Ｉ＿（ｎ＋１）における対応するノード位置Ｘ＿（ｎ＋１）に対する探索は、動き予測子により発生した位置で開始される。速度が一定であると仮定して、先行する２つのフレーム間でのノードの変位を表わすディスパリティベクトル（Ｘ＿ｎ－Ｘ＿（ｎ－１））を計算する。ディスパリティまたは変位ベクトルＤ＿ｎを位置Ｘ＿ｎに加算して、ノード位置Ｘ＿（ｎ＋１）を予測することができる。この線形動きモデルは、一定速度の動きに対処するのに特に好都合である。線形動きモデルはまた、追跡されている物体の加速度と比較してフレームレートが高い場合に優れた追跡をもたらす。しかしながら、フレームレートが画像シーケンスにおける物体の加速度と比較して低すぎれば、線形動きモデルの性能は低い。動きモデルがこういった条件下で物体を追跡するのは困難であるため、フレームレートのより高いカメラを用いることが推奨される。

【0029】

線形動きモデルが発生する推定動きベクトルＤ＿ｎが大きすぎると、動き予測における誤差の累積につながり得る。したがって、線形予測を減衰定数ｆ＿Ｄを用いて減衰することができる。結果として得られる、予測された動きベクトルは、Ｄ＿ｎ＝ｆ＿Ｄ＊（Ｘ＿ｎ－Ｘ＿（ｎ－１））である。適切な減衰定数は０．９である。先行するフレームＩ＿（ｎ－１）がない場合、たとえば、ランドマーク発見直後のフレームに対し、予測される動きベクトルは０と等しくなるように設定される（Ｄ＿ｎ＝０）。

【0030】

１次元に適用される、ガウス画像ピラミッドに基づく追跡技術は図１０に示される。当初の画像解像度を用いる代わりに、画像を２から４倍にダウンサンプリングして画像のガウスピラミッドを作成する。４レベルの画像ピラミッドは、結果として、最も粗いレベルにおいて３画素のみとして表わされている最も精細な当初の解像度レベルに対し２４画素の距離をもたらす。ピラミッドのいずれかのレベルでジェットを計算および比較することができる。

【0031】

一般的に、ガウス画像ピラミッドにおけるノードの追跡は、最初に最も粗いレベルで行ない次に最も精細なレベルに移る。ジェットは、上記のように減衰された線形動き予測Ｘ＿（ｎ＋１）＝（Ｘ＿ｎ＋Ｄ＿ｎ）を用いて、位置Ｘ＿（ｎ＋１）の実際の画像フレームＩ＿（ｎ＋１）の最も粗いガウスレベルで抽出され、先行する画像フレームの最も粗いガウスレベルで計算した対応するジェットと比較される。これらの２つのジェットから、ディスパリティを求める、すなわちＸ＿（ｎ＋１）から、先行するフレームからのジェットに最もよく対応する位置までを指し示す２次元ベクトルを求める。この新しい位置がＸ＿（ｎ＋１）に割当てられる。このディスパリティ計算については、以下でさらに詳細に説明する。最も粗いガウスレベルの位置Ｘ＿（ｎ＋１）に対応する、実際の画像（２＊Ｘ＿（ｎ＋１）である）の次に精細なガウスレベルの位置が、この次に精細なレベルのディスパリティ計算についての開始点である。この点で抽出されたジェットは、先行する画像フレームの同じガウスレベルについて計算された対応するジェットと比較される。このプロセスは、最も精細な解像度レベルに達するまで、または、先行する画像の位置に対応するノードの位置を求めるのに特定されたガウスレベルに達するまで、すべてのガウスレベルに対して繰返される。

【0032】

ガウス画像ピラミッドの代表的な２つのレベルが図１０に示されており、粗い方のレベ

Microsoft Exhibit 1002 - Page 1156
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

ル９４は上であり、精細な方のレベル９６は下である。各ジェットは２つの周波数レベルに対するフィルタ応答を有すると仮定される。粗い方のガウスレベルの位置Ｘ＿（ｎ＋１）＝Ｘ＿ｎ＋Ｄ＿ｎで始めて、最低周波数ジェット係数のみを用いた第１のディスパリティ移動により位置２に至る。双方の周波数レベルのすべてのジェット係数を用いた第２のディスパリティ移動により位置３に至り、これはこのガウスレベルの最終位置である。精細な方のガウスレベルの位置１は、座標が２倍の粗い方のレベルの位置３に対応する。ディスパリティ移動シーケンスは繰返され、最も精細なガウスレベルの位置３が、追跡されたランドマークの最終位置である。追跡をより正確にするために、ガウスおよび周波数レベルの数を増やしてもよい。

【0033】

実際の画像フレームにおいて追跡されたノードの新規の位置を求めた後、すべのガウスレベルにおけるジェットをこの位置で計算する。追跡されたノードを表わす、先行するフレームに対して計算されたジェットの記憶されたアレイを、現在のフレームに対して計算されたジェットの新規のアレイと置き換える。

【0034】

ガウス画像ピラミッドを用いることには２つの主要な利点がある。第１に、粗い方のレベルにおける画素に関しノードの移動が当初の画像におけるものよりも遥かに小さく、これによって、大きな画像領域において徹底的に探索を行なう代わりに局所的な移動のみを行なうことによって追跡が可能になる。第２に、ジェット成分の計算が低周波数に対して非常に速い。なぜなら、この計算は、当初の解像度の画像の大きなカーネルウィンドウに対してではなく、ダウンサンプリングされた画像の小さなカーネルウィンドウを用いて行なわれるからである。

【0035】

なお、対応レベルは動的に選択してもよい。たとえば、顔の特徴の追跡の場合、対応レベルを顔の実際の大きさに依存して選択してもよい。ガウス画像ピラミッドの大きさも、追跡プロセスを通して変更できる。すなわち、この大きさを動きが速くなったときに大きくし動きが遅くなったときに小さくできる。典型的には、最も粗いガウスレベルの最大ノード移動は４画素に制限される。なお、動き予測は最も粗いレベルで行なわれることが多い。

【0036】

同じガウスレベルの所与の２つのジェット間の移動ベクトル（ディスパリティベクトル）の計算について次に説明する。連続する２つのフレーム間の変位を計算するために用いるある方法は、本来、D. J. FleetおよびA. D. Jepson, Computation of component image velocity from local phase information, International Journal of Computer Vision, volume 5, issue 1, pages 77-104, 1990、ならびに、W. M. TheimerおよびH. A. Mallot, Phase-based binocular vergence control and depth reconstruction using active vision, CVGIP: Image Understanding, volume 60, issue 3, pages 343-358, November 1994に基づき、ステレオ画像におけるディスパリティ推定に対して開発されたものである。

【0037】

複合フィルタ応答の位相の強い変化を用いてサブピクセル精度で変位を明確に計算する（Wiskott, L., "Labeled Graphs and Dynamic Link Matching for Face Recognition and Scene Analysis", Verlag Harri Deutsch, Thun-Frankfurt
am Main, Reihe Physik 53 (PhD thesis, 1995)）、振幅a_jおよび位相jに関しj番目のガボールフィルタへの応答Ｊを書くことにより、類似度関数を以下のように定めることができる。

【0038】

【数4】

Microsoft Exhibit 1002 - Page 1157
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

$$S(J, J', d) = \frac{\sum_j a_j a'_j \cos(\phi_j - \phi_{j'} - d \cdot k_j)}{\sqrt{\sum_j a_j^2 \sum_{j'} a'^2_{j'}}} \qquad (6)$$

【0039】
ＪおよびＪ′を位置ＸおよびＸ′＝Ｘ＋ｄの２つのジェットとすると、変位ｄは、ｄに関する類似度Ｓを最大化することによって発見でき、k_jはJ_jを発生するフィルタと関連する波数ベクトルである。ｄの推定は、小さな変位、すなわちガボールジェットの大きな重なりのみに対して正確であるため、大きな移動ベクトルは第１の推定のみとして扱われ、このプロセスは以下の態様で繰返される。最初に、最も周波数レベルの低いフィルタ応答のみを用いて第１の推定ｄ＿１が生まれる。次に、この推定を実行し、ジェットＪをジェットＪ′の位置Ｘ′により近い位置Ｘ＿１＝Ｘ＋ｄ＿１で再計算する。次に、２つの最も低い周波数レベルを変位ｄ＿２の推定のために用い、ジェットＪを位置Ｘ＿２＝Ｘ＿１＋ｄ＿２で再計算する。これは、用いた最大周波数レベルに達するまで反復され、２つの開始ジェットＪおよびＪ′間の最終ディスパリティｄが、ｄ＝ｄ＿１＋ｄ＿２＋…として与えられる。このようにして、最低周波数のカーネルの波長の半分まで変位を計算することができる（先のWiskott、1995参照）。
【0040】
変位は浮動小数点数を用いて求めているが、ジェットを（整数）画素位置のみで抽出してもよい（すなわち畳込みによって計算してもよい）。その結果、システム的な丸め誤差が生まれる。このサブピクセル誤差Δｄを補償するために、複合ガボールフィルタ応答の位相を以下に従いシフトする必要がある。
【0041】
【数5】

$$\Delta\phi_j = \Delta d \cdot k_j \qquad (7)$$

【0042】
こうすれば、ジェットは、あたかも正しいサブピクセル位置で抽出されたかのように見えるであろう。このように、ガボールジェットを、さらなる丸め誤差を考慮せずに、サブピクセル精度で追跡できる。なお、ガボールジェットは画像処理において実質的な利点をもたらす。その理由は、サブピクセル精度の問題は他のほとんどの画像処理方法において対処がより困難なためである。
【0043】
追跡誤差は、信頼度または類似度の値が予め定められたしきい値よりも小さいかどうかを判断することによって検出できる（図９のブロック８４）。類似度（または信頼度）の値Ｓを計算して、２つの画像フレームにおける２つの画像領域がいかにうまく対応しているかを、連続する画像フレーム間のノードの変位の計算と同時に、示すことができる。典型的には、信頼度の値が１に近いことは、対応度の高いことを示す。信頼度の値が１に近くなければ、画像において対応するポイントが発見されていないか（たとえばフレームレートが動いている物体の速度と比較して低すぎるため）、または、この画像領域があるフレームから次のフレームへとあまりにも大幅に変化しているため対応性をうまく定めることができないかである（たとえば瞼を追跡するノードに対し瞼が閉じられる）。信頼度の値があるしきい値よりも低いノードはスイッチオフされる。
【0044】
何らかの幾何学的制約が侵害されたときにも追跡誤差が検出される（ブロック８６）。同時に多くのノードが追跡される場合、ノードの幾何学的構成が一致しているかどうかについて検査される。このような幾何学的制約はかなり緩やかでよい。たとえば、顔の特徴

Microsoft Exhibit 1002 - Page 1158
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

を追跡するとき鼻は目と口との間になければならないといったことである。代わりに、こういった幾何学的制約はかなり厳しいものでもよい。たとえば、追跡される顔の正確な形状情報を含むモデルといったものである。この中間の精度に対しては、制約は平面モデルに基づくものである。平面モデルでは、顔グラフのノードは平面にあると仮定される。正面図で始まる画像シーケンスについては、追跡されるノード位置を、アフィン変換により実際のフレームに変換される正面グラフの対応するノード位置と比較することができる。最適アフィン変換の６つのパラメータが、ノード位置における最小二乗誤差を最小にすることによって発見される。追跡されたノード位置と変換されたノード位置との間のずれがしきい値と比較される。しきい値よりもずれの大きいノードはスイッチオフされる。アフィン変換のパラメータを用いて、姿勢および相対的なスケール（開始グラフと比較したもの）を同時に求めることができる（ブロック８８）。このように、この大まかな平面モデルによって、追跡誤差が予め定められたしきい値よりも大きくなることが確実になくなる。

【0045】

追跡されたノードが追跡誤差のためにスイッチオフされた場合、ノードを、異なる姿勢を含むバンチグラフを有利に用いて正しい位置で再び活性化し（ブロック９０）、修正された位置から追跡を続行することができる（ブロック９２）。追跡されたノードがスイッチオフされた後、システムは、姿勢に固有のバンチグラフが存在する予め規定された姿勢に達するまで待ってもよい。それ以外の場合は、正面のバンチグラフのみが記憶されているならば、システムは、正面の姿勢に達するまで待って追跡誤差を修正しなければならない。記憶されたジェットのバンチを適合位置を囲む画像領域と比較してもよい（たとえば平面モデルからのもの）。これは追跡と同じ態様で作用するが、異なる点は、先行する画像フレームのジェットとの比較の代わりに、比較は例のバンチのジェットすべてについて繰返され最も似ているものが取込まれることである。顔の特徴はわかっているので、たとえば、実際の姿勢、スケールおよび大まかな位置までもわかっているので、グラフマッチングまたは画像における徹底的な探索および／または姿勢空間は不要であり、ノード追跡修正をリアルタイムで行なうことができる。

【0046】

追跡訂正のために、多くの異なる姿勢およびスケールに対するバンチグラフは不要である。なぜなら、画像面における回転およびスケールは、局所的画像領域またはバンチグラフのジェットの変換を図１１に示すように行なうことにより、考慮されているからである。正面の姿勢に加え、深さにおける回転に対してのみバンチグラフを作成する必要がある。

【0047】

再初期化プロセスの速度を、画像シーケンス中は追跡される人物のアイデンティティが同じであるという事実を利用して、高めることができる。したがって、最初の学習セッションでは、人物の最初のシーケンスに、正面の顔の表情の全レパートリーを表わしている人物を与える。この最初のシーケンスを、異なる多くの人物に関する知識を含む大きな一般化されたバンチグラフに基づき上述の追跡および訂正方法を用いて、精度高く追跡することができる。このプロセスをオフラインで行ない、個人別にされた新たなバンチグラフを生成することができる。次に、個人別にされたバンチグラフを用いて、この人物をリアルタイムで高速レートで追跡できる。なぜならば、個人別にされたバンチグラフは一般化された大きなバンチグラフよりも遥かに小さいからである。

【0048】

再初期化プロセスの速度を、部分バンチグラフ再初期化を利用して高めることもできる。部分バンチグラフは、全バンチグラフのノードのサブセットのみを含む。このサブセットの大きさは１つのノードぐらいでしかない。

【0049】

姿勢推定バンチグラフは、画像面において定められる２次元バンチグラフの一族を利用する。１つの族内の異なるグラフは、顔の、異なる姿勢および／またはスケールを説明す

Microsoft Exhibit 1002 - Page 1159
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

る。ランドマーク発見プロセスは、画像における頭の姿勢または大きさを求めるために、その族からの各バンチグラフを入力画像とマッチングさせようとする。こうした姿勢推定手順の一例が図１２に示される。この姿勢推定の第１ステップは、通常のランドマーク発見のものと等しい。画像（ブロック９８）は、グラフ類似度関数を用いるために、変換される（ブロック１００および１０２）。次に、１つだけではなく、３つのバンチグラフの族を用いる。第１のバンチグラフは正面の姿勢の顔のみを含み（上記の正面図と等しい）、他の２つのバンチグラフは４分の１だけ回転させた顔を含む（一方が左への回転を表わし、他方が右への回転を表わす）。先のように、グラフ各々に対する初期位置は左上隅にあり、グラフの位置は画像においてスキャンされ、ランドマーク発見後最も高い類似度を戻す位置およびグラフが選択される（ブロック１０４－１１４）。

【0050】

各グラフに対する最初のマッチングの後、最終位置の類似度が比較される（ブロック１１６）。画像において与えられた姿勢に最もよく対応しているグラフは類似度が最も高い。図１２において、左に回転させたグラフは、類似度によって示されるように最もよく適合している（ブロック１１８）。像における顔の解像度および回転の角度に応じて、正しいグラフおよび他の姿勢に対するグラフの類似度は、変化し、グラフを規定した２つの姿勢間のおよそ中間に顔があるときに、非常に近くなる。より多くの姿勢に対してバンチグラフを作成することにより、姿勢推定手順がより精細になり、これにより、他の方向（たとえば上または下）への頭の回転およびハンドル回転のより多くの角度が識別される。

【0051】

カメラから任意の距離にある顔を確実に発見するために、同様の方策を用いて、各々がスケールの異なる２または３の異なるバンチグラフを用いてもよい。画像における顔は、最高のものを顔の画像に戻すバンチグラフと同じスケールを有すると仮定される。

【0052】

上記の技術に関連する３次元（３Ｄ）ランドマーク発見技術を用いて、異なる姿勢に適合させた複数のバンチグラフを用いることもできる。しかしながら、この３次元方策は３次元空間で規定されるバンチグラフ１つのみを用いる。３次元グラフのジオメトリは、平均的な顔または頭のジオメトリを反映する。回転度数の異なる数人の人物の顔の画像からジェットを抽出することにより、３次元バンチグラフを作成する。これは、２次元方策と似ている。次に各ジェットを３つの回転角度でパラメータ化する。２次元方策のように、ノードは顔の画の基準点に位置する。次に、３次元グラフの突起をマッチングプロセスで用いる。３次元方策におけるある重要な一般化は、各ノードに、異なる姿勢に適合するバンチジェットのパラメータ化された族を設けることである。第２の一般化は、グラフが画像面での変換のみではなく３次元空間でユークリッド変換されることである。

【0053】

グラフマッチングプロセスは、粗から精への方策として定めることができる。ここでは初めにノードおよびカーネルの少ないグラフを用い、次に後続のステップではより密度の高いグラフを利用する。粗から精への方策は、顔のある領域における特徴ポイントの高精度の局所化が所望される場合に特に適している。このように、階層的方策を採用することによって、計算上の手間を省く。ここでは、最初に粗い解像度についてランドマーク発見を行ない、次に、適合したグラフをより高い解像度で検査して、ある領域をより精細に解析する。

【0054】

さらに、計算上の作業負荷を、マルチプロセッサマシンで簡単に分割できる。こうすれば一旦粗い領域が発見されると、少数の子プロセスが並列に、各々が画像全体のうちそれ自身の部分に対して作業を開始する。子プロセスの最後に、これらプロセスはそれらが位置する特徴座標をマスタプロセスに送り、マスタプロセスは適切にこれらをスケーリングおよび組合せて当初の画像に適合するようにし、こうして計算の総時間が大幅に短縮する。

【0055】

Microsoft Exhibit 1002 - Page 1160
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

図１３に示すように、ノードに対応する顔の特徴を分類して、たとえば瞬きや口の開きといった不適切な追跡誤差の表示に対応することができる。顔の特徴に対応する、バンチグラフにおける異なるジェットに、たとえば目が開いている／閉じている、口が開いている／閉じているなどの、ラベルを添付する。このラベルを、現在の画像と比較して最も類似している、バンチグラフにおける対応するジェットとともに、コピーする。追跡誤差が検出されたかどうかにかかわらず、ラベル追跡を連続してモニタする。このようにして、以下について、分類ノードが追跡されたノードに添付される。

【0056】

目が開いている／閉じている。

口が開いている／閉じている。

【0057】

舌が見えているまたは見えていない。

紙の種類の分類。

【0058】

鍵の検出（たとえば額の鍵）。

このように、追跡により２つの情報源を利用できる。一方の情報源は特徴の場所すなわちノード位置に基づき、他方の情報源は特徴分類に基づく。特徴分類情報は、テクスチャに一層基づいており、局所的画像領域を１組の記憶された例と比較することにより、ノード位置のみに基づく特徴分類情報よりも、低い解像度および追跡精度で機能し得る。

【0059】

本発明の顔検知は、図１４に示すように、静的および動的な、人間の姿を与えたものの、作成および動画化に適用できる。この人間の姿を与えたものは、一般的な顔のモデルに基づく、または、ある人物に固有の顔のモデルに基づく。追跡および顔の表情の認識を利用して、その人物の特徴を有するようにこの人間の姿を与えたものを具体化できる。

【0060】

一般的な顔のモデルを、代表的な数の個人に適合させ、写実的な動画化を行ない、広範囲にまたがる顔の特徴および／または表情を与えることができる。一般的なモデルは以下の技術によって得ることができる。

【0061】

１．モノカメラシステムを用いて（T. Akimoto他、１９９３）、低価格のテレイマージョンシステムにおいて用いるために、実物に似た、人間の姿を与えたものを作成する。サジタル平面および頭頂面から見た、個人の横顔情報を併合して、人間の姿を与えたものを得る。

【0062】

２．ステレオカメラシステムは、カメラを十分に校正した場合（カメラパラメータは校正プロセスを通して計算される）、正確な３次元測定を行なうことができる。次に、個々の顔のモデルは、一般的な顔のモデルを、得られた３次元データに適合させることによって得ることができる。ステレオアルゴリズムは非テクスチャ領域に対する正確な情報を与えないので、活性テクスチャ光の投射を利用する。

【0063】

３．個々の顔に対してマーカを用いる、特徴に基づくステレオ技術によって、マーカの正確な３次元位置を計算する。次に３次元情報を用いて一般的なモデルに適合させる。

【0064】

４．センサまたは位置発見装置が、測定される各平面の点に対して動かされる、３次元デジタイザ。

【0065】

５．パターンが投影され、結果として得られるビデオストリームを処理して３次元測定値を抽出するアクティブ構成光。

【0066】

６．正確な顔測定値をもたらす、レーザに基づいた表面スキャン装置（Cyberware, Inc

Microsoft Exhibit 1002 - Page 1161
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

が開発するもののようなもの）。

【0067】

７．以前の技術の組合せ

こうした異なる技術はユーザにとって等しく好都合ではない。１回のプロセスで個人の測定値を得ることができるものもあれば（顔は測定期間中所望の姿勢をとっている）。一方で、サンプルの収集が必要であり使用するのに面倒なものもある。

【0068】

特定の人物に対する一般的な３次元頭モデルを、正面および側面を示す２つの顔の画像を用いて生成できる。顔の検知により、３次元頭モデルを効率的かつ強力に生成できる。

【0069】

顔の輪郭の抽出は、人物の目、鼻、口および頬の局所化とともに行なわれる。図１４に示すように、この特徴局所情報は、弾性バンチグラフ技術を階層的マッチングとともに用いて、自動的に顔の特徴を抽出することにより得ることができる。次に、特徴場所情報を組合せ（T. AkimotoおよびY. Suenaga, Automatic Creation of 3D Facial Models, IEEE Computer Graphics & Applications, Pages 16-22, September 1993参照）、人物の頭の３次元モデルを生成する。一般的な３次元頭モデルを適合させて、そのプロポーションが画像の測定値と関連するようにする。最後に、側面および正面の画像を組合せ、人間の姿を与えたものに対しよりよいテクスチャモデルを得る、すなわち、正面図を用いてモデルの正面をテクスチャマッピングし、側面図をモデルの側面に対して用いる。顔の検知によりこの技術が向上する。なぜなら抽出された特徴をラベルづけし（既知のポイントは横顔において定められる）、２つの画像が同時に取込まれないようにするからである。

【0070】

人間の姿を与えたものの画像は、以下の一般的な技術によって動画化できる（F.I.ParkeおよびK.Waters, Computer Facial Animation, A K Peters, Ltd., Wellesley, Massachusetts, 1996）。

【0071】

１．キーフレーミングおよび幾何内挿。多数の重要な姿勢および表情を規定する。次に幾何内挿をキーフレーム間で用いて動画化を行なう。このようなシステムは、性能に基づく（または性能により駆動される）モデルと呼ばれることが多い。

【0072】

２．直接パラメータ化。これは表情および姿勢を１組のパラメータに直接マッピングし次にこれを用いてモデルを駆動する。

【0073】

３．幾何学的変形を用いて筋肉動作をシミュレートする擬似筋肉モデル。

４．筋肉および皮膚を物理的モデルを用いてモデル化する、筋肉に基づくモデル。

【0074】

５．２次元および３次元モーフィング。これは、ビデオストリームにおける画像間で２次元モーフィングを用い、２次元動画を生成する。１組のランドマークを識別しこれを用いてシーケンスの２つの画像間のワープを行なう。このような技術は３次元に拡張できる（F.F.Pighin, J.Hecker, D.Lischinski, R.Szeliski,D.H.Salesin, Synthesizing Realistic Facial Expression from Photographs, SIGGRAPH 98 Conference Proceedings, pages 75-84, July 1998参照）。

【0075】

６．制御ポイントおよび有限要素モデルといった他の方策。

これらの技術に対し、顔検知は、顔の特徴の自動抽出および特徴化によって、動画化プロセスを向上させる。抽出された特徴を用いて、キーフレーミングおよび内挿モデルの場合は表情を内挿し、または、直接パラメータ化モデルまたは擬似筋肉または筋肉モデルの場合はパラメータを選択できる。２次元および３次元モーフィングの場合は、顔検知を用いて、自動的に顔の特徴を選択し、幾何学的変換を行なうのに適切な情報を与える。

【0076】

Microsoft Exhibit 1002 - Page 1162
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

顔の特徴の追跡および分類を利用した、人間の姿を与えたものの動画化の例は、図１５に関連付けて示される。訓練相の間、個人は、一連の予め定められた顔の表情をするようにされる（ブロック１２０）。検知を用いて特徴を追跡する（ブロック１２２）。予め定められた場所で、ジェットおよび画像パッチを種々の表情に対して抽出する（ブロック１２４）。顔の特徴を囲む画像パッチは、これらの特徴から抽出したジェット１２６とともに集められる。これらのジェットを後で用いて、顔の特徴１２８を分類またはタグづけする。これは、これらのジェットを用いて、個人別のバンチグラフを生成し、上記のような分類法を適用することによって、行なわれる。

【0077】

図１６に示すように、人間の姿を与えたものを動画化するために、このシステムは、すべての画像パッチ１２８とともに、顔全体１３０（「顔フレーム」）の画像から画像パッチにおいて示された部分をマイナスしたものを、遠隔場所に送る（ブロック１３２および１３４）。動画化エンジンのためのソフトウェアも送る必要がある。次に、検知システムは、ユーザの顔を観察して、顔の検知を適用してどの画像パッチが現在の顔の表情に最も似ているかを判断する（ブロック１３６および１３８）。画像タグは遠隔場所に送られ（ブロック１４０）、動画化エンジンが正しい画像パッチを用いて顔１４２を組立てることができるようにする。

【0078】

画像パッチをスムーズに画像フレームに適合させるために、ガウスぼかしを用いることができる。写実的にするためには、局所画像モーフィングが必要である。なぜなら、動画は、画像の連続が検知によって与えられた通りに現れるという意味において、不連続かもしれないからである。モーフィングは、画像空間において対応するポイントの線形内挿を用いて実現される。中間画像を作成するために、以下の等式を用いて線形内挿を適用する。

【0079】

$$P_i = (2-i)P_1 + (i-1)P_2 \qquad (7)$$

$$I_i = (2-i)I_1 + (i-1)I_2 \qquad (8)$$

式中、P_1およびP_2は画像I_1およびI_2において対応するポイントであり、I_iはｉ番目に内挿された画像で、$1 \leq i \leq 2$である。なお、プロセス効率のために、画像内挿を、予め計算したP_iおよびI_iに対するハッシュ表を用いて実現できる。用いるポイントの数および精度、それらの正確度、ならびに内挿された顔のモデルが、一般的に、結果として得られる画像の品質を決定する。

【0080】

このように、遠隔ディスプレイにおいて再構成された顔は、学習ステップにおいて検出された表情に対応する画像の部分を集めることによって作成できる。したがって、こうして人間の姿を与えたものは、動画化を命令する人物に対応する特徴を示している。したがって、初期化時、１組のクロッピングされた画像は、追跡された顔の各特徴、および、結果として得られる、各特徴が除去された後の画像としての「顔コンテナ」に対応する。動画化が開始され、前述のように、顔の検知を用いて、送られる特定のタグを生成する。送られたタグと関連する画像部分を選択することによりデコードが生じる。たとえば、「笑っている口」というタグ１４６（図１６）でラベルづけられた口の画像である。

【0081】

上記のような動的テクスチャ生成を、図１７に示すようなボリュームモーフィングの従来技術と統合した場合に、より進んだレベルで、人間の姿を与えたものを動画化できる。ボリュームモーフィングを行なうために、ノード位置のロケーションを用いてメッシュ１５０の制御ポイントを駆動する。次に、タグを用いて動的に生成されたテクスチャ１５２をメッシュにマッピングし、実物に似た顔の画像１５４を生成する。検知されたノード位置をメッシュの制御ポイントのドライバとして用いる代わりに、タグを用いて局所的モーフィングターゲットを選択する。モーフィングターゲットは、サンプルジェットを収集した対象の、顔の異なる表情およびジェスチャに対して求められた、局所的メッシュ構成で

Microsoft Exhibit 1002 - Page 1163
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

ある。局所的メッシュジオメトリはステレオ視覚技術によって求めることができる。モーフィングターゲットの使用はさらに、以下の関連団体によって開発されている。（J.R.Kent, W.E.Carlson, R.E.Parent, Shape Transformation for Polyhedral Objects, SIGGRAPH 92 Conference Proceeding, volume 26, pages 47-54, August 1992, Pighin et al, 1998参照）。

【0082】

視覚に基づき人間の姿を与えたものを動画化することに役立つ拡張は、図１８に示すように正しい唇の動きを合成するために顔の検知を音声解析と統合することである。リップシンク技術は特に、音声の結果として現われる唇の動きを、人物の姿を与えたものにマッピングするのに役立つ。これはまた、視覚に基づく唇の追跡に失敗した場合のバックアップとしても役立つ。

【0083】

上記は本発明の好ましい実施例を開示しているが、当業者であれば本発明の範囲から逸脱することなく好ましい実施例を種々に変形できることが理解される。本発明は前掲の特許請求の範囲によってのみ規定される。

【図面の簡単な説明】

【0084】

【図1】本発明に従う、人間の姿を与えたものを動画化するシステムおよびプロセスのブロック図である。

【図2】図１の人間の姿を与えたものを動画化するシステムおよびプロセスのための、本発明に従う顔の特徴検知装置およびプロセスのブロック図である。

【図3】図２の顔の特徴検知装置を実現するためのビデオ画像プロセッサのブロック図である。

【図4】図２の顔の特徴検知装置およびシステムのランドマーク発見技術を示すためのフロー図に写真を添付したものである。

【図5】本発明に従う、ガボールウェーブレットを用いた顔の画像の処理を示す一連の画像である。

【図6】本発明に従う、図５のウェーブレット処理技術を用いた、ジェット、画像グラフおよびバンチグラフの構成を示す、一連のグラフである。

【図7】顔の画像を処理するための、本発明に従うモデルグラフの図である。

【図8】顔の特徴の場所を求めるためのウェーブレット処理の使用を示す２つの図を含む。

【図9】図４のランドマーク発見技術により発見されるランドマークを追跡するための追跡技術を示すフロー図である。

【図10】１次元でのランドマーク追跡を示すためのガウス画像ピラミッド技術の図である。

【図11】２つの顔の一連の画像に、５０の一連の画像フレームにわたる顔の特徴の追跡を示した姿勢の角度対フレーム数のグラフを添付したものである。

【図12】図２の顔の特徴検知装置およびシステムの姿勢推定技術を示すフロー図に写真を添付したものである。

【図13】粗から精へのランドマーク発見技術を示すための、顔を抽出された目および口領域とともに示す概略図である。

【図14】図６の弾性バンチグラフ技術を用いた横顔および顔の特徴の抽出を示す写真である。

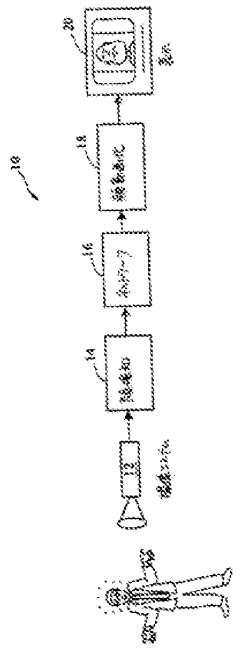
【図15】本発明に従う、タグづけされ個別化されたバンチグラフの生成を示すフロー図とともに、人間の姿を与えたものの動画化のための、人物の種々の表情を含む対応の画像パッチのギャラリーを示したものである。

【図16】遠隔場所に送られる画像パッチを用いて人間の姿を与えたものを動画化するための技術を示すフロー図であり、この画像パッチは、人物の現在の顔の表情に関連した顔の検知に基づき、送られたタグに基づいて、遠隔場所で選択される。

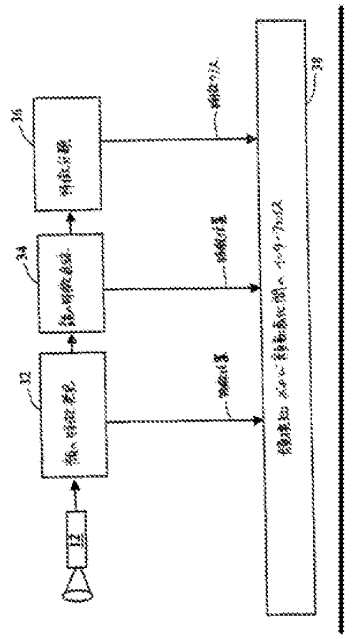
Microsoft Exhibit 1002 - Page 1164
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

【図17】顔の特徴の位置およびタグに基づき、動的テクスチャ生成と統合されたボリュームモーフィングを用いて生成された、３次元の顔の画像を与えることを示す、フロー図である。
【図18】本発明に従う、人間の姿を与えたものを動画化するシステムのブロック図であり、人間の姿を与えたものの動画化のためのオーディオ解析を含む。
【符号の説明】
【0085】
１０　分身動画化システム。

【図1】

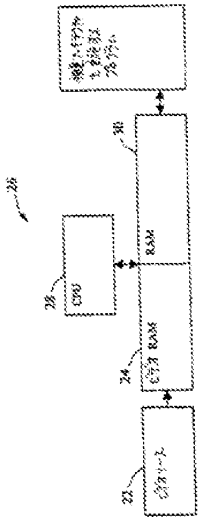


【図2】

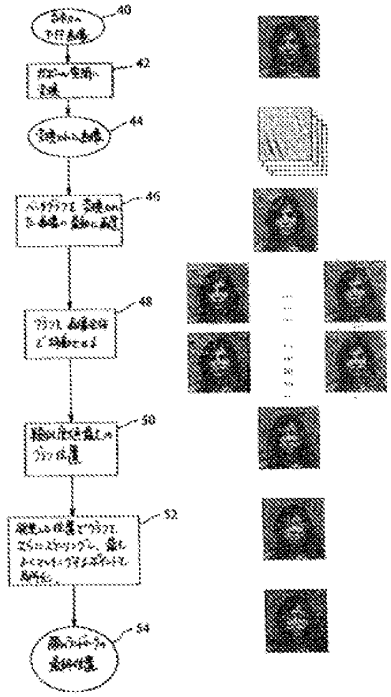


Microsoft Exhibit 1002 - Page 1165
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

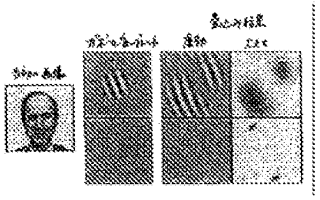
【図３】



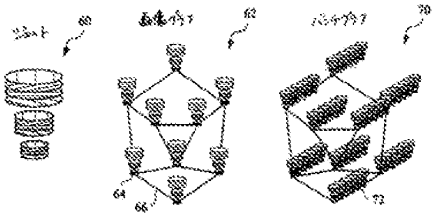
【図４】



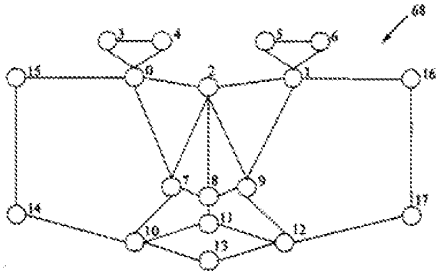
【図５】



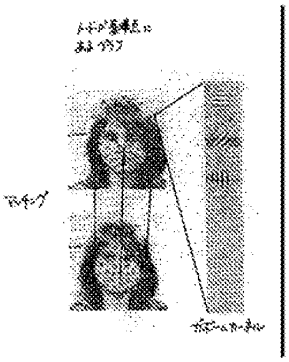
【図６】



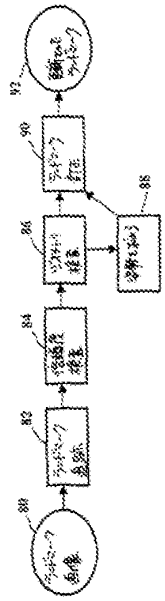
【図７】



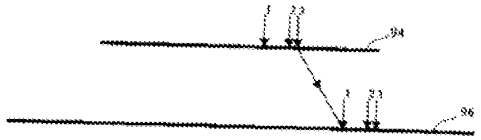
【図８】



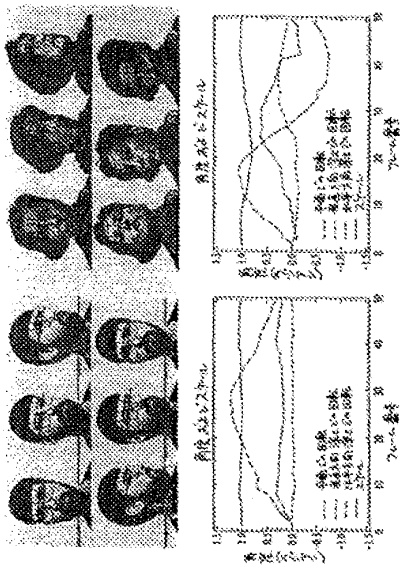
【図9】



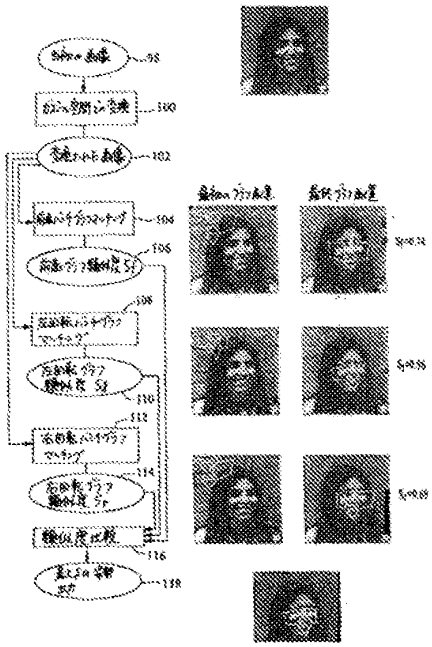
【図10】



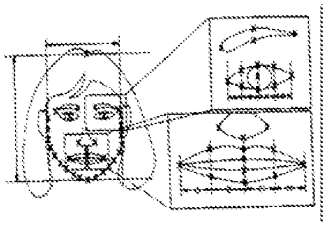
【図11】



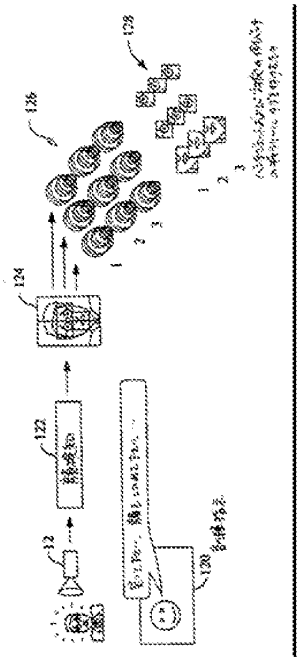
【図12】



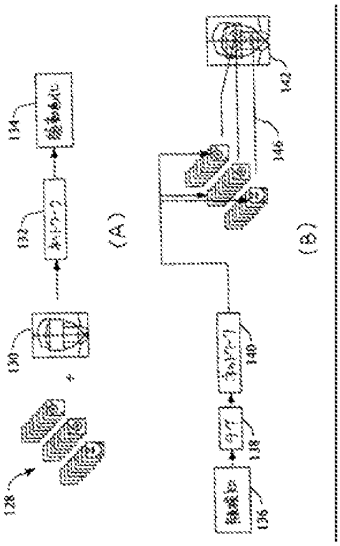
【図13】



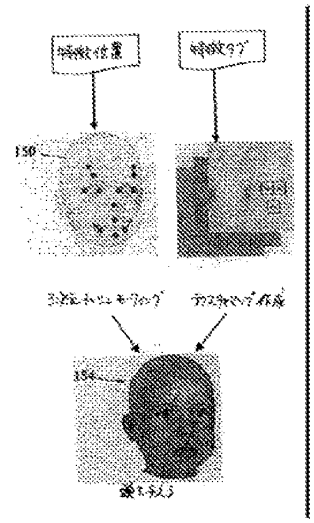
【図15】



【図16】

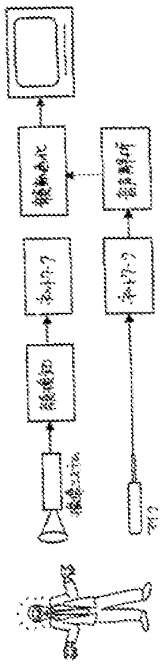


【図17】



Microsoft Exhibit 1002 - Page 1168
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

【図18】



【図14】



Microsoft Exhibit 1002 - Page 1169
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

(72)発明者　マウラー，トーマス
アメリカ合衆国、９００３４　カリフォルニア州、ロス・アンジェルス、ジャスミン・アベニュ、３６８５、ナンバー・１６
(72)発明者　エラジン，イゴー・バレリビッチ
アメリカ合衆国、９００１７　カリフォルニア州、ロス・アンジェルス、セベランス・ストリート、２６３６、ナンバー・エイ
(72)発明者　ノセラ，ルシアノ・パスクァレ・アゴスティーノ
アメリカ合衆国、９００２５　カリフォルニア州、ロス・アンジェルス、サウス・ウェストゲート・アベニュ、１２３０、ユニット・エフ
(72)発明者　ステファンズ，ヨハネス・バーナード
アメリカ合衆国、９０２３０　カリフォルニア州、カルバー・シティ、グリーン・バレー・サークル、６４２０、ナンバー・２０７
(72)発明者　ネベン，ハルトムット
アメリカ合衆国、９０４０５　カリフォルニア州、サンタ・モニカ、トゥエンティエイス・ストリート、２３３６、ナンバー・イー
Ｆターム(参考)　5B050 AA02　EA01
5L096 AA06　CA04　FA22　FA69　HA02　HA05　JA03

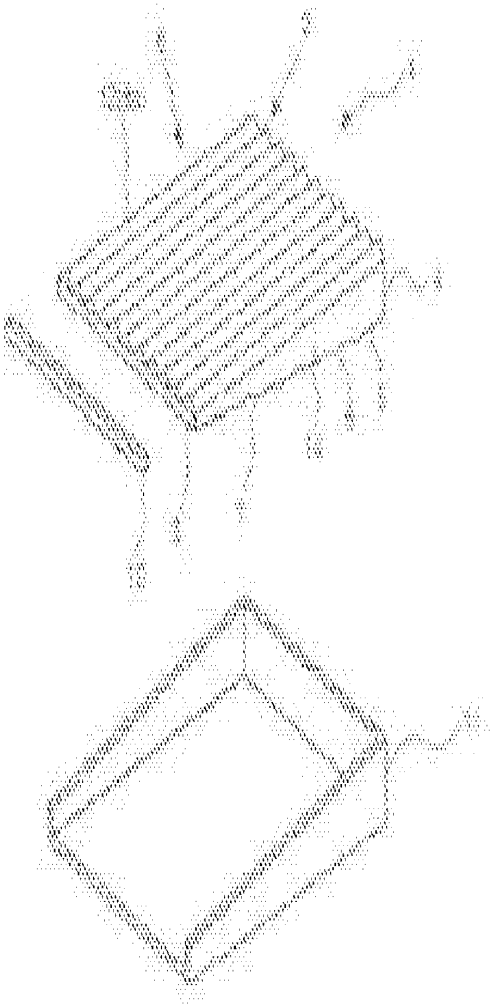
Microsoft Exhibit 1002 - Page 1170
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

Abstract of JP2007273288 (A)

Translate this text into [1]

Select language [v] [redacted]

PROBLEM TO BE SOLVED: To control occurrence of reflection of a light source, and generation of luminance spots or light emission color spots in the vicinity of an incident end surface part, and to secure a large utilized emission surface.
;SOLUTION: This light guide plate 2 is formed into an outline shape such that the thickness between the front surface part 8 and the back surface part 5 is minimized in an incident end surface part 3, and the thickness between the front surface part 8 and the back surface part 5 is maximized in a counter incident end surface part 4 so that straight-ahead light entered from the incident end surface part 3 breaks a critical angle while it is reflected by the counter incident end surface part 4 and travels from the counter incident end surface part 4 to the incident end surface part 3 without breaking the critical angle while it travels to the counter incident end surface part 4.; The back surface part 5 is formed into a stepped shape where gentle first inclined surface parts 6 directed to the counter incident end surface part 4 and steep second inclined surface parts 7 are alternately and continuously connected. The front surface part 8 is provided with light deflection parts 8a each having a projecting or/and recessed cross section, and extending in the directions of the incident end surface part 3 and the counter end surface part 4.
;COPYRIGHT: (C)2008,JPO&INPIT



(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2007-273288
(P2007-273288A)
(43)公開日　平成19年10月18日(2007.10.18)

(51)Int.Cl.		F I			テーマコード（参考）
F21V 8/00	***(2006.01)***	F21V	8/00	601B	2H038
G02B 6/00	***(2006.01)***	F21V	8/00	601A	
F21Y 101/02	*(2006.01)*	F21V	8/00	601C	
F21Y 103/00	*(2006.01)*	G02B	6/00	331	
		F21Y	101:02		

審査請求 有　請求項の数 8　OL　（全 29 頁）　最終頁に続く

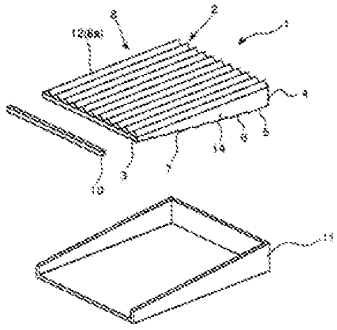
(21)出願番号　特願2006-98237(P2006-98237)
(22)出願日　平成18年3月31日(2006.3.31)

(71)出願人　391013955
日本ライツ株式会社
東京都多摩市永山六丁目２２番地６
(74)代理人　100067323
弁理士　西村　教光
(74)代理人　100124268
弁理士　鈴木　典行
(72)発明者　カランタル　カリル
東京都多摩市永山六丁目２２番地６　日本ライツ株式会社内

Ｆターム(参考)　2H038 AA55　BA06

(54)【発明の名称】導光板および平面照明装置

(57)【要約】
【課題】入射端面部近傍での光源の映り込みや輝度斑や発光色斑の発生をコントロールでき、利用出射面を大きく取る。
【解決手段】導光板２は、入射端面部３から入射された直進光が反入射端面部４に進行する間に臨界角を破らず、反入射端面部４で反射され反入射端面部４から入射端面部３に進行する間に臨界角を破るように、入射端面部３において表面部８と裏面部５との厚さが最小になり、反入射端面部４において表面部８と裏面部５との厚さが最大になるような外形形状をなし、裏面部５は反入射端面部４に向く緩やかな第１の傾斜面部６と鋭い第２の傾斜面部７とが交互に連続的に接続した階段形状をなし、表面部８には断面が凸形状または／および凹形状に入射端面部３および反入射端面部４方向に延在する光偏向部８ａを設ける。
【選択図】　図１



Microsoft Exhibit 1002 - Page 1172
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

【特許請求の範囲】
【請求項1】
光を導く入射端面部と、前記入射端面部の反対側に位置し、光を反射する反入射端面部と、当該光を出射する表面部または／および裏面部と、これら前記表面部と前記裏面部とに交わる側面部を有し、前記入射端面部から入射された直進光が前記反入射端面部に進行する間に臨界角を破らず、前記反入射端面部で反射され該反入射端面部から前記入射端面部に進行する間に臨界角を破るように、前記入射端面部において前記表面部と前記裏面部との厚さが最小になり、前記反入射端面部において前記表面部と前記裏面部との厚さが最大になるような外形形状の導光板であって、
前記裏面部は前記反入射端面部に向く緩やかな第１の傾斜面部と鋭い第２の傾斜面部とが交互に連続的に接続した階段形状をなし、前記表面部には断面が凸形状または／および凹形状に前記入射端面部および前記反入射端面部方向に延在する光偏向部を設けることを特徴とする導光板。
【請求項2】
前記光偏向部は、断面形状が円弧形状または三角形状を有するとともに傾斜面が直線または曲線または前記断面の頂部が平坦に欠切したことを特徴とする請求項１記載の導光板。
【請求項3】
前記断面は、前記反入射端面部で最大となり、前記入射端面部に近づく程小さくなることを特徴とする請求項１記載の導光板。
【請求項4】
前記第２の傾斜面部は、２つの前記側面部から同距離位置を中心とし、前記中心が前記入射端面部方向に近い円弧状になすことを特徴とする導光板。
【請求項5】
前記反入射端面部は、２つの前記側面部から同距離位置の中心位置が膨らんだ円弧形状であることを特徴とする導光板。
【請求項6】
光を導く入射端面部と、前記入射端面部の反対側に位置し、光を反射する反入射端面部と、当該光を出射する表面部と、前記表面部の反対側に位置する裏面部と、これら前記表面部と前記裏面部とに交わる側面部を有し、前記入射端面部から入射された直進光が前記反入射端面部に進行する間に臨界角を破らず、前記反入射端面部で反射され前記反入射端面部から前記入射端面部に進行する間に臨界角を破るように、前記入射端面部において前記表面部と前記裏面部との厚さが最小になり、前記反入射端面部において前記表面部と前記裏面部との厚さが最大になるような外形形状であって、前記裏面部は前記反入射端面部に向く緩やかな第１の傾斜面部と鋭い第２の傾斜面部とが交互に連続的に接続した階段形状をなし、前記表面部には断面が凸形状または／および凹形状に前記入射端面部および前記反入射端面部方向に延在する光偏向部を設けた導光板と、
前記導光板の前記入射端面部および前記表面部以外の部分を覆う反射性を有した反射体とを具備することを特徴とする平面照明装置。
【請求項7】
さらに前記導光板の出射面側の上部に鋭角部分を前記導光板方向に向けるとともにプリズム部が前記入射端面部および前記反入射端面部方向に並設するようにプリズムシートを具備することを特徴とする請求項６記載の平面照明装置。
【請求項8】
光を導く入射端面部と、前記入射端面部の反対側に位置し、光を反射する反入射端面部と、当該光を出射する表面部および裏面部と、これら前記表面部と前記裏面部とに交わる側面部を有し、前記入射端面部から入射された直進光が前記反入射端面部に進行する間に臨界角を破らず、前記反入射端面部で反射され前記反入射端面部から前記入射端面部に進行する間に臨界角を破るように、前記入射端面部において前記表面部と前記裏面部との厚さが最小になり、前記反入射端面部において前記表面部と前記裏面部との厚さが最大になる

Microsoft Exhibit 1002 - Page 1173
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

ような外形形状であって、前記裏面部は前記反入射端面部に向く緩やかな第１の傾斜面部と緩い第２の傾斜面部とが交互に連続的に接続した階段形状をなし、前記表面部には断面が凸形状または／および凹形状に前記入射端面部および前記反入射端面部方向に延在する光偏向部を設けた導光板と、

前記導光板の前記入射端面部および出射面以外の部分を覆う反射性を有した反射体とを【発明の詳細な説明】する平面照明装置。

【技術分野】

【0001】

本発明は、導光板の厚さが入射端面部の位置が最小になるようにして、裏面部が入射端面部と反対方向に向く緩やかな第１の傾斜面部と緩い第２の傾斜面部とが交互に連続的に接続した階段形状をなして、光源からの直進光が入射端面部から反入射端面部に進む時には、楔形状の導光板自身の傾きによるテーパーリークを起さず、光を反射するようにした反入射端面部で反射され、入射端面部に進む時に、裏面部の第１の傾斜面部でテーパーリークを起したり、全反射を行って表面部方向に進み、また裏面部の第２の傾斜面部では全反射の反射角度が小さく表面部に対して略垂直な角度で進み、表面部に設けた断面が凸形状や凹形状の入射端面部および反入射端面部に延在する光偏向部によって、表面部に進んで来た光を集光させて、表面部に対して略直角方向に出射することができ、また入射端面部近傍に光源からの強い光の映り込みを回避するとともに導光板の側面近傍に光源を備える場合において光源が少ない時による導光板の入射端面部付近の両端部での暗部発生を回避することができる導光板および平面照明装置に関するものである。

【背景技術】

【0002】

従来の導光板および平面照明装置としては、光源からの光を最大限に利用する目的で導光板の厚さを入射端面部から離れるほど厚さを薄くさせる、所謂楔形状に成形して、入射端面部から入射端面部の反対方向に向かう光が導光板自身の傾きによるテーパーリークを利用する方法が知られている。

【0003】

さらに、大きな平明照明装置の場合には、上記の導光体の厚さを入射端面部から離れるほど厚さを薄くし、入射端面部から入射端面部の反対方向に向かう光のテーパーリークを利用する方法を用いて導光板の対向する２つの端面を入射端面部とする方法が知られている。

【0004】

また、従来の導光板の出射面と反対側に白色の光散乱剤を印刷する場合には、入射端面部から遠ざかるほど印刷部を増加させたり、導光板に凸凹等のドットを設ける場合でも入射端面部から遠ざかるほどドットを増加させていた。

【0005】

また、従来の光源がＬＥＤ等の点光源を用いた平面照明装置として、導光板の側面にＬＥＤを複数並べ、これらＬＥＤに対向する位置の導光板の入射端面部にプリズム等の凸や凹の形状を設け、導光板の両端隅部分的まで光線が達するようにする方法が知られている。

【特許文献1】特開２００３－３３７３３３号公報

【特許文献2】特開２００３－０２９２６０号公報

【発明の開示】

【発明が解決しようとする課題】

【0006】

上述した従来の導光板および平面照明装置として、ここでは楔形状の導光板２１に光を入射させたときの光線の軌跡を図１９および図２０を参照しながら説明する。

図１９に示すように、従来の導光板２１は、入射端面部３１から入射端面部３１の反対側に位置する反入射端面部４１に向かう程に厚さが薄くなる楔形状をなしている。このため、入射光Ｌ０１が入射端面部３１の反対側に位置する反入射端面部４１に進む間におい

Microsoft Exhibit 1002 - Page 1174
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

て、光線Ｌ０１は表面部６１に向かう表面部６１に対しての入射角が約４２° 内（アクリル樹脂の場合）ならば表面部６１で全反射し、光線Ｌ０２として裏面部７１方向に進む。しかし、導光板２１は光線が進む方向に対して薄なる楔形状なので、裏面部７１に対する入射角が臨界角より小さいために臨界角を破り、光線Ｌ０３や光線Ｌ０４として裏面部７１より出射してしまう。

尚、ここでは説明上、裏面部７１のみに臨界角を破る出射光を示したが、表面部６１にも同様に臨界角を破る出射光が存在する。

【0007】

このように、図２０（ａ）および図２０（ｂ）に示すように、光源９からの光を最大限に利用する目的で導光板２１の厚さを入射端面部３１から離れるほど厚さを薄くさせる、所謂楔形状に成形して、入射端面部３１から入射端面部３１の反対方向に向かう光のテーパーリークを利用する方法では、光源９が指向性のある場合に入射端面部３１の近傍で直ちに臨界角を破り、即ちテーパーリークによって高輝度な光が出射される。そして、この光は高輝度で指向性の強い出射光のため、光源全体、例えば半導体発光素子（ＬＥＤ）の光源９の場合には半導体発光素子９自身の形状が出射面から観測（映り込み）されてしまう課題がある。

【0008】

さらに、上記のように導光板の厚さを入射端面部３１から離れるほど厚さを薄くした導光板２１では、半導体発光素子９自身の形状が出射面から観測されてしまうのを回避するべく、実際には入射端面部３１近傍を利用しないで用いるため、平面照明装置の必要面積以上に大きな導光板２１を使用しなければならない課題がある。

【0009】

また、従来の大きな平面照明装置の場合、上記の導光板２１の厚さを入射端面部３１から離れるほど厚さを薄くし、入射端面部３１から入射端面部３１の反対方向に向かう光のテーパーリークを利用する方法を用いて導光板２１の対向する２つの端面を入射端面部３１とする構成では、図２１に示すように、導光板２１の中心部分の厚さが最も薄い部分となり、全体を軽量化すればするほど中心部分の厚さが薄くなり機械的（構造的）強度に課題がある。

【0010】

さらに、光源としてＲＧＢ（赤色発光、緑色発光、青色発光）の三色の光源を用いて白色光を得るため、ＲＧＢの各光源を順次並べてアレー状にした場合には、各発光色が入射端面部近傍では混ざりにくい。このために、入射端面部近傍では白色にならず各発光色が出射面から斑状に出射してしまう課題がある。

【0011】

また、従来の導光板と、１つのＬＥＤ等の点光源を入射端面部の中心に用いた平面照明装置では、図２０（ａ）および図２０（ｂ）に示すように、ＬＥＤ等の半導体発光素子の光源９が指向性を有するために、光束が狭い範囲で反入射端面部４１方向に進むとともに入射端面部３１から反入射端面部４１方向に進む間に臨界角を破ってしまう。このために、入射端面部３１の両端部分（入射端面部３１と入射光線Ｌ０との間）が暗部となってしまう課題がある。

【0012】

また、従来の導光板や平面照明装置では、導光板内に閉じ込めた光を単にテーパーリークや導光板の表面部や裏面部に設けた溝や凸凹形状で出射させているので、光源からの光をそのまま出射したり拡散したりしている。このため、光の輝度やエネルギが低い状態での光しか出射することができず、例えば液晶表示装置のＲＧＢの各ピクセルに対して弱い光のため、開口面積を広くしなければならず、そのためにピクセルを微細化するための障害となっていた。

【0013】

（発明の目的）

本発明は、上記のような課題を解決するためになされたもので、以下に示す特徴を有す

Microsoft Exhibit 1002 - Page 1175
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

る導光板および平面照明装置を提供することにある。

【0014】

複数の半導体発光素子の単色光または赤色光、緑色光、青色光の三原色光あるいは波長変換材利用の白色光やアレー状または指向性の有する単体の半導体発光素子およびＣＣＦＬ等からなる光源と、光を導く入射端面部と、入射端面部の反対側に位置し、光が反射する反入射端面部と、当該光を出射する表面部または／および裏面部と、これら表面部と裏面部とに交わる側面部を有し、入射端面部から入射された直進光が反入射端面部に進行する間に臨界角を破らず、反入射端面部で反射され反入射端面部から入射端面部に進行する間に臨界角を破るように、入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になるような外形形状の導光板であって、裏面部は反入射端面部に向く緩やかな第１の傾斜面部と鋭い第２の傾斜面部とが交互に連続的に接続した階段形状をなし、表面部には断面が凸形状または／および凹形状に入射端面部および反入射端面部方向に延在する光偏向部を設けた導光板と、導光板の入射端面部および出射面以外の部分を覆う反射性を有した反射体とを具備する。これにより、光源からの直進光が入射端面部から反入射端面部に進む時には楔形状の導光板自身の傾きによるテーパーリークを起さず表面部や裏面部で全反射させ、この表面部や裏面部で全反射する角度が反入射端面部に向かうに従い大きな角度に変化し、光を反射するようにした反入射端面部で反射され入射端面部に進む時、裏面部の第１の傾斜面部でテーパーリークを起こしたり、全反射を行い臨界角に近い光が表面部方向に進む。また、裏面部の第２の傾斜面部では全反射の反射角度が小さく表面部に対して略垂直な角度で進み、表面部に設けた断面が凸形状や凹形状の入射端面部および反入射端面部方向に延在する光偏向部によって、表面部に進んで来た光を集光させて、表面部に対して略直角方向に出射することができる。

【0015】

また、入射端面部近傍に光源からの強い光の映り込みを回避するとともに導光板の側面近傍に光源を備える場合において光源が少ない時による導光板の入射端面部付近の両端部での暗部発生を回避することができる。

【0016】

さらに、表面部に断面形状が円弧形状または三角形状を有する光偏向部を設けることにより、裏面部からの全反射された光を側面部方向に集光することができる。例えば光偏向部が円弧形状の断面形状の場合には、ＬＣＤでのＲＧＢの各ピクセルに対して各方向に対して鋭い光束を出射するので、ピクセルの開口面積を小さくすることができる。これにより、ＲＧＢの各々のピクセルのサイズを小さくすることによって、より微細で単位面積当たりのピクセル量を多くすることができるために鮮明な画像を提供することができる。

【0017】

また、表面部に設けた光偏向部の断面形状が反入射端面部で最大となり、入射端面部に近づく程小さくなるようにすることで、反入射端面部に近くなる程、光偏向部の断面の面積が増加するために、広がりを持った光でも反入射端面部方向に向かう光が多くなり、反入射端面部で反射する光を多くすることができ、出射光量が多くなり明るい出射光を得ることができる。

【0018】

さらに、反入射端面部を２つの側面部から同距離位置の中心位置が膨らんだ円弧形状にするとともに第２の傾斜面部を２つの側面部から同距離位置の中心とし、反入射端面部とは反対に中心が入射端面部方向に近い円弧状にすることで、入射端面部方向から進んできた広がりの有る光を反入射端面部で中心方向に集光作用をもって反射し入射端面部方向に反射した光が第２の傾斜面部で全反射する時に拡がりのある反射光を表面部方向へ向かわせて表面部全体を均一な出射光を出射することができる。

【0019】

またさらに、光源の映り込みや輝度斑を無くすことができるとともにＲＧＢ等の単色光源を並べた光源の場合でも入射端面部近傍ですぐに出射せず一度導光板の入射端面部の反

Microsoft Exhibit 1002 - Page 1176
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

対側で全反射してから出射するために、その間に導光板内を幾度か全反射を繰り返しながら進行するためにＲＧＢの単色光が混合され完全な白色光を得ることができる。また、輝度とともに輝度斑や発光色斑をコントロールすることができ、導光板の利用出射面を大きく取れ、さらに大型の導光板や平面照明装置でも光源近傍の両端の入射端面部が最小で中央部が最大の厚みになるので、機械的強度にも優れた導光板や平面照明装置を提供することができる。

【課題を解決するための手段】

【0020】

本発明の請求項１に係る導光板は、光を導く入射端面部と、入射端面部の反対側に位置し、光を反射する反入射端面部と、当該光を出射する表面部または／および裏面部と、これら表面部と裏面部とに交わる側面部を有し、入射端面部から入射された直進光が反入射端面部に進行する間に臨界角を破らず、反入射端面部で反射され該反入射端面部から入射端面部に進行する間に臨界角を破るように、入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になるような外形形状の導光板であって、

裏面部は反入射端面部に向く緩やかな第１の傾斜面部と鋭い第２の傾斜面部とが交互に連続的に接続した階段形状をなし、表面部には断面が凸形状または／および凹形状に入射端面部および反入射端面部方向に延在する光偏向部を設けることを特徴とする。

【0021】

請求項１に係る導光板は、光を導く入射端面部と、入射端面部の反対側に位置し、光を反射する反入射端面部と、当該光を出射する表面部または／および裏面部と、これら表面部と裏面部とに交わる側面部を有し、入射端面部から入射された直進光が反入射端面部に進行する間に臨界角を破らず、反入射端面部で反射され該反入射端面部から入射端面部に進行する間に臨界角を破るように、入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になるような外形形状の導光板であって、

裏面部は反入射端面部に向く緩やかな第１の傾斜面部と鋭い第２の傾斜面部とが交互に連続的に接続した階段形状をなし、表面部には断面が凸形状または／および凹形状に入射端面部および反入射端面部方向に延在する光偏向部を設けるので、光源からの直進光が入射端面部から反入射端面部に進む時には楔形状の導光板自身の傾きによるテーパーリークを起さず表面部や裏面部で全反射させる。そして、この表面部や裏面部で全反射する角度が反入射端面部に向かうに従い大きな角度に変化し、光を反射するようにした反入射端面部で反射され入射端面部に進む時に、裏面部の第１の傾斜面部でテーパーリークを起こしたり、全反射を行い臨界角に近い光が表面部方向に進む。また裏面部の第２の傾斜面部では全反射の反射角度が小さく表面部に対して略垂直な角度で進み、表面部に設けた断面が凸形状や凹形状の入射端面部および反入射端面部方向に延在する光偏向部によって、表面部に進んで来た光を集光させて、表面部に対して略直角方向に出射することができる。

【0022】

また、本発明の導光板自身が入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になる形状である。このため、入射端面部近傍でテーパーリークを発生させずに入射端面部近傍での光源からの強い光の映り込みを回避することができる。

【0023】

さらに、請求項２に係る導光板は、光偏向部の断面形状が円弧形状または三角形状を有するとともに傾斜面が直線または曲線または断面の頂部が平坦に欠切したことを特徴とする。

【0024】

請求項２に係る導光板は、光偏向部の断面形状が円弧形状または三角形状を有するとともに傾斜面が直線または曲線または断面の頂部が平坦に欠切したので、裏面部から全反射された光は側面部方向に広がりを持ち、光偏向部の傾斜面によって偏向され光偏向部の頂

Microsoft Exhibit 1002 - Page 1177
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

部上方方向に集光することができる。

【0025】

また、稜の頂部が平坦に欠切した場合には、裏面部から全反射し頂部の平坦部分に達した光は、そのまま表面部から出射し、他の傾斜面部で偏向される。

【0026】

さらに、請求項３に係る導光板は、光偏向部の断面が反入射端面部で最大となり、入射端面部に近づく程小さくなることを特徴とする。

【0027】

請求項３に係る導光板は、光偏向部の断面が反入射端面部で最大となり、入射端面部に近づく程小さくなるので、反入射端面部に近くなる程、光偏向部の断面の面積が増加するため、広がりを持った光でも反入射端面部方向に向かう光が多くなり、反入射端面部で反射する光を多くすることができる。

【0028】

また、裏面部に設けた第１の傾斜面部のような緩やかな傾斜面からの入射端面部方向に向かう全反射光では、第１の傾斜面部の傾きと光偏向部の傾きが常に逆方向に向いている。このため、第１の傾斜面部のような微小な傾きで全反射された大きな反射角度の反射光でも光偏向部で光偏向部の傾斜度だけ小さな出射角で出射することができる。

【0029】

さらに、裏面部に設けた第２の傾斜面部の傾きの方が光偏向部の傾きよりも大きい。このため、第２の傾斜面部で全反射した光の表面部への入射角と光偏向部の傾きが等しい時に出射光は光偏向部で偏向されずに出射されるが、第２の傾斜面部で光偏向部へ垂直に全反射した光はやや反入射端面部方向に出射する。

【0030】

また、請求項４に係る導光板は、第２の傾斜面部が２つの側面部から同距離位置を中心とし、中心が入射端面部方向に近い円弧状になすことを特徴とする。

【0031】

請求項４に係る導光板は、第２の傾斜面部が２つの側面部から同距離位置を中心とし、中心が入射端面部方向に近い円弧状になすので、反入射端面部からの反射光を表面部方向に広がりを持って全反射することができる。

【0032】

さらに、請求項５に係る導光板は、反入射端面部が２つの側面部から同距離位置の中心位置が膨らんだ円弧形状であることを特徴とする。

【0033】

請求項５に係る導光板は、反入射端面部が２つの側面部から同距離位置の中心位置が膨らんだ円弧形状であるので、反入射端面部での反射光に集光性を得ることができる。

【0034】

また、請求項６に係る平面照明装置は、光を導く入射端面部と、入射端面部の反対側に位置し、光を反射する反入射端面部と、当該光を出射する表面部と、表面部の反対側に位置する裏面部と、これら表面部と裏面部とに交わる側面部を有し、入射端面部から入射された直進光が反入射端面部に進行する間に臨界角を破らず、反入射端面部で反射され反入射端面部から入射端面部に進行する間に臨界角を破るように、入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になるような外形形状であって、裏面部は反入射端面部に向く緩やかな第１の傾斜面部と鋭い第２の傾斜面部とが交互に連続的に接続した階段形状をなし、表面部には断面が凸形状または／および凹形状に入射端面部および反入射端面部方向に延在する光偏向部を設けた導光板と、

導光板の入射端面部および表面部以外の部分を覆う反射性を有した反射体とを具備することを特徴とする。

【0035】

請求項６に係る平面照明装置は、光を導く入射端面部と、入射端面部の反対側に位置し

Microsoft Exhibit 1002 - Page 1178
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

、光を反射する反入射端面部と、当該光を出射する表面部と、表面部の反対側に位置する裏面部と、これら表面部と裏面部とに交わる側面部を有し、入射端面部から入射された直進光が反入射端面部に進行する間に臨界角を破らず、反入射端面部で反射され反入射端面部から入射端面部に進行する間に臨界角を破るように、入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になるような外形形状であって、裏面部は反入射端面部に向く緩やかな第１の傾斜面部と鋭い第２の傾斜面部とが交互に連続的に接続した階段形状をなし、表面部には断面が凸形状または／および凹形状に入射端面部および反入射端面部方向に延在する光偏向部を設けた導光板と、

導光板の入射端面部および表面部以外の部分を覆う反射性を有した反射体とを具備するので、光源からの直進光が入射端面部から反入射端面部に進む時には楔形状の導光板自身の傾きによるテーパーリークを起さず表面部や裏面部で全反射させ、この表面部や裏面部で全反射する角度が反入射端面部に向かうに従い大きな角度に変化し、光を反射するようにした反入射端面部で反射され入射端面部に進む時、裏面部の第１の傾斜面部でテーパーリークを起したり、全反射を行い臨界角に近い光が表面部方向に進む、また裏面部の第２の傾斜面部では全反射の反射角度が小さく表面部に対して略垂直な角度で進み、表面部に設けた断面が凸形状や凹形状の入射端面部および反入射端面部方向に延在する光偏向部によって、表面部に進んで来た光を集光させて、表面部に対して略直角方向に出射することができる。

【0036】

さらに、本発明の導光板自身が入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になる形状である。このため、入射端面部近傍でテーパーリークを発生させないので、指向性の強い光源でも入射端面部近傍での高輝度の出射光や半導体発光素子自身等の光源の形状が出射面から観測（映り込み）や輝度斑が無い。

【0037】

また、導光板自身が入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になる形状である。このため、反入射端面部で反射された一部の光は表面部と裏面部との間で全反射を多数繰り返すうちに臨界角に近くなって第１の傾斜面部の傾斜角度が小さいために第１の傾斜面部で微小の光が臨界角を破って裏面部から出射した光を反射体によって再度導光板内に反射することができる。

【0038】

さらに、より多くの光が反入射端面部で全反射をした後にテーパーリークは起こすことができるので、ＲＧＢ等の単色光源を並べた光源の場合でも入射端面部近傍ですぐに出射しない。これにより、発光色斑の発生を回避することができ、入射光が一度導光板の入射端面部の反対側で全反射してから出射する。このために、その間に導光板内を幾度か全反射を繰り返しながら進行し、ＲＧＢの単色光が混合され完全な白色光を得ることができる。

【0039】

さらに、請求項７に係る平面照明装置は、導光板の出射面側の上部に鏡角部分を導光板方向に向けるとともにプリズム部が入射端面部および反入射端面部方向に並設するようにプリズムシートを具備することを特徴とする。

【0040】

請求項７に係る平面照明装置は、導光板の出射面側の上部に鏡角部分を導光板方向に向けるとともにプリズム部が入射端面部および反入射端面部方向に並設するようにプリズムシートを具備するので、反入射端面部からの反射光が、反入射端面部から入射端面部方向へ進み光偏向部（表面部）から入射端面部方向へ向いた光が導光板の光偏向部（表面部）に沿うように導光板の外部に出射した光をプリズムの１面に達し、プリズムで屈折してプリズム内部に進行した後、プリズムの他方の面で全反射を行いプリズムの平面から略垂直に出射することができる。

Microsoft Exhibit 1002 - Page 1179
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

【0041】
また、請求項８に係る平面照明装置は、光を導く入射端面部と、入射端面部の反対側に位置し、光を反射する反入射端面部と、当該光を出射する表面部および裏面部と、これら表面部と裏面部とに交わる側面部を有し、入射端面部から入射された直進光が反入射端面部に進行する間に臨界角を破らず、反入射端面部で反射され反入射端面部から入射端面部に進行する間に臨界角を破るように、入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になるような外形形状であって、裏面部は反入射端面部に向く緩やかな第１の傾斜面部と鋭い第２の傾斜面部とが交互に連続的に接続した階段形状をなし、表面部には断面が凸形状または／および凹形状に入射端面部および反入射端面部方向に延在する光偏向部を設けた導光板と、
導光板の入射端面部および出射面以外の部分を覆う反射性を有した反射体とを具備することを特徴とする。
【0042】
請求項８に係る平面照明装置は、光を導く入射端面部と、入射端面部の反対側に位置し、光を反射する反入射端面部と、当該光を出射する表面部および裏面部と、これら表面部と裏面部とに交わる側面部を有し、入射端面部から入射された直進光が反入射端面部に進行する間に臨界角を破らず、反入射端面部で反射され反入射端面部から入射端面部に進行する間に臨界角を破るように、入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になるような外形形状であって、裏面部は反入射端面部に向く緩やかな第１の傾斜面部と鋭い第２の傾斜面部とが交互に連続的に接続した階段形状をなし、表面部には断面が凸形状または／および凹形状に入射端面部および反入射端面部方向に延在する光偏向部を設けた導光板と、
導光板の入射端面部および出射面以外の部分を覆う反射性を有した反射体とを具備するので、光源からの直進光が入射端面部から反入射端面部に進む時には楔形状の導光板自身の傾きによるテーパーリークを起さず表面部や裏面部で全反射させ、この表面部や裏面部で全反射する角度が反入射端面部に向かうに従い大きな角度に変化し、光を反射するようにした反入射端面部で反射され入射端面部に進む時、裏面部の第１の傾斜面部でテーパーリークを起こしたり、全反射を行い臨界角に近い光が表面部方向に進む。また裏面部の第２の傾斜面部では全反射の反射角度が小さく表面部に対して略垂直な角度で進み、表面部に設けた断面が凸形状や凹形状の入射端面部および反入射端面部方向に延在する光偏向部によって、表面部に進んで来た光を集光させて、表面部に対して略直角方向に出射することができる。
【0043】
また、本発明の導光板自身が入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になる形状である。このため、入射端面部近傍でテーパーリークを発生させずに入射端面部近傍での光源からの強い光の映り込みを回避することができる。
【0044】
さらに、導光板自身が入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になる形状である。このため、反入射端面部で反射された一部の光は表面部と裏面部との間で全反射を多数繰り返すうちに臨界角に近くなって第１の傾斜面部の傾斜角度が小さいために第１の傾斜面部で微小の光が臨界角を破って裏面部から出射した光を反射体によって再度導光板内に反射することができる。
【0045】
また、より多くの光が反入射端面部で全反射をした後にテーパーリークは起こすことができるので、ＲＧＢ等の単色光源を並べた光源の場合でも入射端面部近傍ですぐに出射しない。これにより、発光色斑の発生を回避することができ、入射光が一度導光板の入射端面部の反対側で全反射してから出射する。このために、その間に導光板内を幾度か全反射を繰り返しながら進行し、ＲＧＢの単色光が混合され完全な白色光を得ることができる。

Microsoft Exhibit 1002 - Page 1180
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

【0046】
さらに、裏面部を出射面とする構成の場合には、出射面を表面部とした時の作用と同様であるが、反射体を備えた方向である表面部から表面部に対して略直角方向に出射し、出射光が反射体で反射をした後に再度導光板（表面部から）へ入射し、導光板の表面部方向から内部に進み裏面部より外部に出射する。
【発明の効果】
【0047】
以上のように、請求項１に係る導光板は、光を導く入射端面部と、入射端面部の反対側に位置し、光を反射する反入射端面部と、当該光を出射する表面部または／および裏面部と、これら表面部と裏面部とに交わる側面部を有し、入射端面部から入射された直進光が反入射端面部に進行する間に臨界角を破らず、反入射端面部で反射され該反入射端面部から入射端面部に進行する間に臨界角を破るように、入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になるような外形形状の導光板であって、
裏面部は反入射端面部に向く緩やかな第１の傾斜面部と鋭い第２の傾斜面部とが交互に連続的に接続した階段形状をなし、表面部には断面が凸形状または／および凹形状に入射端面部および反入射端面部方向に延在する光偏向部を設けるので、光源からの直進光が入射端面部から反入射端面部に進む時には楔形状の導光板自身の傾きによるテーパーリークを起さず表面部や裏面部で全反射させ、この表面部や裏面部で全反射する角度が反入射端面部に向かうに従い大きな角度に変化し、光を反射するようにした反入射端面部で反射され入射端面部に進む時、裏面部の第１の傾斜面部でテーパーリークを起こしたり、全反射を行い臨界角に近い光が表面部方向に進む。また裏面部の第２の傾斜面部では全反射の反射角度が小さく表面部に対して略垂直な角度で進み、表面部に設けた断面が凸形状や凹形状の入射端面部および反入射端面部方向に延在する光偏向部によって、表面部に進んで来た光を集光させて、表面部に対して略直角方向に出射することができる。
そのため、光を最大限に有効に利用することができ、均一で斑の無い高輝度の出射光を得ることができる。
【0048】
また、本発明の導光板自身が入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になる形状である。このため、入射端面部近傍でテーパーリークを発生させずに入射端面部近傍での光源からの強い光の映り込みを回避することができる。これにより、光量をコントロールすることができるとともに光源の映り込みが無く、入射端面部近傍の入射端面部の両端をも暗部が無く明るく均一な出射光を得ることができる。その結果、その分実際に使用でき得る導光板の面積が大きく取れ、さらに光源が並列（アレー状）に設けてあっても互いに隣り合う光源からの光を重ならずに輝度斑の発生を防ぐことができる。
また、大型化する場合に両端を入射端面部とし、中心部分の厚さが一番厚いので、導光板の機械的安定および強度に優れる。
【0049】
請求項２に係る導光板は、光偏向部の断面形状が円弧形状または三角形状を有するとともに傾斜面が直線または曲線または断面の頂部が平坦に欠切したので、光偏向部の傾斜面によって偏向され光偏向部の頂部上方方向に集光することができる。
そのため、例えば、ＬＣＤでのＲＧＢの各ピクセルに対して各方向に対して鋭い光束を出射するので、ピクセルの開口面積を小さくすることができる。これにより、ＲＧＢの各々のピクセルのサイズを小さくすることによって、より微細で単位面積当たりのピクセル量を多くすることができ、鮮明な画像を提供することができる。
【0050】
また、稜の頂部が平坦に欠切した場合には、裏面部から全反射し頂部の平坦部分に達した光は、そのまま表面部から出射し、他の傾斜面部で偏向される。
そのため、頂部上方で全て集光された光ばかりでなく、やや広がりの有る光と集光され

Microsoft Exhibit 1002 - Page 1181
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

た光とが混在され、導光板全体として明るい出射光を得ることができる。

【0051】

請求項３に係る導光板は、光偏向部の断面が反入射端面部で最大となり、入射端面部に近づく程小さくなるので、反入射端面部に近くなる程、光偏向部の断面の面積が増加するため広がりを持った光でも反入射端面部方向に向かう光が多くなり、反入射端面部で反射する光を多くすることができる。

そのため、出射光量が多くなり明るい出射光を得ることができる。

【0052】

また、裏面部に設けた第１の傾斜面部のような緩やかな傾斜面からの入射端面部方向に向かう全反射光では、第１の傾斜面部の傾きと光偏向部の傾きが常に逆方向に向いているために、第１の傾斜面部のような微小な傾きで全反射された大きな反射角度の反射光でも光偏向部で光偏向部の傾斜度だけ小さな出射角で出射することができる。

そのため、入射端面部方向への出射角の大きな出射光は存在しない。

【0053】

さらに、裏面部に設けた第２の傾斜面部の傾きの方が光偏向部の傾きよりも大きいために第２の傾斜面部で全反射した光の表面部への入射角と光偏向部の傾きが等しい時に出射光は光偏向部で偏向されずに出射されるが、第２の傾斜面部で光偏向部へ垂直に全反射した光はやや反入射端面部方向に出射する。

そのため、裏面部で必ず垂直方向に全反射させなくとも表面部の光偏向部からは垂直な光を得ることができる。

【0054】

請求項４に係る導光板は、第２の傾斜面部が２つの側面部から同距離位置を中心とし、中心が入射端面部方向に近い円弧状になすので、反入射端面部からの反射光を表面部方向に広がりを持って全反射することができる。

そのため、特に指向性の有る点状光源を複数用いた場合には、反入射端面部で反射された各々の点状光源からの光を第２の傾斜面部で広がりを持って全反射し、出射面から斑の無い均一な出射光を得ることができ、例えばＲＧＢのような点状光源からの光を互いに混合し、完全な白色光を得ることができる。

【0055】

請求項５に係る導光板は、反入射端面部が２つの側面部から同距離位置の中心位置が膨らんだ円弧形状であるので、反入射端面部での反射光に集光性を得ることができる。

そのため、例えば複数の点状光源等の場合に、光源からの反射光が側面方向から漏れにくくしながら互いに混合することができる。

【0056】

請求項６に係る平面照明装置は、光を導く入射端面部と、入射端面部の反対側に位置し、光を反射する反入射端面部と、当該光を出射する表面部と、表面部の反対側に位置する裏面部と、これら表面部と裏面部とに交わる側面部を有し、入射端面部から入射された直進光が反入射端面部に進行する間に臨界角を破らず、反入射端面部で反射され反入射端面部から入射端面部に進行する間に臨界角を破るように、入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になるような外形形状であって、裏面部は反入射端面部に向く緩やかな第１の傾斜面部と鋭い第２の傾斜面部とが交互に連続的に接続した階段形状をなし、表面部には断面が凸形状または／および凹形状に入射端面部および反入射端面部方向に延在する光偏向部を設けた導光板と、

導光板の入射端面部および表面部以外の部分を覆う反射性を有した反射体とを具備するので、光源からの直進光が入射端面部から反入射端面部に進む時には楔形状の導光板自身の傾きによるテーパーリークを起さず表面部や裏面部で全反射させ、この表面部や裏面部で全反射する角度が反入射端面部に向かうに従い大きな角度に変化し、光を反射するようにした反入射端面部で反射され入射端面部に進む時、裏面部の第１の傾斜面部でテーパーリークを起したり、全反射を行い臨界角に近い光が表面部方向に進む。また裏面部の第２

Microsoft Exhibit 1002 - Page 1182
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

の傾斜面部では全反射の反射角度が小さく表面部に対して略垂直な角度で進み、表面部に設けた断面が凸形状や凹形状の入射端面部および反入射端面部方向に延在する光偏向部によって、表面部に進んで来た光を集光させて、表面部に対して略直角方向に出射することができる。

そのため、光を最大限に有効に利用することができ、均一で斑の無い高輝度の出射光を得ることができる。

【0057】

さらに、本発明の導光板自身が入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になる形状である。このため、入射端面部近傍でテーパーリークを発生させないので、指向性の強い光源でも入射端面部近傍での高輝度の出射光や半導体発光素子自身等の光源の形状が出射面から観測（映り込み）や輝度斑が無い。

そのため、光量をコントロールすることができるとともに光源の映り込みが無く、入射端面部近傍の入射端面部の両端をも暗部が無く明るく均一な出射光を得ることができ、その分実際に使用でき得る導光板の面積が大きく取れる。

【0058】

また、導光板自身が入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になる形状である。このため、反入射端面部で反射された一部の光は表面部と裏面部との間で全反射を多数繰り返すうちに臨界角に近くなって第１の傾斜面部の傾斜角度が小さいために第１の傾斜面部で微小の光が臨界角を破って裏面部から出射した光を反射体によって再度導光板内に反射することができる。

そのため、光源からの光を無駄なく利用し、全ての光が出射面から出射することができる。

【0059】

さらに、より多くの光が反入射端面部で全反射をした後にテーパーリークは起こすことができるので、ＲＧＢ等の単色光源を並べた光源の場合でも入射端面部近傍ですぐに出射しない。これにより、発光色斑の発生を回避することができ、入射光が一度導光板の入射端面部の反対側で全反射してから出射する。このために、その間に導光板内を幾度か全反射を繰り返しながら進行し、ＲＧＢの単色光が混合され完全な白色光を得ることができる。

そのため、光源が並列（アレー状）に設けてあっても互いに隣り合う光源からの光を重ならずに輝度斑の発生を防ぐことができるように光源の種類を選ばず利用することができるとともに光源にＲＧＢ等の半導体発光の光源を用いることができ、軽量化、小型化、機械的強度、低温環境での発光、省電力化、高輝度化および環境にも優しい平面照明装置を得ることができる。

また、大型化する場合に両端を入射端面部とし、中心部分の厚さが一番厚いので、導光板の機械的安定および強度に優れる。

【0060】

請求項７に係る平面照明装置は、導光板の出射面側の上部に鋭角部分を導光板方向に向けるとともにプリズム部が入射端面部および反入射端面部方向に並設するようにプリズムシートを具備するので、反入射端面部からの反射光が、反入射端面部から入射端面部方向へ進み光偏向部（表面部）から入射端面部方向へ向いた光が導光板の光偏向部（表面部）に沿うように導光板の外部に出射し出射角の大きな光をプリズムの１面に達し、プリズムで屈折してプリズム内部に進行した後、プリズムの他方の面で全反射を行いプリズムの平面から略垂直に出射することができる。

そのため、表面部から出射する光を全て略垂直に出射することができ、明るい出射光を得ることができる。

【0061】

請求項８に係る平面照明装置は、光を導く入射端面部と、入射端面部の反対側に位置し、光を反射する反入射端面部と、当該光を出射する表面部および裏面部と、これら表面部

Microsoft Exhibit 1002 - Page 1183
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

と裏面部とに交わる側面部を有し、入射端面部から入射された直進光が反入射端面部に進行する間に臨界角を破らず、反入射端面部で反射され反入射端面部から入射端面部に進行する間に臨界角を破るように、入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になるような外形形状であって、裏面部は反入射端面部に向く緩やかな第１の傾斜面部と鋭い第２の傾斜面部とが交互に連続的に接続した階段形状をなし、表面部には断面が凸形状または／および凹形状に入射端面部および反入射端面部方向に延在する光偏向部を設けた導光板と、

導光板の入射端面部および出射面以外の部分を覆う反射性を有した反射体とを具備するので、光源からの直進光が入射端面部から反入射端面部に進む時には楔形状の導光板自身の傾きによるテーパーリークを起さず表面部や裏面部で全反射させ、この表面部や裏面部で全反射する角度が反入射端面部に向かうに従い大きな角度に変化し、光を反射するようにした反入射端面部で反射され入射端面部に進む時、裏面部の第１の傾斜面部でテーパーリークを起したり、全反射を行い臨界角に近い光が表面部方向に進む。また裏面部の第２の傾斜面部では全反射の反射角度が小さく表面部に対して略垂直な角度で進み、表面部に設けた断面が凸形状や凹形状の入射端面部および反入射端面部方向に延在する光偏向部によって、表面部に進んで来た光を集光させて、表面部に対して略直角方向に出射することができる。

そのため、光を最大限に有効に利用することができ、均一で斑の無い高輝度の出射光を得ることができる。

【0062】

さらに、本発明の導光板自身が入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になる形状である。このため、入射端面部近傍でテーパーリークを発生させずに入射端面部近傍での光源からの強い光の映り込みを回避することができる。

これにより、光量をコントロールすることができるとともに光源の映り込みが無く、入射端面部近傍の入射端面部の両端をも暗部が無く明るく均一な出射光を得ることができ、その分実際に使用でき得る導光板の面積が大きく取れる。

【0063】

また、導光板自身が入射端面部において表面部と裏面部との厚さが最小になり、反入射端面部において表面部と裏面部との厚さが最大になる形状である。このため、反入射端面部で反射された一部の光は表面部と裏面部との間で全反射を多数繰り返すうちに臨界角に近くなって第１の傾斜面部の傾斜角度が小さいために第１の傾斜面部で微小の光が臨界角を破って裏面部から出射した光を反射体によって再度導光板内に反射することができる。

そのため、光源からの光を無駄なく利用し、全ての光が出射面から出射することができる。

【0064】

さらに、より多くの光が反入射端面部で全反射をした後にテーパーリークは起こすことができるので、ＲＧＢ等の単色光源を並べた光源の場合でも入射端面部近傍ですぐに出射しない。これにより、発光色斑の発生を回避することができ、入射光が一度導光板の入射端面部の反対側で全反射してから出射する。このために、その間に導光板内を幾度か全反射を繰り返しながら進行し、ＲＧＢの単色光が混合され完全な白色光を得ることができる。

そのため、光源が並列（アレー状）に設けてあっても互いに隣り合う光源からの光を重ならずに輝度斑の発生を防ぐことができるように光源の種類を選ばず利用することができる。

また、大型化する場合に両端を入射端面部とし、中心部分の厚さが一番厚いので導光板の機械的安定および強度に優れる。

【0065】

さらに、裏面部を出射面とする構成の場合には、出射面を表面部とした時の作用と同様であるが、反射体を備えた方向である表面部から表面部に対して略直角方向に出射し、出

Microsoft Exhibit 1002 - Page 1184
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

射光が反射体で反射をした後に再度導光板（表面部から）へ入射し、導光板の表面部方向から内部に進み裏面部より外部に出射する。

そのため、反入射端面部からの反射光が直接出射面（裏面部）から出射せず、出射面（裏面部）からは全て略垂直な光を出射することができる。

【発明を実施するための最良の形態】

【0066】

以下、本発明の実施の形態を添付図面に基づいて説明する。

尚、本発明の導光板は、表面部と裏面部との間の間距離が入射端面部で最小になり、入射端面部から最大離距離において間距離が最大になり、裏面部は入射端面部と反対方向に向く緩やかな第１の傾斜面部と鋭い第２の傾斜面部とが交互に連続的に接続した階段形状をなしてこれらの面が鏡面をなし、表面部には光を集光させる光偏向部を設けたものである。

【0067】

また、本発明の平面照明装置は、上記導光板と、指向性の有する光源と、導光板の入射端面部および出射面以外の部分を覆う反射性を有した反射体とを具備するものである。本発明は、上記構成によって、導光板の入射端面部近傍での光源の映り込みや輝度環や発光色斑の発生をコントロールすることができ、導光板の利用出射面を大きく取ることができる導光板および平面照明装置を提供するものである。

【0068】

図１～図７は本発明に係る平面照明装置の略斜視図、図８は本発明に係る導光板の概念の略断面図および軌跡図、図９は本発明に係る導光板の略断面図および軌跡図、図１０は本発明に係る導光板の略表面図および軌跡図、図１１は本発明に係る導光板の略断面図および軌跡図、図１２は本発明に係る導光板の略裏面図、図１３は本発明に係る平面照明装置の略斜視図、図１４は本発明に係る導光板の部分拡大図、図１５は本発明に係る平面照明装置の略斜視図、図１６は本発明に係る平面照明装置の略断面図、図１７は本発明に係る平面照明装置の略斜視図、図１８は本発明に係る平面照明装置の略断面図および軌跡図である。

【0069】

図１に示す平面照明装置１は、導光板２と光源１０と反射体１１を備えて概略構成されている。

【0070】

導光板２は、屈折率が１．４～１．７程度の透明なアクリル樹脂（ＰＭＭＡ）やポリカーボネート（ＰＣ）等で形成される。導光板２は、光源１０からの光を導く入射端面部３と、この入射端面部３と反対側に位置する反入射端面部４と、光を出射する表面部８と、この表面部８と反対側に位置する裏面部５と、表面部８と裏面部５とに接続する側面部１４とからなる。

尚、ここでは入射端面部３が矩形形状の導光板２の１側面を用いているが、入射端面部３は導光板２の周辺側のどこでも良く、形状も規定していない。

【0071】

また、導光板２は、表面部８と裏面部５との間の間距離（導光板２の厚さ）が入射端面部３で最小（薄く）になり、入射端面部３から最大離距離（入射端面部３の反対側に位置する反入射端面部４）において間距離（厚さ）が最大（厚く）になるような形状を有する。そして、光源１０は、導光板２の厚さが薄い入射端面部３の近傍に配置し、光源１０の反対側（最大離距離）が導光板２の厚さが厚い配置となる。

尚、図示していないが反入射端面部４には反射するように反射体を施したり、反射体１１によって反射されるようにしてある。

【0072】

さらに、導光板２の裏面部５は、入射端面部３と反対方向（反入射端面部４）に向く緩やかな第１の傾斜面部６と鋭い第２の傾斜面部７とが交互に連続的に接続した階段形状をなしている。尚、これら第１の傾斜面部６と第２の傾斜面部７の面は各々鏡面をなしてい

Microsoft Exhibit 1002 - Page 1185
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

る。

【0073】

また、導光板２に入射した光は、屈折角γが０≦｜γ｜≦Ｓｉｎ$^{-1}$（１／ｎ）の式を満たす範囲で導光板２内に進む。例えば一般の導光板２に使用されている樹脂材料であるアクリル樹脂の屈折率はｎ＝１．４９程度であるので、入射端面部３の表面部８方向から裏面部５方向への光および裏面部５方向から表面部８方向への光の最大入射角が９０°となり、入射端面部３で屈折する屈折角γがγ＝０～±４２°程度の範囲内になる。

但し、表面部８近傍では裏面部５方向のみのγ＝－４２°のみ、裏面部５近傍では表面部８方向のみのγ＝＋４２°のみとなる。

【0074】

さらに、屈折角γ＝０～±４２°の範囲内で導光板２内に入射した光は、導光板２と空気層（屈折率ｎ＝１）との境界面において、Ｓｉｎα＝（１／ｎ）の式により臨界角を表わすことができる。例えば一般の導光板２に使用されている樹脂材料であるアクリル樹脂の屈折率はｎ＝１．４９程度であるので、臨界角αはα＝４２°程度になり、導光板２の表面部８や裏面部５に光線を偏向する溝等が無かったり、導光板２の入射端面部３方向から徐々に導光板２の厚さが薄くなるような全体の傾斜角が６°程度になるように臨界角αを越えなければ導光板２内の光は表面部８や裏面部５で全て全反射しながら反入射端面部４方向へ進むことになる。

【0075】

しかし、本発明の導光板２は、厚さ（表面部８と裏面部５との間の間隔距）が入射端面部３から入射端面部３の反対側に位置する反入射端面部４に向かう程厚く（入射端面部３から最大離距離で最大に厚く）なる楔形状（一般または従来の導光板のような入射端面部から最大離距離に向かう程厚さが薄くなる楔形状とは逆）である。これにより、図８に示すように、入射端面部３からの入射光Ｌｎ１が入射端面部３の反対側に位置する反入射端面部４に進む間に導光板２が楔形状であっても臨界角を破る光線は無く、表面部８や裏面部５で全反射を繰り返した光線Ｌｎ２が反入射端面部４で全反射をして、反射光線Ｌｎ３が臨界角αに近い角度で表面部８に進み、導光板２の表面部（傾斜）に対する入射角が臨界角αを破り表面部８から光線Ｌｎ４を出射することができる。

尚、ここで図８の導光板２の裏面部５での入射端面部３の反対方向である反入射端面部４に向く緩やかな第１の傾斜面部６と鋭い第２の傾斜面部７とを図示しないで、全体の形状等がわかり易いように１つの緩やかな傾斜面としての裏面部５を図示している。

【0076】

また、図９に示すように、導光板２の裏面部５は、入射端面部３と反対方向である反入射端面部４に向く緩やかな第１の傾斜面部６と鋭い第２の傾斜面部７とが交互に連続的に接続した階段形状をなしている。また、これらの面が鏡面をなしている。

【0077】

導光板２は概略楔形状であり、反入射端面部４に向く緩やかな第１の傾斜面部６と鋭い第２の傾斜面部７とが交互に連続的に接続した階段形状をなしているが、入射端面部３からの入射光Ｌｎ１が入射端面部３の反対側に位置する反入射端面部４に進む間において臨界角を破る光線は無く、表面部８と裏面部５の緩やかな第１の傾斜面部６や鋭い第２の傾斜面部７で全反射を繰り返し、反入射端面部４に達し反入射端面部４で全反射をして、全反射した光線Ｌｎ２が再度入射端面部３方向に進む。このとき緩やかな第１の傾斜面部６ではあまりテーパーリークは起き難く、起きた場合でも裏面部５に沿うように大きな出射角度で出射する。

また、緩やかな第１の傾斜面部６で全反射して表面部８からテーパーリークを起した場合でも表面部８に沿うように大きな出射角度で出射する。

【0078】

しかし、鋭い第２の傾斜面部７に到達した光線は、テーパーリークを起こし易い状態の光線であるため、第２の傾斜面部７によって全反射をして光線Ｌｎ３が表面部８方向に進み、表面部８から略直角に光線Ｌｎ４を出射することができる。

Microsoft Exhibit 1002 - Page 1186
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

【0079】
また、第２の傾斜面部７では臨界角に近い光線でなくとも大きな傾向角の全反射を行い、略垂直な光や広範囲の光を直接表面部８から出射することができる。
そのために、入射端面部３近傍でテーパーリークは起こらないので、指向性の強い光源１０でも入射端面部３近傍での高輝度の出射光や半導体発光素子自身等の光源１０の形状が出射面から観測（映り込み）や輝度斑が無い。
【0080】
さらに、反入射端面部４で全反射をした光線によって初めてテーパーリーク等を起こすことができるので、ＲＧＢ等の単色光源１０を並べた光源１０の場合でも入射端面部３近傍ですぐに出射しない。これにより、発光色斑の発生を回避することができ、入射光が一度導光板２の入射端面部３の反対側で全反射してから出射する。このために、その間に導光板２内を幾度か全反射を繰り返しながら進行し、ＲＧＢの単色光が混合されて完全な白色光を得ることができる。
【0081】
また、第２の傾斜面部７で臨界角に近い光線でなくとも全反射を行い直接表面部８から略垂直に出射することができ、この略垂直の出射光は入射端面部３と反入射端面部４方向での伝播によって鋭いピーク幅の光線となって出射することができる。
【0082】
また、導光板２の表面部８は、入射端面部３および反入射端面部４方向に延在するように断面が凸形状または／および凹形状に光偏向部８ａを設けてある。
尚、これら光偏向部８ａおよび表面部８の面は鏡面をなしている。
【0083】
図１に示す光偏向部８ａは、断面形状が三角形状１２であり、凸形状と凹形状とが連続に並設されている。
また、図２に示す光偏向部８ａは、断面形状が凸形状の円弧形状１３であり、凸形状が連続に並設されている。
さらに、図３に示す光偏向部８ａは、断面形状が凸形状の三角形状１２が飛び飛びに設けてあり、これら三角形状１２の間は表面部８の平面（鏡面）８ｂが存在している。
また、図４に示す光偏向部８ａは、断面形状が凸形状の円弧形状１３が飛び飛びに設けてあり、これら円弧形状１３の間は表面部８の平面（鏡面）８ｂが存在している。
【0084】
そして、これら光偏向部８ａは、図１０（１０ａ，１０ｂ）に示すように、断面形状が外側に凸形状を有している。このために、裏面部５の第１の傾斜面部６や第２の傾斜面部７からの全反射された光Ｌｒは、表面部８の光偏向部８ａ方向に進み、三角形状１２の空気（屈折率の異なる空間）との境界部分や円弧形状１３の空気（屈折率の異なる空間）との境界部分で屈折し、この屈折光Ｌｒｒが三角形状１２や円弧形状１３の頂部方向に進む。そして、これら光偏向部８ａの互いに異なる方向の傾斜面によって三角形状１２や円弧形状１３の頂部の上部位置方向で集光されるように互いの異なる方向の傾斜面から屈折光Ｌｒｒが交差するように光偏向部８ａから出射される。
【0085】
また、図１４に示すように、光偏向部８ａの断面形状は、三角形状１２の傾斜面が直線（図１４（ａ）の直線傾斜面１２）又は曲線（図１４（ｂ），（ｃ）の曲線傾斜面１２ｃ１，１２ｃ２）にすることができる。これにより、光偏向部８ａの傾斜面によって傾向され、光偏向部８ａの頂部上方方向に集光することができる。
また、図１４（ａ）の直線傾斜面１２を標準とすると、図１４（ｂ）の凹曲線傾斜面１２ｃ１の方がやや広がりを持って集光し、図１４（ｃ）の凸曲線傾斜面１２ｃ２の方はより集光が強くなる。
尚、図１４（ｂ）の凹曲線傾斜面１２ｃ１の場合には、曲率や全体の傾きによって、光偏向部８ａで透過（屈折）せずに全反射し対向する傾斜面に向かい裏面部５方向に戻される。

Microsoft Exhibit 1002 - Page 1187
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

【００８６】
何れにせよこれらの傾斜面の形状により集光作用を有し、特に鋭い集光をする場合、例えばＬＣＤでのＲＧＢの各ピクセルに対して各方向に対して鋭い光束を出射するので、ピクセルの開口面積を小さくすることができる。これにより、ＲＧＢの各々のピクセルのサイズを小さくすることによって、より微細で単位面積当たりのピクセル量を多くすることができ、鮮明な画像を提供することができる。
【００８７】
さらに、図１４（ｄ）～（ｆ），（ｈ）に示すように、光偏向部８ａの断面形状は、図１４（ａ）の三角形状１２や図１４（ｇ）の円弧形状１３の頂部が平坦に欠切（図１４の（ｄ）～（ｆ），（ｈ）の平坦面１２ｃ３～１２ｃ５、１３ｃ１）にすることができる。これにより、裏面部５から全反射し頂部の平坦部分に達した光は、そのまま表面部８から出射し、他の側面部で偏向される。
【００８８】
そのため、頂部上方で全て集光された光ばかりでなく、やや広がりの有る光と集光された光とが混在され、導光板２全体として明るい出射光を得ることができる。
【００８９】
さらに、図５および図６に示すように、光偏向部８ａは、三角形状１２ｂや円弧形状１３ｂの断面が反入射端面部４で最大となり、入射端面部３に近づく程小さくなるように設けることができる。
【００９０】
図１１に示すように、三角形状１２ｂや円弧形状１３ｂに対して裏面部５に設けた第１の傾斜面部６から入射端面部３方向に向かう最大全反射角の光Ｌｒｃが光偏向部８ａに達し、この光偏向部８ａの傾斜角度分だけ出射角が小さい出射光Ｌｒｃｏを出射する。
同様に、ある程度有する反射角の光Ｌｒが光偏向部８ａに達し、この光偏向部８ａの傾斜角度分だけ出射角が小さい出射光Ｌｒｏを出射する。
【００９１】
ここで、本発明と対比するために、点線で示した表面部８が平坦の場合には、同様の第１の傾斜面部６から入射端面部３方向に向かう最大全反射角の光Ｌｒｃの光は、大きな出射角度で出射し、出射光Ｌｒｃｍのように表面部８により沿った状態で出射される。
同様に、入射端面部３方向に向かうある程度有する反射角の光Ｌｒの光は、大きな出射角度で出射し、出射光Ｌｒｍのように表面部８にある程度沿った状態で出射される。
【００９２】
このように、裏面部５に設けた第１の傾斜面部６のような緩やかな傾斜面からの入射端面部３方向に向かう全反射光では、第１の傾斜面部６の傾きと光偏向部８ａの傾きが常に逆方向に向いている。これにより、第１の傾斜面部６のような微小な傾きで全反射された反射角度の大きな光でも光偏向部８ａで光偏向部８ａの傾斜度だけ小さな出射角で出射することができる。
そのため、入射端面部３方向へ導光板２の表面部８に沿う様な出射角の大きな出射光は存在しない。
【００９３】
また、同様に図１１に示すように、三角形状１２ｂや円弧形状１３ｂに対して裏面部５に設けた第２の傾斜面部７によって入射端面部３方向に向かう光が略垂直に全反射した反射光Ｌｒｓが光偏向部８ａに達し、この光偏向部８ａの傾斜角度分が導光板２の屈折分を吸収し、表面部８に対して垂直に出射光Ｌｒｓｏを出射する。
さらに、裏面部５に設けた第２の傾斜面部７によって入射端面部３方向に向かう光が垂直に全反射した反射光Ｌｒｒが光偏向部８ａに達し、この光偏向部８ａの傾斜角度分が導光板２の屈折分よりも大きい。このため、表面部８に対して、やや反入射端面部４方向に片寄った略垂直に出射光Ｌｒｒｏを出射する。
【００９４】
このように、裏面部５に設けた第２の傾斜面部７の傾きの方が光偏向部８ａの傾きより

Microsoft Exhibit 1002 - Page 1188
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

も大きい。このため、第２の傾斜面部７で全反射した光の表面部８への入射角と光偏向部８ａの傾きが等しい時に出射光は光偏向部８ａで偏向されずに出射されるが、第２の傾斜面部７で光偏向部８ａへ垂直に全反射した光はやや反入射端面部４方向に出射する。

これにより、裏面部５で必ず垂直方向に全反射させなくとも表面部８の光偏向部８ａからは垂直な光を得ることができる。

【００９５】

尚、図１３の光源１０を少なくとも１つの隅に設け、表面部８に円弧形状１３ｂの光偏向部８ａを設けた平面照明装置１ｂの導光板２ｃと、図示しないが図１３の光偏向部８ａが三角形状１２ｂを設けた平面照明装置１ｂの導光板２ｃにおける光の作用は同等であるため、説明を省略する。

【００９６】

また、図７および図１２に示すように、平面照明装置１ｄは、導光板２ｂの反入射端面部４ｄが２つの側面部１４から同距離位置の中心位置が膨らんだ円弧形状である。

さらに、裏面部５に設ける第２の傾斜面部７ｄは、２つの側面部１４から同距離位置を中心とし、中心が入射端面部３方向に近い円弧状になす形状を有している。

尚、図７の導光板２ｂの表面部８に設けてある光偏向部８ａは省略してある。

【００９７】

そのため、反入射端面部４ｄでの反射光に集光性を得ることができる。例えば複数の点状光源１０等の場合に、光源１０からの反射光が側面部１４方向から漏れにくくしながら互いに混合することができる。

【００９８】

また、第２の傾斜面部７ｄによって反入射端面部４ｄからの反射光を表面部８方向に広がりを持って全反射することができる。特に指向性の有る点状光源１０を複数用いた場合には、反入射端面部４ｄで反射された各々の点状光源１０からの光を第２の傾斜面部７ｄで広がりを持って全反射し、出射面８から斑の無い均一な出射光を得ることができる。例えばＲＧＢのような点状光源１０からの光を互いに混合し、完全な白色光を得ることができる。

【００９９】

さらに、図１５に示すように、平面照明装置１ｃは、導光板２の表面部８を下向きに反射体１１の方向に向け、裏面部５を出射方向に向けて利用するもので、出射方向に第１の傾斜面部６と第２の傾斜面部７を備え、反射体１１の方向の下向きに断面形状が三角形状１２や円弧形状１３の光偏向部８ａを備える。図１５における光偏向部８ａは断面形状が三角形状１２のものを図示している。

【０１００】

図示しないが入射端面部３からの入射光が入射端面部３の反対側に位置する反入射端面部４に進む間に導光板２が概略楔形状であり、出射面（裏面部５）に設けた反入射端面部４に向く緩やかな第１の傾斜面部６と鋭い第２の傾斜面部７とが交互に連続的に接続した階段形状をなしても臨界角を破る光線は無く、表面部８と裏面部５の緩やかな第１の傾斜面部６や鋭い第２の傾斜面部７で全反射を繰り返し、反入射端面部４に達し反入射端面部４で全反射をして、全反射した光線が再度入射端面部３方向に進む、このとき緩やかな第１の傾斜面部６ではあまりテーパーリークは起き難く、起きた場合でも裏面部５に沿うように大きな出射角度で出射する。

また、緩やかな第１の傾斜面部６で全反射して表面部８からテーパーリークを起こした場合でも表面部８に沿うように大きな出射角度で出射する。

【０１０１】

同様に図１６に示すように、反入射端面部４で反射した反射光Ｌｒ１は鋭い第２の傾斜面部７に到達し、全反射をし、光線Ｌｒ２が下方向の表面部８（光偏向部８ａ）方向に進み、光偏向部８ａによって集光されて表面部８（光偏向部８ａ）から外部に屈折して光線Ｌｒｏ１を出射する。この光線Ｌｒｏ１は導光板２の下に備えた反射体１１に達し、反射体１１で反射し、反射光Ｌｒｏｒが再度導光板２に進み、表面部８（光偏向部８ａ）で屈

Microsoft Exhibit 1002 - Page 1189
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

折して裏面部５方向に光Ｌｒｉが進む。この光Ｌｒｉは緩やかな第１の傾斜面部６できらに屈折し、外部に出射光Ｌｒｏ２として出射することができる。

【0102】

また、同様に入射端面部３近傍でテーパーリークは起こらないので、指向性の強い光源１０でも入射端面部３近傍での高輝度の出射光や半導体発光素子自身等の光源１０の形状が出射面から観測（映り込み）や輝度斑が無い。

【0103】

さらに、反入射端面部４で全反射をした光線によって初めてテーパーリーク等を起こすことができるので、ＲＧＢ等の単色光源１０を並べた光源１０の場合でも入射端面部３近傍ですぐに出射しない。これにより、発光色斑の発生を回避することができ、入射光が一度導光板２の入射端面部３の反対側で全反射してから出射する。このために、その間に導光板２内を幾度か全反射を繰り返しながら進行し、ＲＧＢの単色光が混合されて完全な白色光を得ることができる。

尚、図２の光偏向部８ａの異なる形状および図３や図４等の導光板２の裏面部５を出射方向に成した平面照明装置１ｃについては上記の説明等で重複するため省略する。

【0104】

また、図示しないが、画面サイズの大きな平面照明装置１の場合には、導光板２の両端に入射端面部３を設ける構造を有し、本発明の概念から導光板２は表面部８と裏面部５との間の距離（導光板２の厚さ）が入射端面部３で最小（薄く）になり、両端の入射端面部３から中心における距離（厚さ）が最大（厚く）になるような形状を有する。

即ち、図示しないが、平面照明装置１は導光板２の両端に２つの光源１０を有し、この２つの光源１０に対向する導光板２の両端部を入射端面部３とし厚さが最も薄く、互いに中心方向に向かう程、導光板２の厚さが厚くなり、中心部で表面部８と裏面部５との距離が最大になる。

【0105】

故に、導光板２は、厚さが（表面部８と裏面部５との間の距離）が２つの入射端面部３から各入射端面部３の反対側に向かう程（各入射端面部３から中心）厚さが厚く（最大に）なる形状である。このため、各入射端面部３からの入射光が中心に進む間に導光板２がテーパ形状であっても互いに中心までは臨界角αを破る光線は無く、表面部８や裏面部５で全反射を繰り返した光線は中心を過ぎ互いに対向する入射端面部３方向に進む時に（表面部８と裏面部５との厚さが徐々に薄くなる）第１の傾斜面部６と第２の傾斜面部７とによって表面部８方向に全反射をして、表面部８から略垂直に光を出射する。

そのため、このような両端の入射端面部３から互いに中心方向に向かう程導光板２の厚さが厚くなり、中心部分の厚さが一番厚いので、導光板の機械的安定および強度に優れる。

【0106】

光源１０は、半導体発光素子であって、ＬＥＤやレーザ等からなり、ＲＧＢ（赤色、緑色、青色）の各単色光を入射端面部３の近傍に設けたり、ＲＧＢ（赤色発光、緑色発光、青色発光）からなる複数の半導体発光素子を組み合わせたアレー状に構成したユニットを入射端面部３に設けても良い。

特に、光源１０として高輝度を必要とする場合は、４元素化合物やＩｎＧａＡｌＰ系、ＩｎＧａＡｌＮ系、ＩｎＧａＮ系等の化合物の高輝度の発光素子を用いる。

【0107】

さらに、光源１０として、半導体発光素子と波長変換材とを用いて白色光を得ても良い。例えば、ＩｎＧａＡｌＮ系の半導体発光素子の青色発光の出射光によって励起し黄色や橙色等に発光する波長変換材（ＹＡＧ系）を設け、半導体発光素子自身の青色発光色と波長変換材からの黄色や橙色等の発光色とによって混合された発光色が白色となる光源１０でも良い。

【0108】

また、光源１０は、入射端面部３が大きい場合や導光板２自体が大きい場合にＣＣＦＬ

Microsoft Exhibit 1002 - Page 1190
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

（冷陰極管）を用いても良く、これらは線状をなし、直接光は導光板２の入射端面部３から導光板２内に入射し、他の光は図示しないリフレクタで反射されながら光源１０とリフレクタとの空間を通って導光板２内に入射する。

尚、この線状の光源１０の場合には、従来の導光板２１では、入射端面部３１の近傍に高輝度な輝線が現れてしまうが、本発明の導光板２を用いることによって輝線の発生を防ぐことができる。

【0109】

反射体１１は、熱可塑性樹脂に例えば酸化チタンのような白色材料を混入したものや熱可塑性樹脂にアルミニウム等の金属蒸着を施したり、金属等からなる。反射体１１は、入射端面部３と表面部８以外の部分を覆い、光源１０からの光が導光板２によって表面部８に出射した以外の光を反射または乱反射し、再び導光板２に入射させて光源１０からの光を全て表面部８から出射するようにする。

また、反入射端面部４や裏面部５に用いる反射体１１に反射面が凹凸形状またはプリズム形状等を施しても良く、凹凸形状やプリズム形状を制御することにより再度導光板２内に戻す位置をコントロールし、最終の出射光の輝度、光量分布および出射角等を調整することができる。

【0110】

さらに、反射体１１は、反射面が凹凸形状またはプリズム形状に施した場合には、光源１０がＲＧＢ等の三原色光の光をプリズム面による反射によって導光板２内で混ざり合うことができ、光源１０からの光を無駄にせず光源１０から導光板２の出射光に変換する効率を良くすることができる。

【0111】

また、ここでは図示しないが、例えば光源１０がＣＣＦＬ（冷陰極管）のような指向性がラジアル方向を示すような場合には、光源１０（ＣＣＦＬ）の周囲にリフレクタを設け導光板２の入射端面部３と光源１０とを包囲するようにし、光源１０からの光を反射し、反射光を導光板２の入射端面部３に再び入射させる。

尚、リフレクタは、例えば白色の絶縁性材料やアルミニウム等の金属を蒸着したシート状または金属等からなる。

【0112】

図１７に示す平面照明装置１ｅは、図１に示した導光板２と光源１０と反射体１１からなる平面照明装置１に、さらにプリズム１５を導光板２の上方に備えた構成である。

尚、図１で説明した内容は重複するので省略する。

【0113】

図１８に示すように、導光板２の表面部８に設けた光偏向部８ａの上にプリズム１５の頂角１５ｄ方向を導光板２（光偏向部８ａ）方向に向けたときの光の軌跡は、反入射端面部４からの反射された光が裏面部５の第１の傾斜面部６や第２の傾斜面部７で全反射する。この全反射による反射光Ｌｒｉ１や反射光Ｌｒｉ２は、光偏向部８ａ方向に進み、光偏向部８ａから臨界角を破り、屈折し入射端面部３方向へ傾き光偏向部８ａ（表面部８）に沿うように出射角の大きな出射光Ｌｒｉｏ１や出射光Ｌｒｉｏ２として導光板２の外部に出射する。この出射光Ｌｒｉｏ１や出射光Ｌｒｉｏ２は、光偏向部８ａの上に備えたプリズム１５の１面１５ａに進み、プリズム１５の１面１５ａで屈折し、プリズム１５の内部に入射光Ｌｐｉ１や入射光Ｌｐｉ２として入射し、プリズム１５内部に進行する。その後、プリズム１５の他方の面１５ｂで入射光Ｌｐｉ１や入射光Ｌｐｉ２は全反射を行い、全反射光Ｌｐｒｉ１や全反射光Ｌｐｒｉ２がプリズム１５の平面１５ｃから略垂直に出射光Ｌｐｏ１や出射光Ｌｐｏ２として出射することができる。

そのため、表面部８から出射する出射角の大きな出射光も略垂直に出射することができ、明るい出射光を得ることができる。

【0114】

さらに、本発明の導光板２と平面照明装置１の例として図１３に示す。

図１３の平面照明装置１ｂは、指向性の有する光源１０を導光板２ｃの１端近傍に備え

Microsoft Exhibit 1002 - Page 1191
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

、薄板状矩形立方体形状を成した導光板２ｃの１端に入射端面部３を設け、表面部８と裏面部５との間の間距離（導光板２ｃの厚さ）が入射端面部３で最小になり、入射端面部３から最大離距離の端隅４において間距離が最大（入射端面部３の対向対称端隅４）になり、裏面部５は入射端面部３と反対の端隅４方向に向く緩やかな第１の傾斜面部６と鋭い第２の傾斜面部７とが交互に連続的に接続した階段形状（入射端面部３から放射状）をなし、表面部８には断面形状が円弧形状をした凸状の光偏向部１３ｃ（８ａ）が入射端面部３と反対の端隅４方向に向く（入射端面部３から放射状になす）ように設けてある。

また、これら緩やかな第１の傾斜面部６と鋭い第２の傾斜面部７とは共に鏡面をなしている。

【0115】

さらに、ここでは図示しないが、図２と同様に表面部には断面形状が円弧形状をした光偏向部８ａが入射端面部３と反対の端隅４方向に向く（入射端面部３から放射状になす）ように設けても良く、図３や図４のようにこれら光偏向部８ａと鏡面からなる平面８ｂとを交互に設けても良い。

【0116】

また、図１３に用いた導光板２ｃ等を入射端面部３に接続する両端側面側から接続する階段形状が互いに略直角に交わり、厚さの異なる部分が互いの側面から略直角に進み、光源１０や１端からの直線上に互いに略直角に交わる形状や、入射端面部３に接続する両端側面側から接続する互いの階段形状が円弧状に交わり、厚さの異なる部分が常にどの位置でも光源１０や１端からの距離が一定であり、両端側面側から円弧状に接続する形状や、入射端面部３に接続する両端側面側から接続する階段形状が互いに直線に交わり、光源１０や１端からの直線に対して略直角になるとともに光源１０や１端からの直線が最短距離に位置する形状でも良い。

【0117】

このように、本発明の導光板２および平面照明装置１は、導光板２の厚さが入射端面部３の位置が最も薄く、入射端面部３から離れる程、導光板２の厚さが厚くなるような構成により入射端面部３から入射端面部３の反対側に位置する反入射端面部４方向に進む時には導光板２の各面の鏡面でより多く全反射をし、反入射端面部４に達し反入射端面部４で全反射を行った後に、再度入射端面部３方向に進む。この入射端面部３方向に進む時には導光板２の厚さが段々薄くなる為、第１の傾斜面部６により偏向され表面部８で臨界角を破る光線や臨界角に近い光線等が多く存在し、テーパーリークとともに光偏向部８ａで集光され臨界角を破り導光板２から出射する。そして、第２の傾斜面部７では臨界角に近い光線でなくとも全反射による偏向する角度が大きくなっているので、全反射を行った時に表面部８への入射角が小さくなり、光偏向部８ａで集光され直接表面部８（光偏向部８ａ）から出射することができる。特に第２の傾斜面部７による全反射した光は略垂直な出射光を得ることができる。

【0118】

同様に導光板２の両端に入射端面部３を設けた場合には、導光板２の厚さが入射端面部３の位置が最も薄く、導光板２の中心部分で導光板２の厚さが最も厚くなるような構成である。このため、入射端面部３から中心部分方向に進むときには各面の鏡面で全反射のみとなり、中心部を超えた位置から反対方向の入射端面部３方向に進むに従って導光板２の厚さが段々薄くなるため、導光板２の中心部を超えてから光線が進みながら臨界角αを破る表面部８への入射角となるとともに光偏向部８ａによって集光され光偏向部８ａから出射するとともに均一で高輝度の出射光を得ることができる。

【0119】

さらに、指向性の強い光源１０でも入射端面部３近傍での高輝度の出射光や半導体発光素子自身等の光源１０の形状が出射面から観測（映り込み）や輝度斑が無い光を出射する。特に導光板２の両端に入射端面部３を設けた場合には、機械的強度に優れ、映り込みの無い分だけ実質的な大きな出射面を確保することができる。また、光源１０が三原色光（ＲＧＢ）を用いて白色光源１０とする場合にも入射端面部３近傍では出射しないので、各

Microsoft Exhibit 1002 - Page 1192
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

色（ＲＧＢ）光線が順方向に進む間に混ざり合い臨界角αを破る時には完全な白色光として出射することができる。

【産業上の利用可能性】

【0120】

小型の液晶表示装置等のバックライトから大型の液晶表示装置等のバックライトまで適し、特に高輝度で輝度斑や色温度斑の無い出射光を得ることができるため例えばモバイル製品から液晶テレビ等汎用品から特殊な用途に至る導光板および平面照明装置を提供することができる。

【図面の簡単な説明】

【0121】

【図1】本発明に係る平面照明装置の略斜視図である。
【図2】本発明に係る平面照明装置の略斜視図である。
【図3】本発明に係る平面照明装置の略斜視図である。
【図4】本発明に係る平面照明装置の略斜視図である。
【図5】本発明に係る平面照明装置の略斜視図である。
【図6】本発明に係る平面照明装置の略斜視図である。
【図7】本発明に係る平面照明装置の略斜視図である。
【図8】本発明に係る導光板の概念の略断面図および軌跡図である。
【図9】本発明に係る導光板の略断面図および軌跡図である。
【図10】（ａ）、（ｂ）本発明に係る導光板の略表面図および軌跡図である。
【図11】本発明に係る導光板の略断面図および軌跡図である。
【図12】本発明に係る導光板の略裏面図である。
【図13】本発明に係る平面照明装置の略斜視図である。
【図14】本発明に係る導光板の部分拡大図である。
【図15】本発明に係る平面照明装置の略斜視図である。
【図16】本発明に係る平面照明装置の略断面図である。
【図17】本発明に係る平面照明装置の略斜視図である。
【図18】本発明に係る平面照明装置の略断面図および軌跡図である。
【図19】従来の導光板の略断面図である。
【図20】（ａ）従来の平面照明装置の略断面図である。　（ｂ）従来の平面照明装置の略平面図である。
【図21】従来の平面照明装置の略断面図である。

【符号の説明】

【0122】

１，１ｂ，１ｃ，１ｄ，１ｅ　平面照明装置
２，２ｂ，２ｃ　導光板
３　入射端面部
４，４ｄ　反入射端面部
５　裏面部
６，６ｄ　第１の傾斜面部
７，７ｄ　第２の傾斜面部
８　表面部
８ａ　光偏向部
８ｂ　平面
９　光源（従来）
１０　光源
１１　反射体
１２，１２ｂ　三角形状
１２ｃ，１２ｃ１　三角形状
１２ｃ２，１２ｃ３　三角形状

Microsoft Exhibit 1002 - Page 1193
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985

１２ｃ４，１２ｃ５　三角形状
１３，１３ｂ，１３ｃ　円弧形状
１３ｃ１　円弧形状
１４　側面部
１５　プリズムシート
２１　導光板
３１　入射端面部
４１　反入射端面部
６１　表面部
７１　裏面部
Ｌｎ１，Ｌｎ２　光線
Ｌｎ３，Ｌｎ４　光線
Ｌｒ，Ｌｒｒ，Ｌｒｏ　光線
Ｌｒｃ，Ｌｒｃｏ　光線
Ｌｒｃｍ，Ｌｒｍ　光線
Ｌｒｓ，Ｌｒｓｏ，Ｌｒｒｏ　光線
Ｌｒ１，Ｌｒ２，Ｌｒｏ１　光線
Ｌｒｏｒ，Ｌｒｉ，Ｌｒｏ２　光線
Ｌｒｉ１，Ｌｒｉ２，Ｌｒｉｏ１　光線
Ｌｒｉｏ２，Ｌｐｉ１，Ｌｐｉ２　光線
Ｌｐｒｉ１，Ｌｐｒｉ２　光線
Ｌｐｏ１，Ｌｐｏ２　光線
Ｌ０１，Ｌ０２，Ｌ０３，Ｌ０４　光線
γ　屈折角
ｎ　屈折率
α　臨界角

Microsoft Exhibit 1002 - Page 1194
Microsoft Corporation v. RealD Spark, LLC
IPR2023-01046 - U.S. Patent No. 10,740,985