US00RE47584E

(19) **United States**
(12) **Reissued Patent**
Park et al.

(10) **Patent Number: US RE47,584 E**
(45) **Date of Reissued Patent: *Aug. 27, 2019**

(54) **DISPLAY DEVICE**

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(73) Assignee: **LG INNOTEK CO., LTD.**, Seoul (KR)

(*) Notice: This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/644,207**

(22) Filed: **Jul. 7, 2017**

Related U.S. Patent Documents

Reissue of:
(64) Patent No.: **9,075,173**
Issued: **Jul. 7, 2015**
Appl. No.: **14/319,886**
Filed: **Jun. 30, 2014**

U.S. Applications:
(63) Continuation of application No. 13/440,562, filed on Apr. 5, 2012, now Pat. No. 8,783,930.

(30) **Foreign Application Priority Data**

Apr. 5, 2011	(KR)	10-2011-0031333
May 11, 2011	(KR)	10-2011-0044139
Jun. 23, 2011	(KR)	10-2011-0061029

(51) **Int. Cl.**
F21V 7/04 (2006.01)
F21V 8/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G02B 6/0026*** (2013.01); ***G02B 6/009*** (2013.01); ***G02B 6/0068*** (2013.01); ***G02B 6/0073*** (2013.01)

(58) **Field of Classification Search**
CPC G02B 6/0023; G02B 6/0026; G02B 6/009; G02B 6/0091; G02B 6/0068; G02B 6/0073
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,084,934	B2	12/2011	Kim et al.	
9,201,189	B2 *	12/2015	Lee	G02B 6/0021
9,664,843	B2 *	5/2017	Hyun	G02F 1/133615
2006/0072339	A1 *	4/2006	Li et al.	362/608

(Continued)

FOREIGN PATENT DOCUMENTS

EP	2061095 A1	5/2009
JP	10-319396 A	12/1998

(Continued)

OTHER PUBLICATIONS

Office Action dated Aug. 17, 2012 in Korean Application No. 10-2011-0044139, filed May 11, 2011.

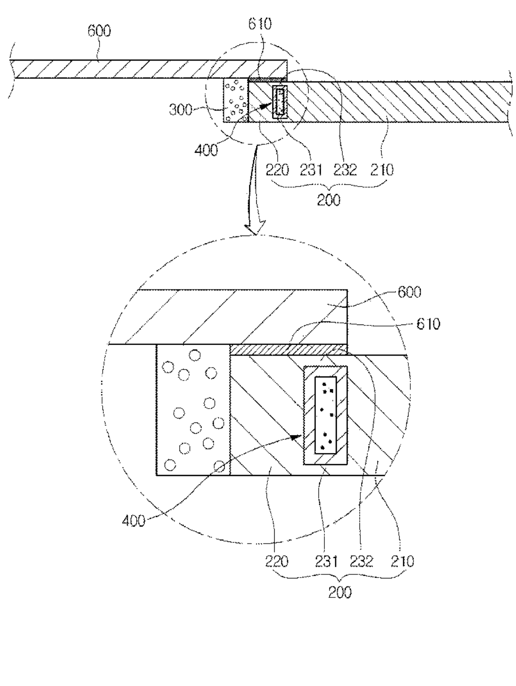
(Continued)

Primary Examiner — James A Menefee
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

Disclosed is a display device. The display device includes a light source, a light guide part to receive a light emitted from the light source, a light conversion member between the light source and the light guide part, and a spacer between the light source and the light conversion member.

20 Claims, 20 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

2007/0036241	A1*	2/2007	Sahinoglu et al.	375/317
2007/0086184	A1*	4/2007	Pugh et al.	362/231
2007/0210326	A1*	9/2007	Kurihara	257/98
2008/0049443	A1*	2/2008	Lee	362/608
2010/0103648	A1*	4/2010	Kim	H01L 33/507 362/97.1
2010/0271844	A1*	10/2010	Wang	G02B 6/0023 362/629
2011/0134626	A1	6/2011	Pugh et al.	
2011/0141769	A1*	6/2011	Lee et al.	362/629

FOREIGN PATENT DOCUMENTS

JP	2000-275636	A	10/2000
JP	2001-297617	A	10/2001
JP	2005-174567	A	6/2005
JP	2006-108076	A	4/2006
JP	2007-5098	A	1/2007
JP	2007-005098	A	1/2007
JP	2007-149665	A	6/2007
JP	2008-112711	A	5/2008
JP	2009-505443	A	2/2009
KR	10-2006-0114523	A	11/2006
KR	10-2011-0012246	A	2/2011
KR	10-2011-0064741	A	6/2011
KR	10-2011-0068110	A	6/2011
WO	WO 2008/026699	A1	3/2008

OTHER PUBLICATIONS

Office Action dated Aug. 31, 2012 in Korean Application No. 10-2011-0061029, filed Jun. 23, 2011.

Office Action dated Feb. 13, 2013 in Korean Application No. 10-2011-0044139, filed May 11, 2011.

Office Action dated Jul. 2, 2013 in Japanese Application No. 2012-086779, filed Apr. 5, 2012.

* cited by examiner

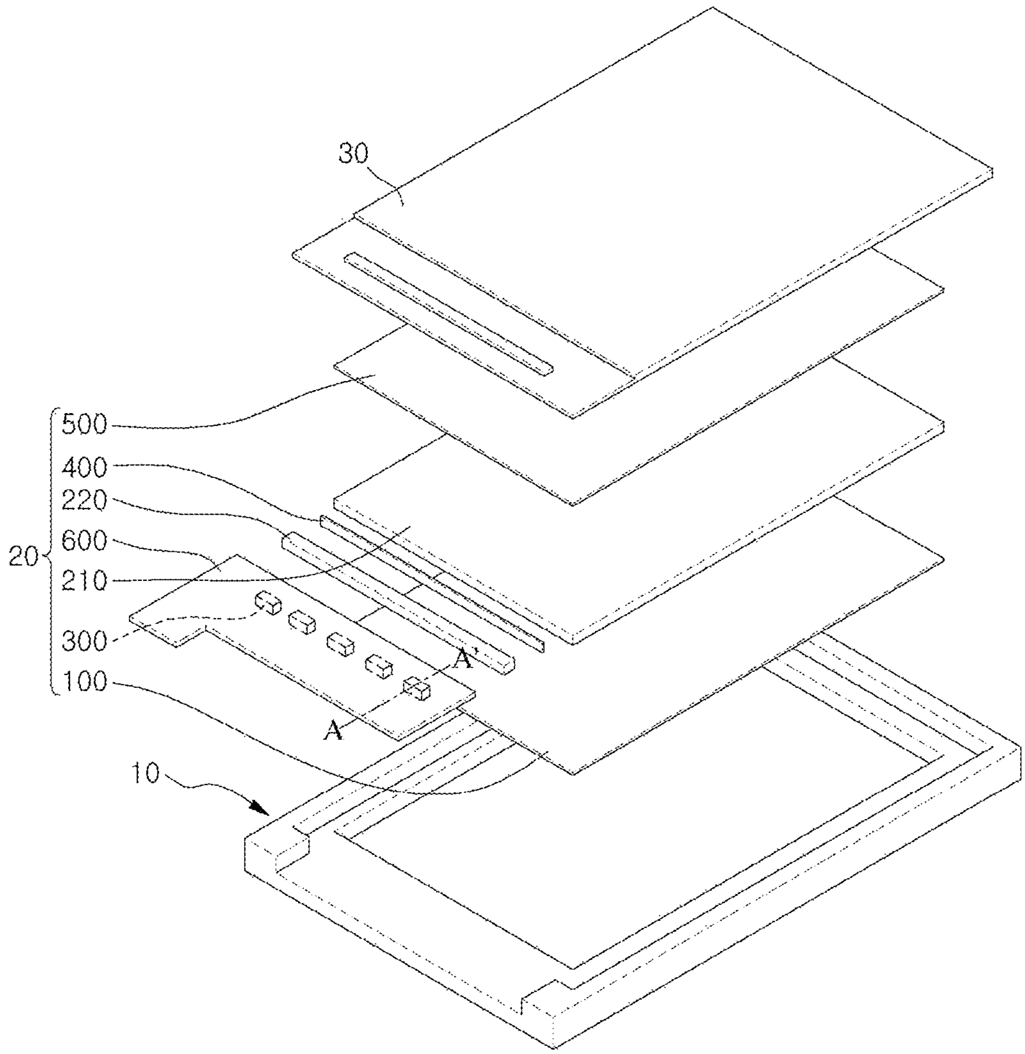
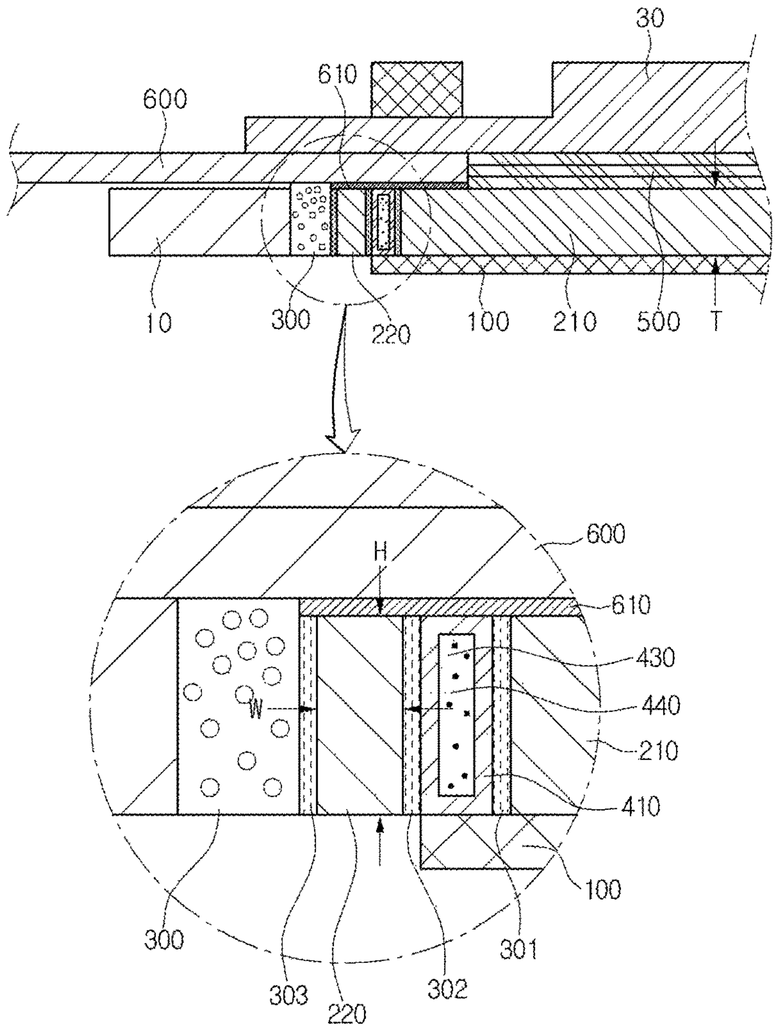


FIG. 1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302
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FIG. 2

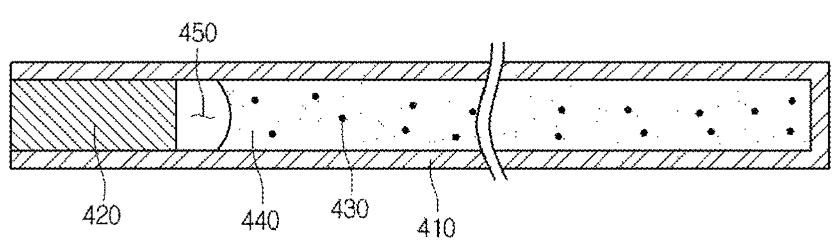
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FIG. 3

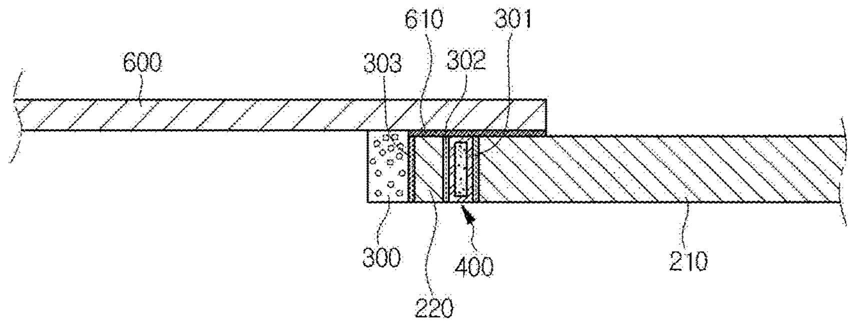
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FIG. 4

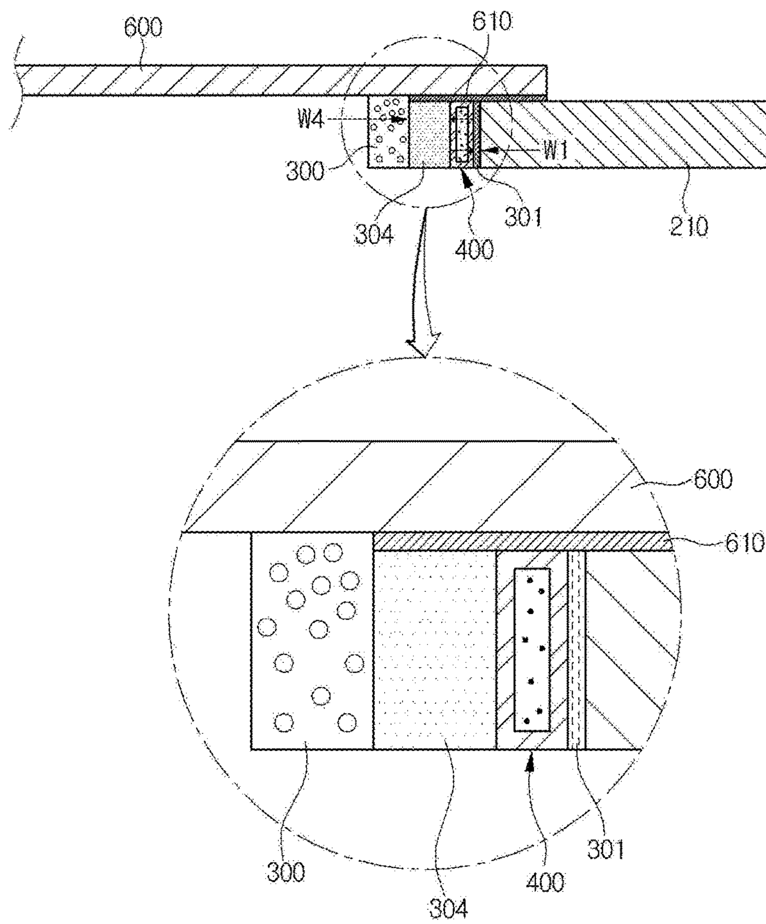
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FIG. 5

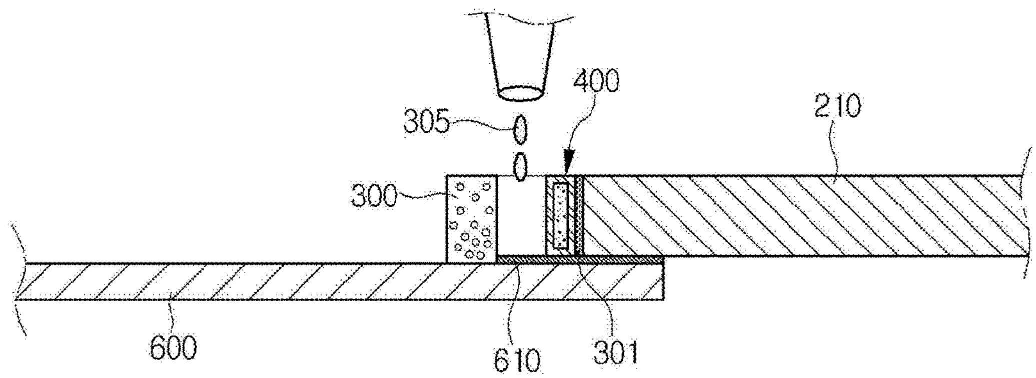
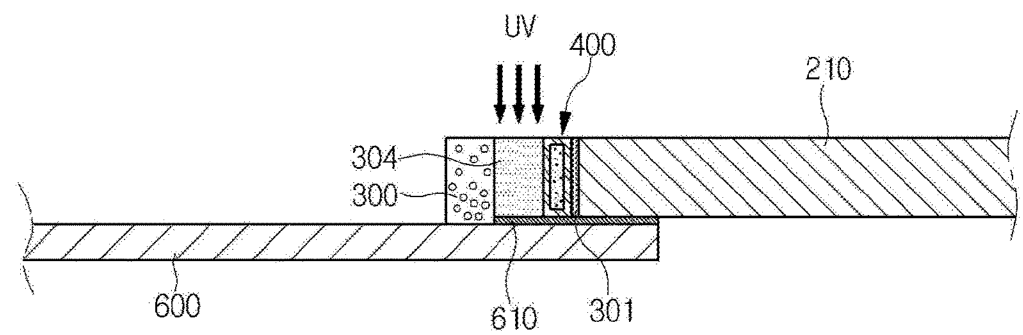


FIG. 6



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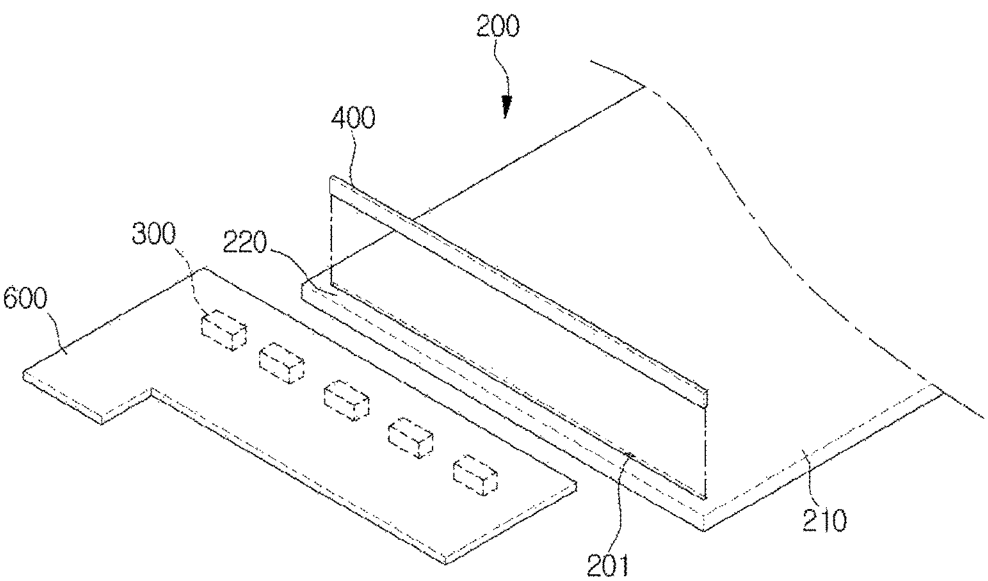
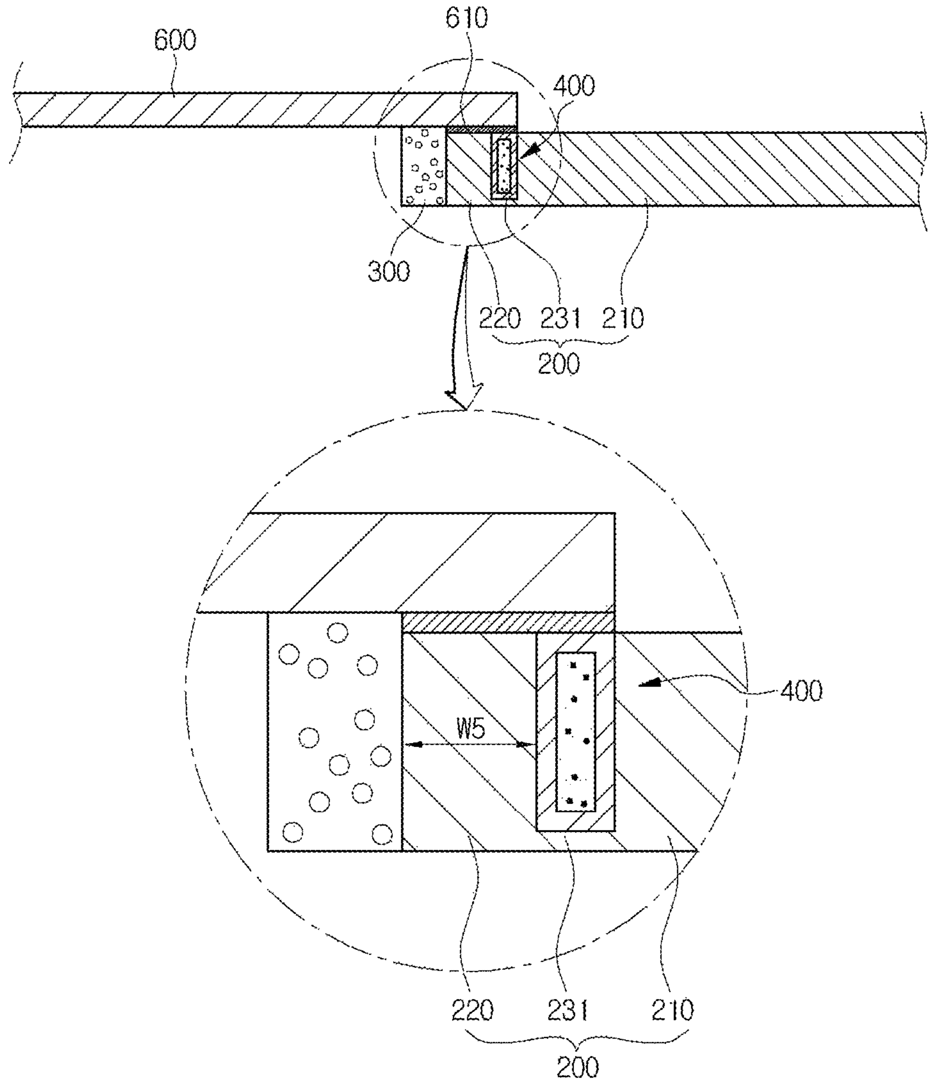


FIG. 8



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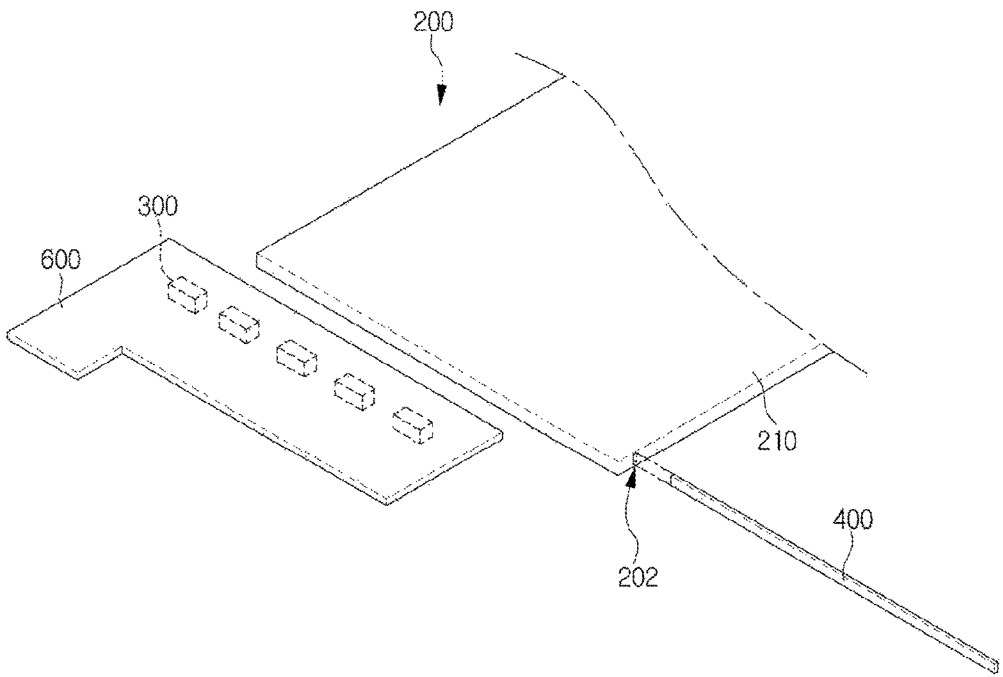

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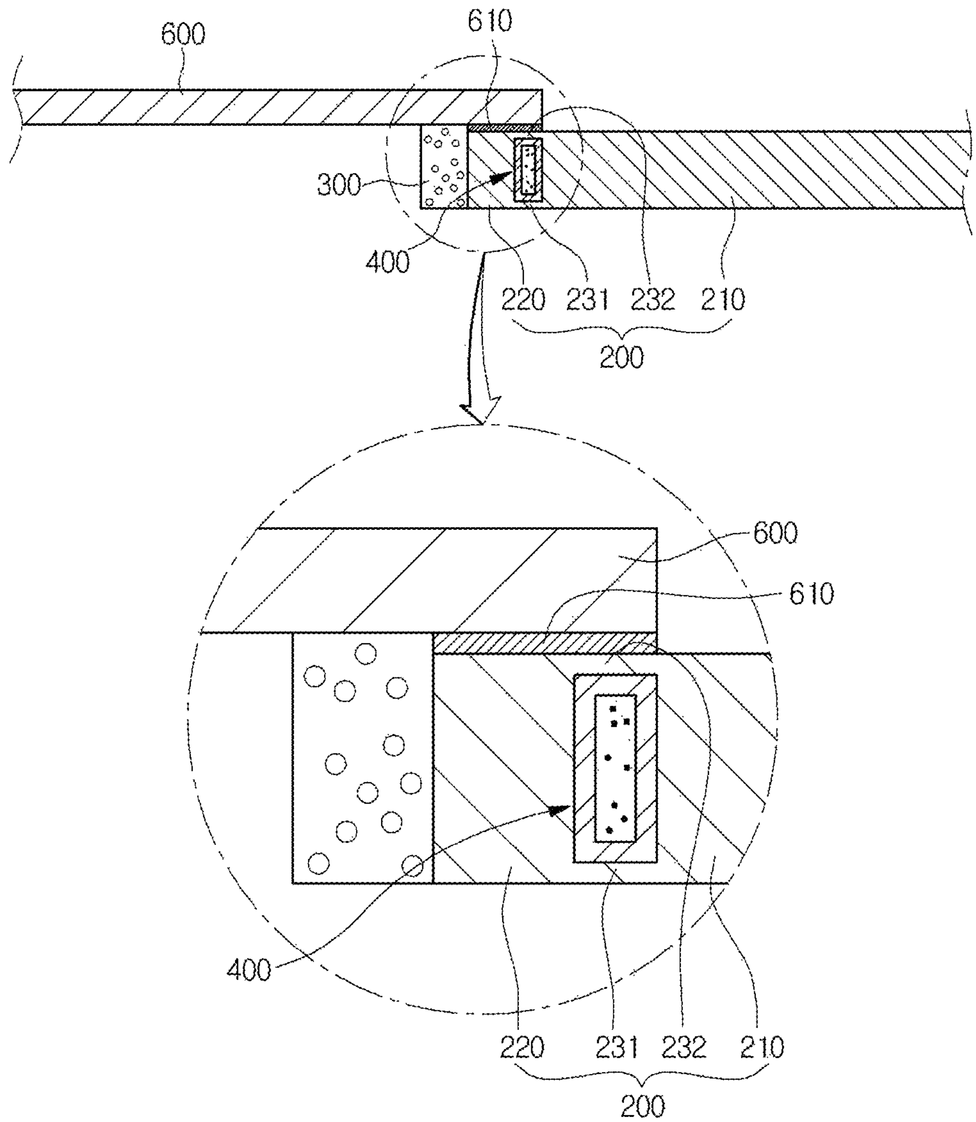
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FIG. 11

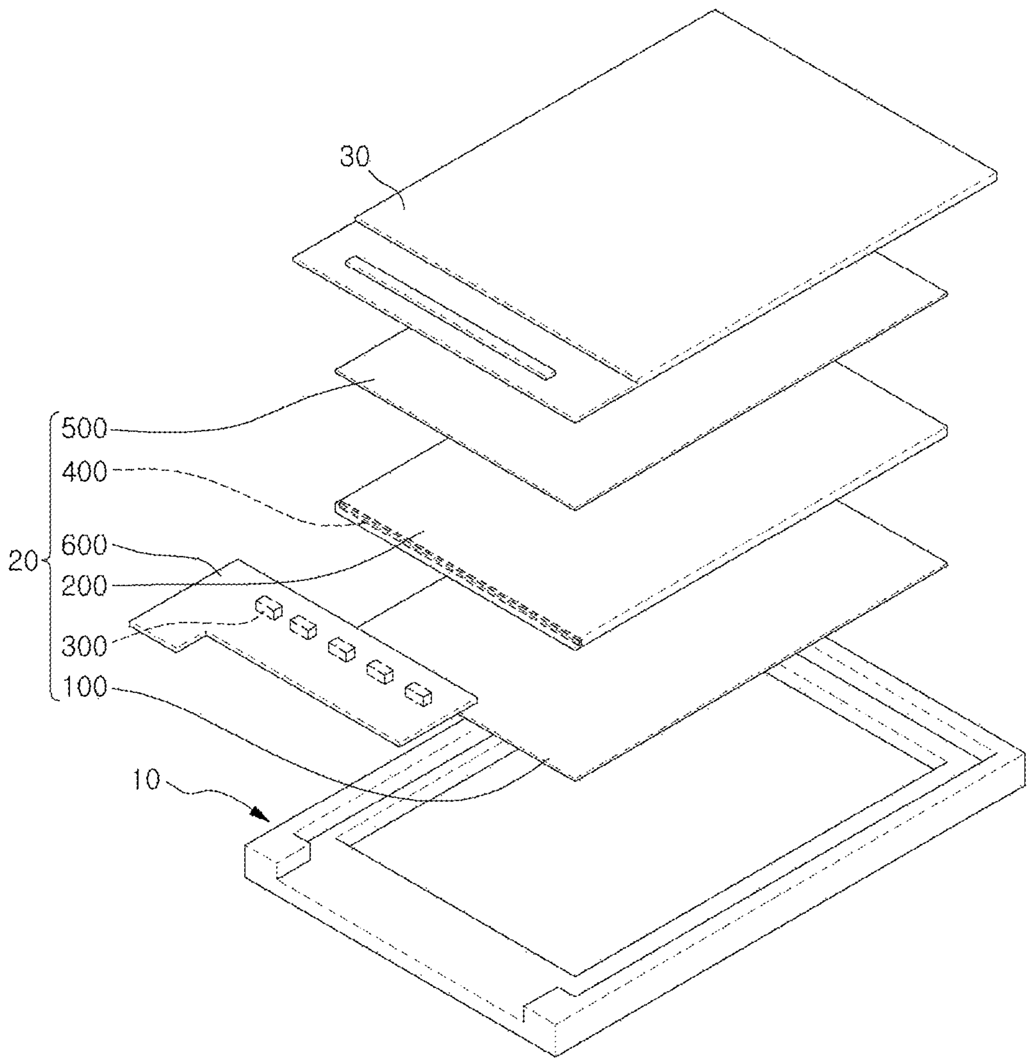

FIG. 12

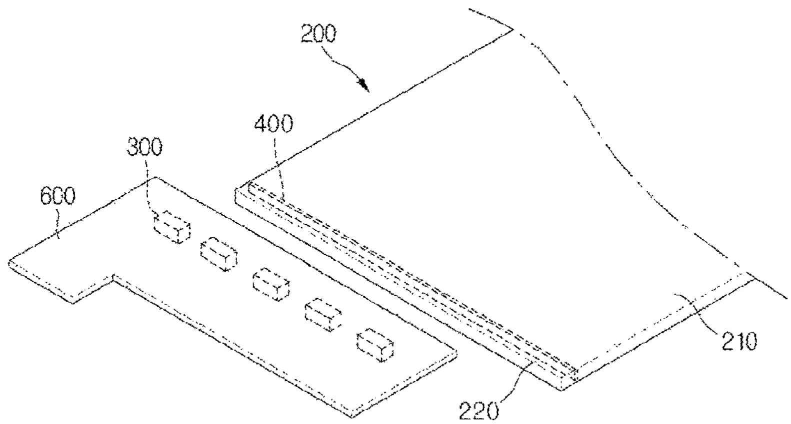
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FIG. 13

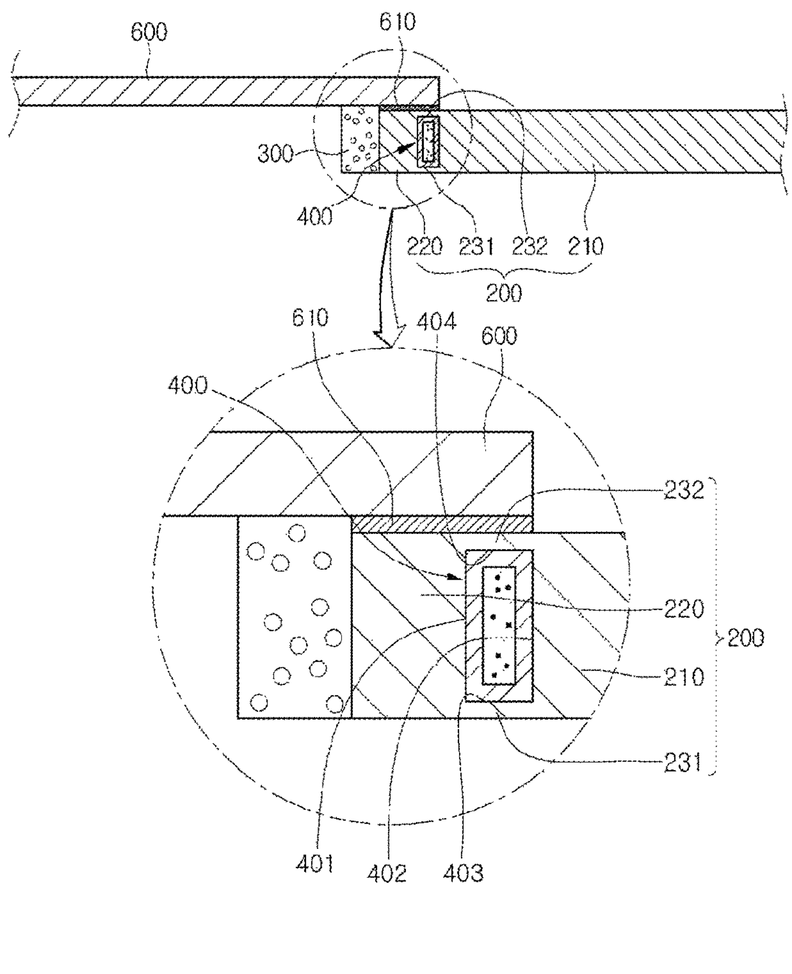
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FIG. 14

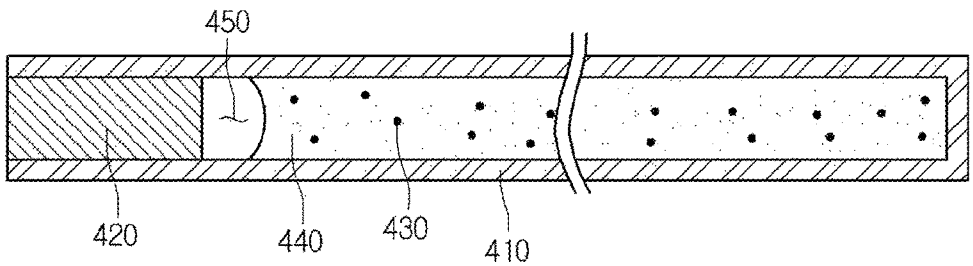


FIG. 15

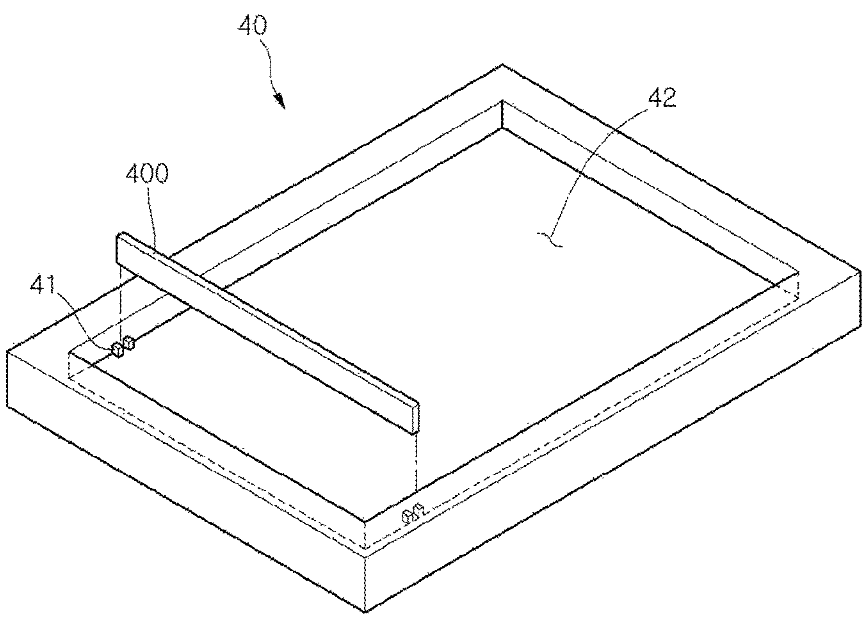


FIG. 16

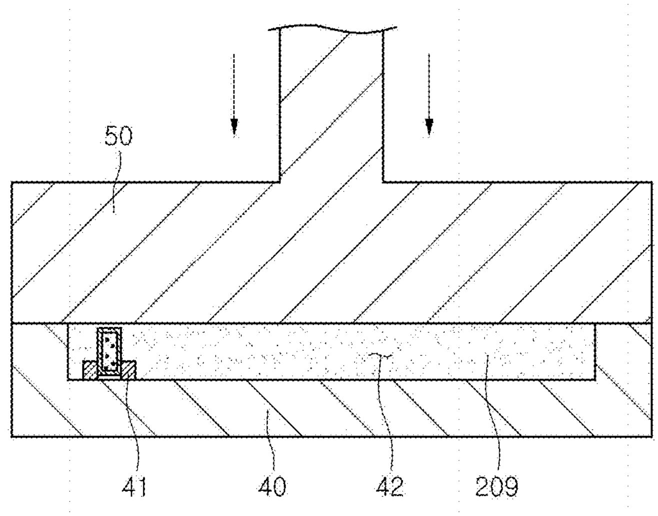


FIG. 17

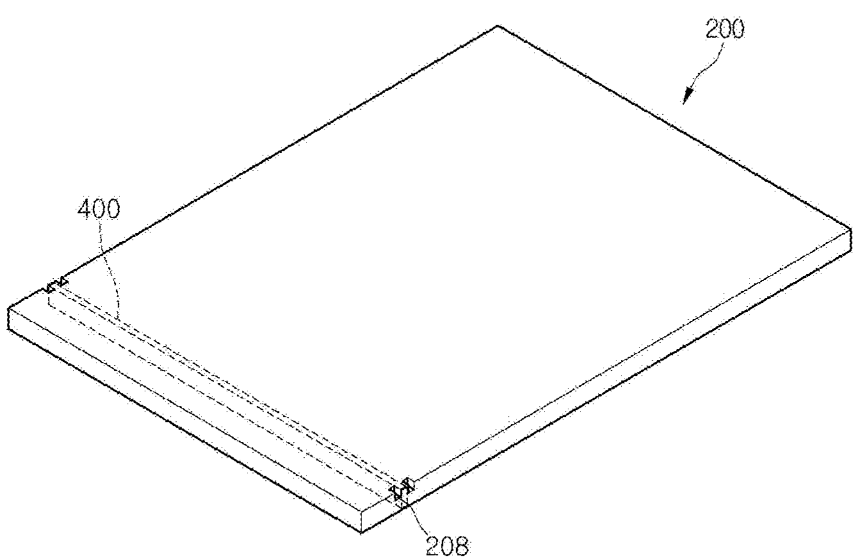


FIG. 18

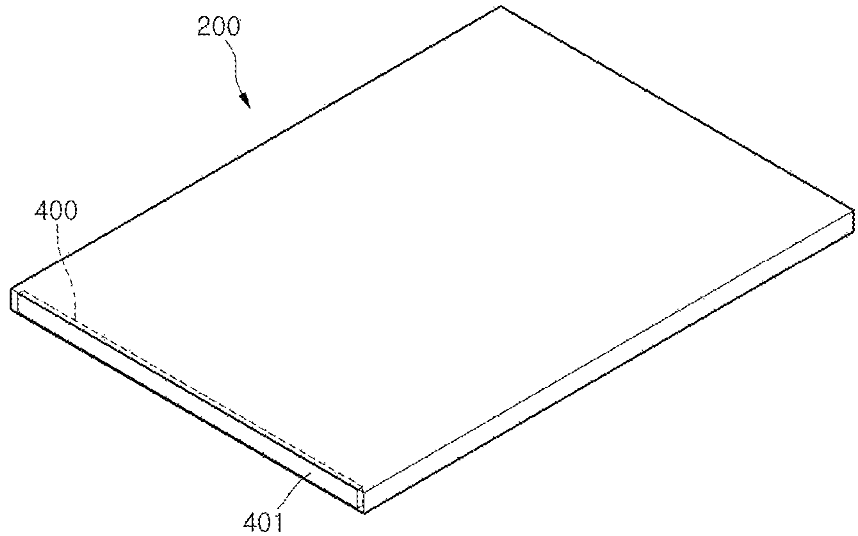
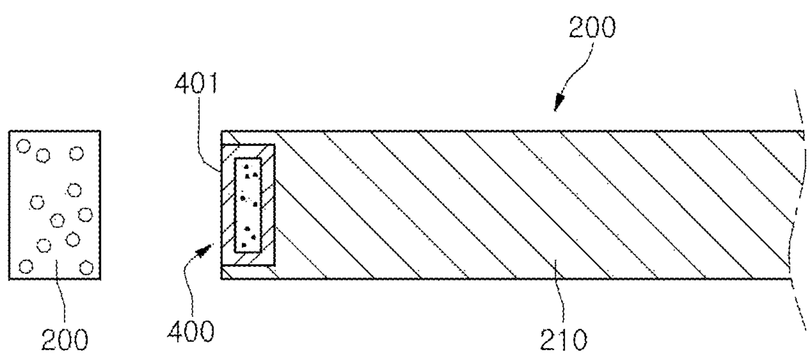


FIG. 19



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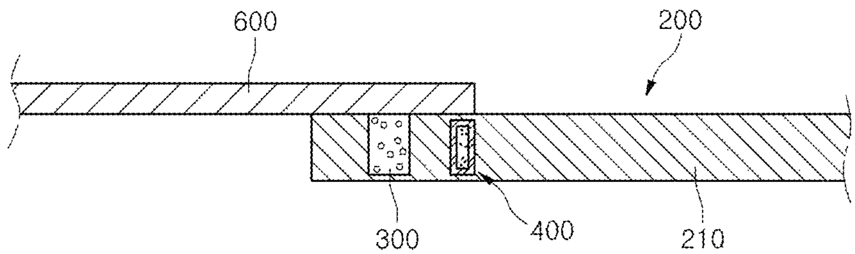


FIG. 21

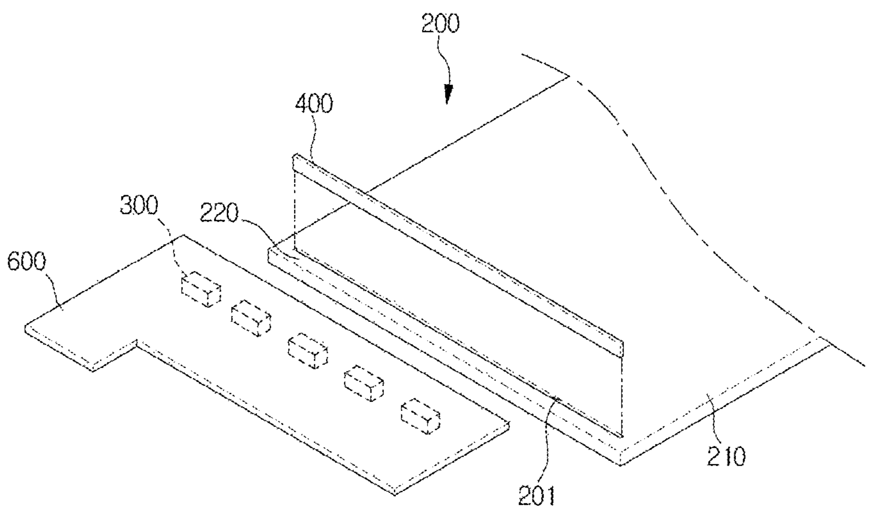
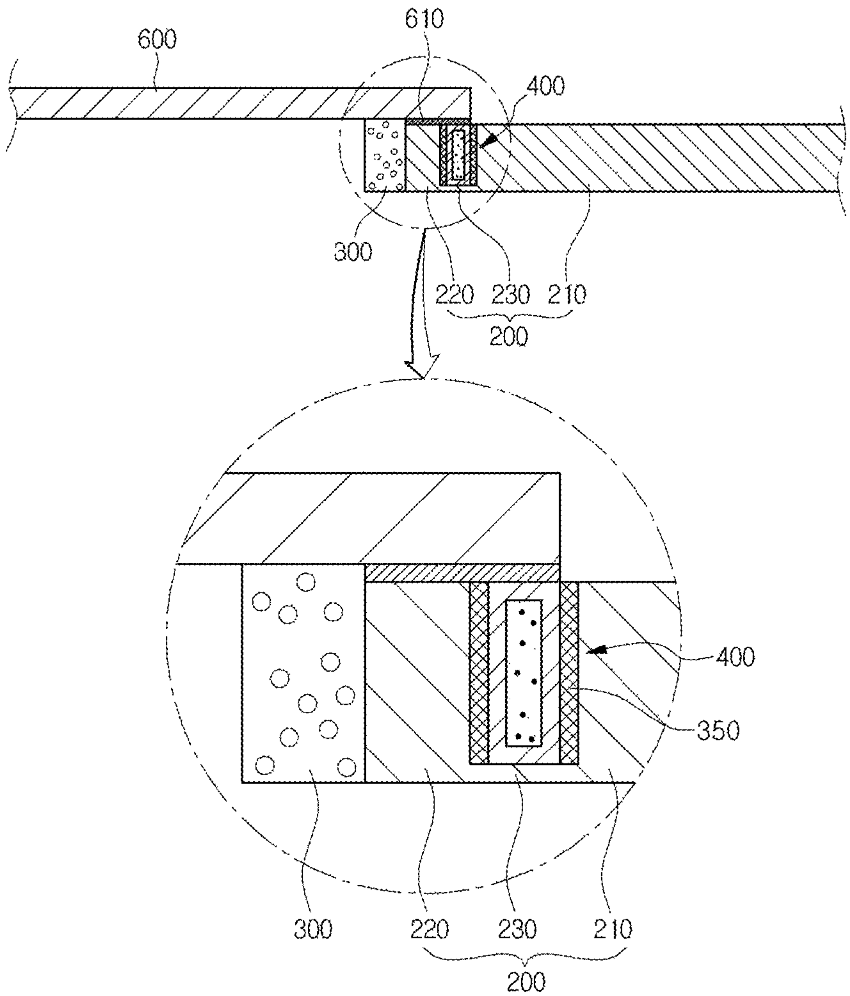


FIG. 22



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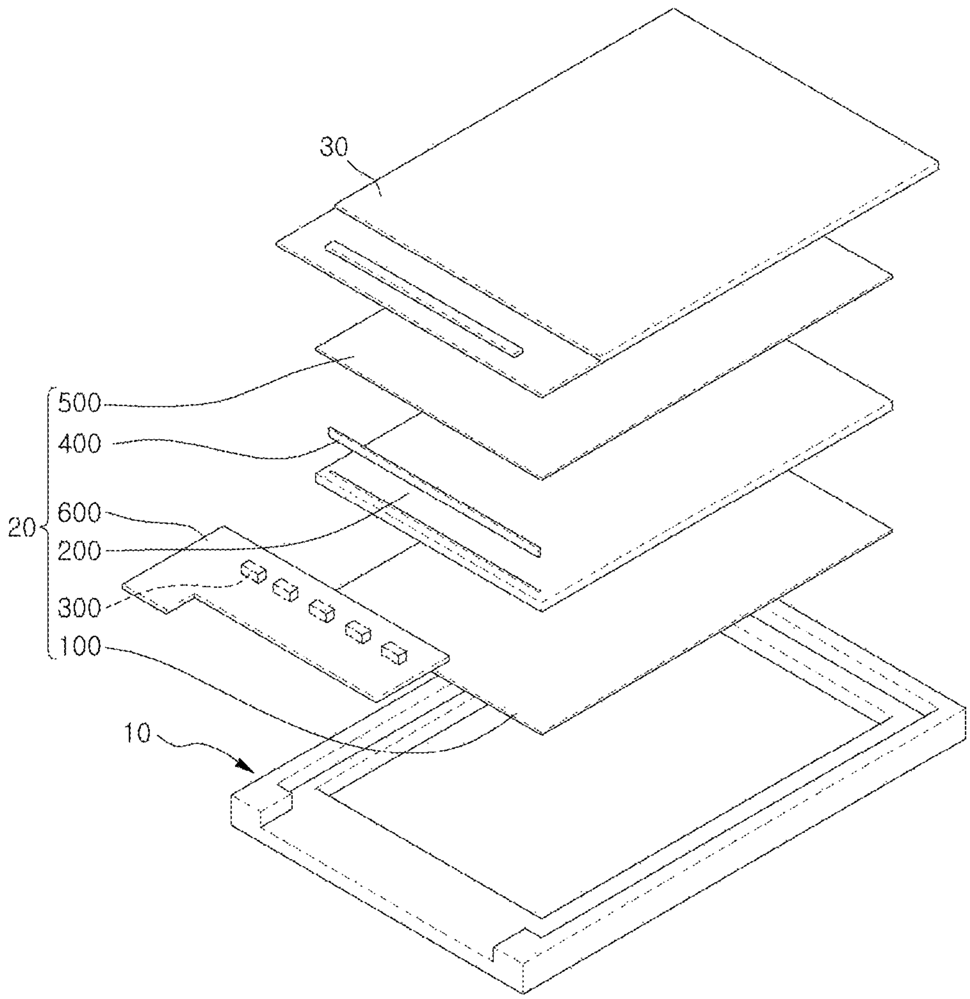

FIG. 24

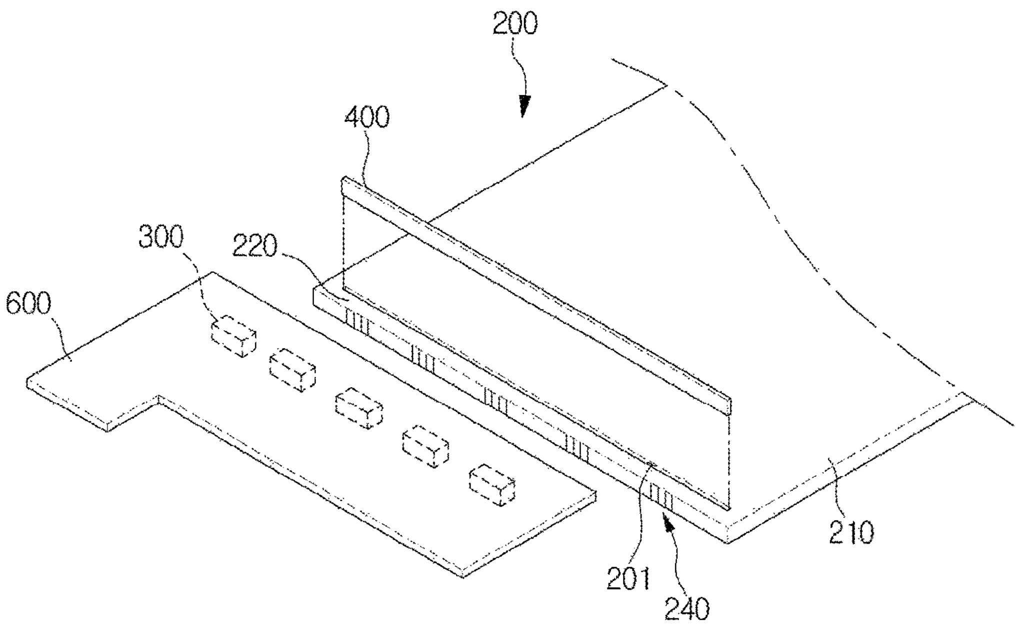

FIG. 25

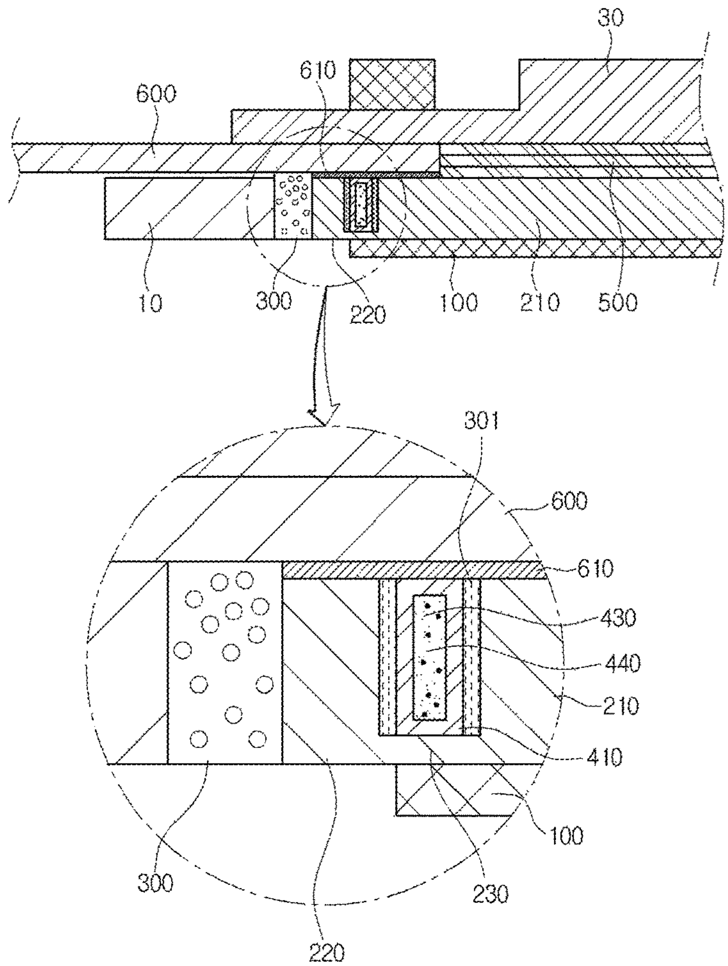
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FIG. 26

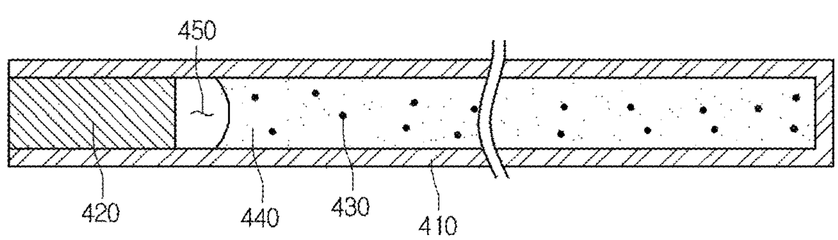
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FIG. 27

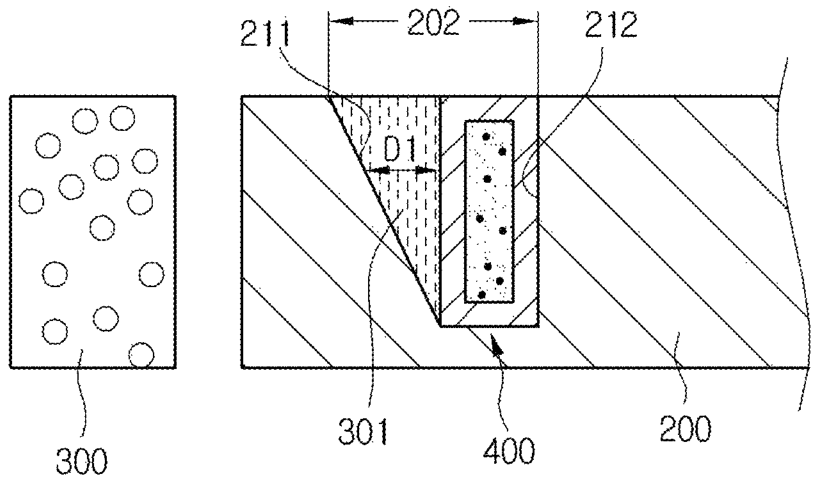
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FIG. 28

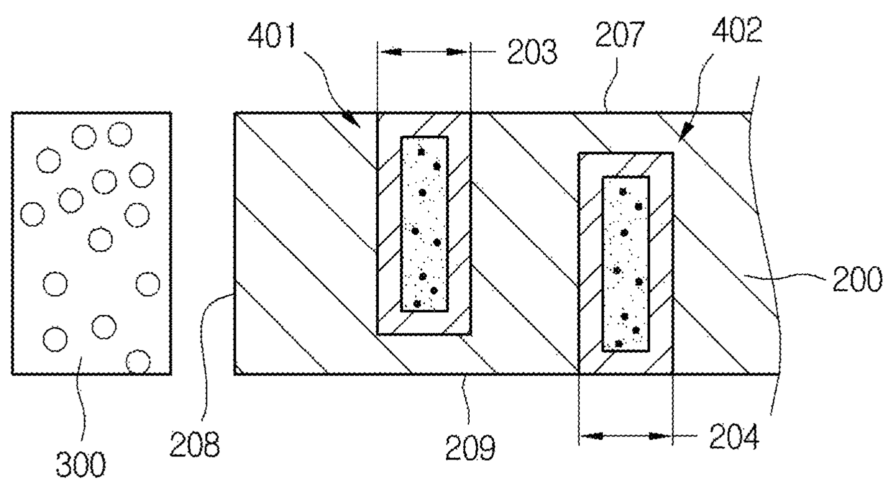
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FIG. 29

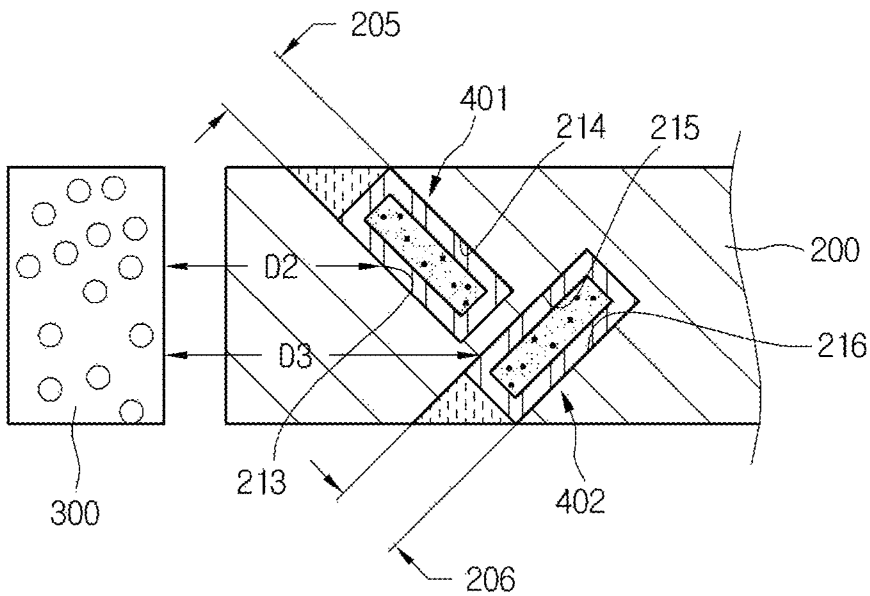

FIG. 30

DISPLAY DEVICE

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS-REFERENCE TO RELATED APPLICATIONS

[This application is a continuation of U.S. application Ser. No. 13/440,562, filed Apr. 5, 2012, which claims the benefit under 35 U.S.C. §119 of Korean Patent Application Nos. 10-2011-0031333, filed Apr. 5, 2011; 10-2011-0044139, filed May 11, 2011; and 10-2011-0061029, filed Jun. 23, 2011, which are hereby incorporated by reference in their entirety.**]** *This application is a reissue application of U.S. application Ser. No. 14/319,886, filed Jun. 30, 2014 and issued as U.S. Pat. No. 9,075,173 on Jul. 7, 2015, which is a continuation of U.S. application Ser. No. 13/440,562, filed Apr. 5, 2012 (now U.S. Pat. No. 8,783,930). The present application also claims the benefit under 35 U.S.C. § 119(a) to Patent Application Nos. 10-2011-0061029 (filed Jun. 23, 2011), 10-2011-0044139 (filed May 11, 2011) and 10-2011-0031333 (filed Apr. 5, 2011), which were all filed in Republic of Korea. All of the above-referenced applications are incorporated by reference into the present application.*

BACKGROUND

The embodiment relates to a display device.

A light emitting diode (LED) is a semiconductor device that converts electricity into ultraviolet ray, visible ray or infrared ray by using characteristics of compound semiconductors. The LED is mainly used for home appliances, remote controllers and large-size electric signboards.

A high-brightness LED is used as a light source for a lighting device. Since the LED represents superior energy efficiency and long life span, the replacement cost thereof may be reduced. In addition, the LED is strong against vibration and impact and it is not necessary to use toxic substances, such as Hg, so the LED substitutes for a glow lamp and a fluorescent lamp in terms of energy saving, environmental protection and cost reduction.

In addition, the LED may be advantageously used as a light source for a middle-size or large-size LCD TV and a monitor. When comparing with a cold cathode fluorescent lamp (CCFL) mainly used in a liquid crystal display (LCD), the LED represents superior color purity and low power consumption and can be fabricated in a small size. Various products equipped with the LED have been produced and studies for the LED have been actively performed.

BRIEF SUMMARY

The embodiment provides a display device which has a simple structure, is easily manufactured, and represents improved brightness, durability, color representation, and reliability.

According to the embodiment, there is provided a display device including a light source, a light guide part to receive a light emitted from the light source, a light conversion

member between the light source and the light guide part, and a spacer between the light source and the light conversion member.

According to the embodiment, there is provided a display device including a light guide plate, a light source at one side of the light guide plate, a light conversion member in a groove or a hole defined in the light guide plate, and a display panel on the light guide plate.

According to the embodiment, there is provided a display device including a light guide plate, a light source to emit a light to the light guide plate, a light conversion member in the light guide plate, and a display panel on the light guide plate. The light guide plate directly adheres to at least one surface of the light conversion member.

As described above, the display device according to the embodiment includes the spacer. The light source is spaced apart from the light conversion member by the spacer. Therefore, the light source is sufficiently spaced apart from the light conversion member so that the light emitted from the light source can be incident onto the light conversion member in a sufficiently diffused state.

Therefore, the liquid crystal display according to the embodiment can inhibit the light emitted from the light source from being intensively incident a part of the light conversion member. Since the liquid crystal display according to the embodiment allows the light to be uniformly incident into the light conversion member, the denaturalization of the light conversion particles caused by the intensively incident light can be inhibited.

In addition, the light source can be sufficiently spaced apart from the light conversion member by the spacer, so that the heat emitted from the light source can be inhibited from being transferred to the light conversion member and, the light conversion member can be inhibited from being degraded by the heat emitted from the light source.

The display device according to the embodiment can represent improved life span and improved durability.

In addition, in the optical member according to the embodiment, the light conversion member is provided in the light guide plate. In other words, the light conversion member is inserted into the light guide plate. Accordingly, the light guide plate can be integrally formed with the light conversion member. The light conversion member and the light guide plate can be simply assembled in order to manufacture the display device according to the embodiment.

In addition, the light conversion member can directly adhere to the light guide plate. Accordingly, the light loss between the light conversion member and the light guide plate can be minimized. Therefore, the display device according to the embodiment can represent improved brightness and improved color representation.

In addition, since the light conversion member is provided in the light guide plate, the light conversion member can be effectively protected by the light guide plate. In particular, the light conversion member can be effectively protected from external physical impact and external chemical impact by the light guide plate.

Therefore, the display device according to the embodiment can represent improved reliability and improved durability.

According to the display device according to the embodiment, at least two light conversion members can be inserted into the top and the bottom of the light guide plate, respectively. Therefore, almost all of lights emitted from the light source can pass through the light conversion members.

Consequently, the display device according to the embodiment can represent improved color representation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded perspective view showing a liquid crystal display according to a first embodiment;

FIG. **2** is a sectional view taken along line A-A' of FIG. **1**;

FIG. **3** is a sectional view showing a light conversion member according to the first embodiment;

FIG. **4** is a sectional view showing a light emitting diode, a spacer, a light conversion member, and a light guide part according to the first embodiment;

FIG. **5** is a sectional view showing a light emitting diode, an adhering member, a light conversion member, and a light guide plate according to a second embodiment;

FIGS. **6** and **7** are sectional views showing a procedure of forming an adhering member according to the second embodiment;

FIG. **8** is a view showing a light emitting diode, a light conversion member, and a light guide plate according to a third embodiment;

FIG. **9** is a sectional view showing the light emitting diode, the light conversion member, and the light guide plate according to the third embodiment;

FIG. **10** is a view showing a light emitting diode, a light conversion member, and a light guide plate according to a fourth embodiment;

FIG. **11** is a sectional view showing the light emitting diode, the light conversion member, and the light guide plate according to the fourth embodiment;

FIG. **12** is an exploded perspective view showing a liquid display device according to a fifth embodiment;

FIG. **13** is a view showing a light emitting diode, a light conversion member, and a light guide plate according to the fifth embodiment;

FIG. **14** is a view showing the light emitting diode, the light conversion member, and the light guide plate according to the fifth embodiment;

FIG. **15** is a sectional view showing the light conversion member according to the fifth embodiment;

FIGS. **16** and **17** are sectional views showing the manufacturing process of the light guide plate according to the fifth embodiment;

FIG. **18** is a perspective view showing a bottom surface of the light guide plate according to the fifth embodiment;

FIG. **19** is a perspective view showing a light conversion member and a light guide plate according to a sixth embodiment;

FIG. **20** is a sectional view showing the light emitting diode, the light conversion member, and the light guide plate according to the sixth embodiment;

FIG. **21** is a sectional view showing a light emitting diode, a light guide plate, and a light conversion member according to a seventh embodiment;

FIG. **22** is a perspective view showing a light emitting diode, a light guide plate, and a light conversion member according to an eighth embodiment;

FIG. **23** is a sectional view showing the light emitting diode, the light guide plate, and the light conversion member according to the eighth embodiment;

FIG. **24** is an exploded perspective view showing a liquid crystal display according to a ninth embodiment;

FIG. **25** is a perspective view showing light emitting diodes, a light guide plate, and a light conversion member according to the ninth embodiment;

FIG. **26** is a sectional view showing the liquid crystal display according to the ninth embodiment;

FIG. **27** is a sectional view showing the light conversion member according to the ninth embodiment;

FIG. **28** is a sectional view showing a light emitting diode, a light guide plate, and a light conversion member according to a tenth embodiment;

FIG. **29** is a sectional view showing a light emitting diode, a light guide plate, and first and second light conversion members according to an eleventh embodiment; and

FIG. **30** is a sectional view showing a light emitting diode, a light guide plate, and first and second light conversion members according to a twelfth embodiment.

DETAILED DESCRIPTION

In the description of the embodiments, it will be understood that when a layer (or film), a region, a pattern, or a structure is referred to as being "on" or "under" another substrate, another layer (or film), another region, another pad, or another pattern, it can be "directly" or "indirectly" on the other substrate, layer (or film), region, pad, or pattern, or one or more intervening layers may also be present. Such a position of the layer has been described with reference to the drawings. The thickness and size of each layer shown in the drawings may be exaggerated, omitted or schematically drawn for the purpose of convenience or clarity. In addition, the size of elements does not necessarily reflect an actual size.

FIG. **1** is an exploded perspective view showing a liquid crystal display according to a first embodiment; FIG. **2** is a sectional view taken along line A-A' of FIG. **1**; FIG. **3** is a sectional view showing a light conversion member according to the first embodiment; and FIG. **4** is a sectional view showing a light emitting diode, a spacer, a light conversion member, and a light guide part according to the first embodiment.

Referring to FIGS. **1** to **4**, a liquid crystal display according to the embodiment includes a mold frame **10**, a backlight assembly **20**, and a liquid crystal panel **30**.

The mold frame **10** receives the backlight assembly **20** and the liquid crystal panel **30** therein. The mold frame **10** has the shape of a rectangular frame. For example, the mold frame **10** may include plastic or enhanced plastic.

In addition, a chassis may be provided under the mold frame **10** to surround the mold frame **10** while supporting the backlight assembly **20**. The chassis may be provided at the lateral sides of the mold frame **10**.

The backlight assembly **20** is provided inside the mold frame **10**, and generates a light to emit toward the liquid crystal panel **30**. The backlight assembly **20** includes a reflective sheet **100**, a light guide part **210**, a light emitting diode **300**, a light conversion member **400**, a spacer **220**, a plurality of optical sheets **500** and a flexible printed circuit board (FPCB) **600**.

The reflective sheet **100** reflects light emitted from the light emitting diode **300** upward.

The light guide part **210** is provided on the reflective sheet **100**. The light guide part **210** receives light emitted from the light emitting diode **300** to reflect the light upward through reflection, refraction, and scattering. The light guide part **210** includes a light guide plate to guide a light emitted from the light emitting diode **300**.

The light guide part **210** has an incident surface facing the light emitting diode **300**. In other words, a lateral side of the light guide part **210** facing the light emitting diode **300** serves as the incident surface.

The light emitting diode **300** is provided at a lateral side of the light guide part **210**. In detail, the light emitting diode **300** is provided at the light incident surface.

The light emitting diode **300** serves as a light source to generate a light. In detail, the light emitting diode **300** emits a light toward the light conversion member **400**.

The light emitting diode **300** may include a blue light emitting diode **300** to emit blue light or an UV light emitting diode **300** to emit ultra-violet light. In other words, the light emitting diode **300** may emit blue light having a wavelength band of about 430 nm to about 470 nm, and may emit ultraviolet light having a wavelength band of about 300 nm to about 400 nm.

The light emitting diode **300** is mounted on the FPCB **600**. The light emitting diode **300** is mounted on a bottom surface of the FPCB **600**. The light emitting diode **300** receives a driving signal through the FPCB **600**.

The light conversion member **400** is interposed between the light emitting diode **300** and the light guide part **210**. In detail, the light conversion member **400** is interposed between the spacer **220** and the light guide part **210**.

As shown in FIG. **4**, the light conversion member **400** adheres to the lateral side of the light guide part **210**. In detail, the light conversion member **400** is attached to the incident surface of the light guide part **210**. In addition, the light conversion member **400** may adhere to the spacer **220**.

In other words, the light conversion member **400** may be attached to the light guide part **210** by a first adhering member **301**, and may be attached to the spacer **220** by a second adhering member **302**. The first adhering member **301** may adhere to the light conversion member **400** and the light guide part **210**. In addition, the first adhering member **301** may adhere to the light conversion member **400** and the spacer **220**.

In addition, the light emitting diode **300** may be attached to the spacer **220**. In this case, a third adhering member **303** may be interposed between the light emitting diode **300** and the spacer **220**. The third adhering member **303** may adhere to the light emitting diode **300** and the spacer **220**.

The light conversion member **400** receives a light emitted from the light emitting diode **300** to change the wavelength of the light. For example, the light conversion member **400** may change a blue light emitted from the light emitting diode **300** to a green light and a red light. In other words, the light conversion member **400** may change a part of the blue light into the green light having a wavelength band of about 520 nm to about 560 nm, and changes another part of the blue light to the red light having a wavelength band of about 630 nm to about 660 nm.

In addition, the light conversion member **400** may convert the UV light emitted from the light emitting diode **300** into the blue light, the green light and the red light. In detail, the light conversion member **400** may convert a part of the UV light into the blue light having the wavelength of about 430 nm to about 470 nm, another part of the UV light into the green light having the wavelength of about 520 nm to about 560 nm, and another part of the UV light into the red light having the wavelength of about 630 nm to about 660 nm.

The white light can be generated by the light passing through the light conversion member **400** and the lights converted by the light conversion member **400**. In detail, the white light can be incident into the light guide part **210** through the combination of the blue light, the green light and the red right.

As shown in FIGS. **2** and **3**, the light conversion member **400** includes a tube **410**, a sealing part **420**, a plurality of light conversion particles **430**, and a matrix **440**.

The tube **410** receives the sealing part **420**, the light conversion particles **430** and the matrix **440** therein. That is, the tube **410** may serve as a receptacle to receive the sealing part **420**, the light conversion particles **430** and the matrix **440**. In addition, the tube **410** extends in one direction with a long length.

The tube **410** may have the shape of a rectangular tube. In detail, a section of the tube **410**, which is vertical to the length direction of the tube **410**, may have the rectangular shape. The tube **410** may have a width of about 0.6 mm and a height of about 0.2 mm. The tube **410** may include a capillary tube.

The tube **410** is transparent and may include a glass capillary tube.

The sealing part **420** is provided in the tube **410**. The sealing part **420** is provided at an end portion of the tube **410**. The sealing part **420** seals the inner part of the tube **410**. The sealing part **420** may include epoxy resin.

The light conversion particles **430** are contained in the tube **410**. In detail, the light conversion particles **430** are uniformly dispersed in the matrix **440**, and the matrix **440** is provided in the tube **410**.

The light conversion particles **430** convert wavelengths of lights emitted from the light emitting diode **300**. The light conversion particles **430** receive the light emitted from the light emitting diode **300** to convert the wavelengths of the light. For instance, the light conversion particles **430** may convert the blue light emitted from the light emitting diode **300** into the green light and the red light. That is, a part of the light conversion particles **430** may convert the blue light into the green light having the wavelength of about 520 nm to about 560 nm and another part of the light conversion particles **430** converts the blue light into the red light having the wavelength of about 630 nm to about 660 nm.

In addition, the light conversion particles **430** can convert the UV light emitted from the light emitting diode **300** into the blue light, the green light and the red light. That is, a part of the light conversion particles **430** converts the UV light into the blue light having the wavelength in the range of about 430 nm to about 470 nm, and another part of the light conversion particles **430** converts the UV light into the green light having the wavelength in the range of about 520 nm to about 560 nm. Further, a part of the light conversion particles **430** converts the UV light into the red light having the wavelength in the range of about 630 nm to about 660 nm.

If the light emitting diode **300** is a blue light emitting diode that emits the blue light, the light conversion particles **430** capable of converting the blue light into the green light and the red light may be employed. In addition, if the light emitting diodes **300** are UV light emitting diodes that emit the UV light, the light conversion particles **430** capable of converting the UV light into the blue light, the green light and the red light may be employed.

The light conversion particles **430** may include a plurality of quantum dots. The quantum dots may include core nano-crystals and shell nano-crystals surrounding the core nano-crystals. In addition, the quantum dots may include organic ligands bonded to the shell nano-crystals. In addition, the quantum dots may include an organic coating layer surrounding the shell nano-crystals.

The shell nano-crystals may be prepared as at least two layers. The shell nano-crystals are formed on the surface of the core nano-crystals. The quantum dots can lengthen the wavelength of the light incident into the core nano-crystals by using the shell nano-crystals forming a shell layer, thereby improving the light efficiency.

The quantum dots may include at least one of a group-II compound semiconductor, a group-III compound semiconductor, a group-V compound semiconductor, and a group-VI compound semiconductor. In detail, the core nano-crystals may include Cdse, InGaP, CdTe, CdS, ZnSe, ZnTe, ZnS, HgTe or HgS. In addition, the shell nano-crystals may include CuZnS, CdSe, CdTe, CdS, ZnSe, ZnTe, ZnS, HgTe or HgS. The quantum dot may have a diameter of about 1 nm to about 10 nm.

The wavelength of the light emitted from the quantum dots can be adjusted according to the size of the quantum dot or the molar ratio between the molecular cluster compound and the nano-particle precursor in the synthesis process. The organic ligand may include pyridine, mercapto alcohol, thiol, phosphine and phosphine oxide. The organic ligand may stabilize the unstable quantum dots after the synthesis process. Dangling bonds may be formed at the valence band and the quantum dots may be unstable due to the dangling bonds. However, since one end of the organic ligand is in the non-bonding state, one end of the organic ligand in the non-bonding state is bonded with the dangling bonds, thereby stabilizing the quantum dots.

In particular, if the size of the quantum dot is smaller than the Bohr radius of an exciton, which consists of an electron and a hole excited by lights and electricity, the quantum confinement effect may occur, so that the quantum dot may have the discrete energy level. Thus, the size of the energy gap is changed. In addition, the charges are confined within the quantum dot, so that the light emitting efficiency can be improved.

Different from general fluorescent pigments, the fluorescent wavelength of the quantum dot may vary depending on the size of the particles. In detail, the light has the shorter wavelength as the size of the particle becomes small, so the fluorescent light having the wavelength band of visible ray can be generated by adjusting the size of the particles. In addition, the quantum dot represents the extinction coefficient, which is 100 to 1000 times higher than that of the general fluorescent pigment, and has the superior quantum yield as compared with the general fluorescent pigment, so that strong fluorescent light can be generated.

The quantum dots can be synthesized through the chemical wet scheme. The chemical wet scheme is to grow the particles by immersing the precursor material in the organic solvent. According to the chemical wet scheme, the quantum dots can be synthesized.

The matrix **440** surrounds the light conversion particles **430**. In detail, the light conversion particles **430** are uniformly distributed in the matrix **440**. The matrix **440** includes polymer and is transparent. That is, the matrix **440** may include transparent polymer.

The matrix **440** is disposed in the tube **410**. In detail, the matrix **440** is fully filled in the tube **410**. The matrix **440** may adhere to an inner surface of the tube **410**.

An air layer **450** is formed between the sealing part **420** and the matrix **440**. The air layer **450** is filled with nitrogen. The air layer **450** performs the damping function between the sealing part **420** and the matrix **440**.

The light conversion member **400** may be formed through the following scheme.

First, the light conversion particles **430** are uniformly dispersed in the resin composition. The resin composition is transparent. The resin composition may have a photo-curable property.

Internal pressure of the tube **410** having a scattering pattern **411** is reduced, an inlet of the tube **410** is immersed in the resin composition in which the light conversion particles **430** are distributed, and ambient pressure is increased. Thus, the resin composition having the light conversion particles **430** distributed therein is introduced into the tube **410**.

Thereafter, a part of the resin composition introduced into the tube **410** is removed and the inlet of the tube **410** becomes empty.

Then, the resin composition introduced into the inlet of the tube **410** is cured by UV light so that the matrix **440** may be formed.

Next, epoxy resin composition is introduced into the inlet of the tube **410**, and the epoxy resin composition is cured so that the sealing member **420** is formed. The process for forming the sealing member **420** is performed under the nitrogen atmosphere, so the air layer **450** including nitrogen is formed between the sealing member **420** and the matrix **440**.

As shown in FIG. **4**, the spacer **220** is interposed between the light emitting diodes **300** and the light conversion member **400**. The spacer **220** spaces the light conversion member **400** apart from the light emitting diodes **300**.

The interval between a light emitting diode **300** and the light conversion member **400** may be greater than a width W of the spacer **220**. For example, the width W of the spacer **220** may be in the range of about 200 μm to about 2.5 mm. In detail, the width W of the spacer **220** may be in the range of about 600 μm to about 2.5 mm. In more detail, the width W of the spacer **220** may be in the range of about 1 mm to about 2.5 mm.

A height H of the spacer **220** may be substantially equal to a thickness T of the light guide part **210**. In addition, the spacer **220** is transparent. The spacer **220** may include transparent polymer or glass. In addition, the refractive index of the spacer **220** may correspond to the refractive index of the light guide part **210**. In other words, the refractive index of the spacer **220** may be substantially equal to the refractive index of the light guide part **210**.

The optical sheets **500** are provided on the light guide part **210**. The optical sheets **500** improve the characteristic of a light passing through the optical sheets **500**.

The FPCB **600** is electrically connected to the light emitting diodes **300**. The FPCB **600** can mount light emitting diodes **300** thereon. The FPCB **600** is installed in the mold frame **10** and arranged on the light guide part **210**.

The FPCB **600** may adhere to the light guide part **210**. In other words, a double-sided adhesive tape may be interposed between the FPCB **600** and the light guide part **210**, so that the FPCB **600** may adhere to the light guide part **210**.

The mold frame **10** and the backlight assembly **20** constitute the backlight unit. That is, the backlight unit includes the mold frame **10** and the backlight assembly **20**.

The liquid crystal panel **30** is provided inside the mold frame **10**, and provided on the optical sheets **500**.

The liquid crystal panel **30** displays images by adjusting intensity of the light passing through the liquid crystal panel **30**. The liquid crystal panel **30** is a display panel to display the images. The liquid crystal panel **30** includes a TFT substrate, a color filter substrate, a liquid crystal layer interposed between the above two substrates and polarizing filters.

As described above, the light emitting diode **300** is spaced apart from the light conversion member **400** by the spacer **220**. Accordingly, the light emitting diode **300** is sufficiently spaced apart from the light conversion member **400**, so that the light emitted from the light emitting diode **300** can be incident into the light conversion member **400** in the sufficiently diffused state.

Therefore, the liquid crystal display according to the embodiment can inhibit the light emitted from the light emitting diode **300** from being intensively incident into a part of the light conversion member **400**. Therefore, since the liquid crystal display according to the embodiment allows the light to be uniformly incident into the light conversion member **400**, the denaturalization of the light conversion particles caused by the intensively incident light can be inhibited.

In other words, the liquid crystal display according to the embodiment can inhibit a part of the light conversion particles from being degraded due to the intensive light irradiation onto the part of the light conversion particles.

In addition, the spacer **220** can enhance the strength of the light conversion member **400**. In other words, the light conversion member **400** is sandwiched between the spacer **220** and the light guide part **210** to protect the light conversion member **400**. Especially, if the tube **410** includes glass, the tube **410** is breakable. In this case, since the spacer **220** protects the tube **410**, the liquid crystal display according to the embodiment can represent improved strength.

Therefore, the display device according to the embodiment can represent improved life span and improved durability.

FIG. **5** is a sectional view showing a light emitting diode, an adhering member, a light conversion member, and a light guide plate according to a second embodiment. FIGS. **6** and **7** are sectional views showing the procedure of forming the adhering member according to the second embodiment. Hereinafter, the present embodiment will be described by making reference to the description of the liquid crystal display according to the previous embodiment, and a fourth adhering member will be further described. In other words, the description of the previous embodiment will be incorporated in the description of the present embodiment except for the modification.

Referring to FIGS. **5** to **7**, a fourth adhering member **304** is interposed between the light emitting diodes **300** and the light conversion member **400**.

The fourth adhering member **304** adheres to the light emitting diodes **300** and the light conversion member **400**. In addition, the fourth adhering member **304** spaces the light emitting diodes **300** apart from the light conversion member **400**. A width W4 of the fourth adhering member **304** is greater than a width W1 of the first adhering member **301**.

For example, the width W4 of the fourth adhering member **304** may be in the range of about 200 μm to about 2.5 mm. In detail, the width W4 of the fourth adhering member **304** may be in the range of about 600 μm to about 2.5 mm.

Therefore, the fourth adhering member **304** allows the light emitting diodes **300** to closely make contact with the light conversion member **400** while spacing the light emitting diodes **300** apart from the light conversion member **400** by a sufficient interval.

Referring to FIGS. **6** and **7**, the fourth adhering member **304** may be formed through the following scheme.

The light emitting diodes **300** are spaced apart from the light conversion member **400** by a desirable interval. In this case, the interval between the light emitting diodes **300** and the light conversion member **400** may be in the range of about 200 μm to about 2.5 mm. In detail, the interval between the light emitting diodes **300** and the light conversion member **400** may be in the range of about 600 μm to about 2.5 mm.

Thereafter, as shown in FIG. **6**, a photocurable resin composition **305** is injected between the light emitting diodes **300** and the light conversion member **400**. The photocurable resin composition **305** may include epoxy resin.

Thereafter, as shown in FIG. **7**, a UV light is irradiated onto the photocurable resin composition **305**, and the photocurable resin composition **305** is cured to form the fourth adhering member **304**.

As described above, the interval between the light emitting diode **300** and the light conversion member **400** is increased by a desirable value through the fourth adhering member **304**. Accordingly, the liquid crystal display according to the embodiment can represent improved life span and improved durability.

In addition, according to the liquid crystal display of the present embodiment, the interval between the light emitting diodes **300** and the light conversion member **400** can be increased without an additional member such as a spacer.

FIG. **8** is a sectional view showing a light emitting diode, a light conversion member, and a light guide plate according to a third embodiment. FIG. **9** is a sectional view showing the light emitting diode, the light conversion member, and the light guide plate according to the third embodiment. Hereinafter, the present embodiment will be described by making reference to the description of the liquid crystal display according to the previous embodiment, and a light guide plate will be additionally described. In other words, the description of the previous embodiment will be incorporated in the description of the present embodiments except for a modification.

Referring to FIGS. **8** and **9**, a groove **201** is formed in a light guide plate **200**. The groove **201** may be formed in a top surface of the light guide plate **200**. The groove **201** has a shape corresponding to a shape of the light conversion member **400**.

In other words, the depth of the groove **201** may correspond to the height of the light conversion member **400**. In addition, the width of the groove **201** may correspond to the width of the light conversion member **400**, and the depth of the groove **201** may be greater than the height of the light conversion member **400**, and the width of the groove **201** may be greater than the width of the light conversion member **400**.

In addition, the light guide plate **200** may include the light guide part **210**, the spacer **220**, and a first support part **231**.

The light guide part **210** guides the light passing through the light conversion member **400** among the lights converted by the light conversion member **400** to emit the light upward. In other words, the light guide part **210** reflects, refracts, and scatters the incident light to output the light upward through the top surface thereof.

In addition, a part of the inner lateral sides of the groove serves as an incident surface of the light guide part **210**.

The spacer **220** is interposed between the light emitting diodes **300** and the light conversion member **400**. The spacer **220** spaces the light emitting diodes **300** apart from the light conversion member **400**.

In other words, an interval between a light emitting diode **300** and the light conversion member **400** may be greater than a width W5 of the spacer **220**. For example, the width W5 of the spacer **220** may be in the range of about 200 μm to about 2.5 mm. In detail, the width W5 of the spacer **220** may be in the range of about 600 μm to about 2.5 mm. In more detail, the width W5 of the spacer **220** may be in the range of about 1 mm to about 2.5 mm.

The first support part **231** extends from the spacer **220** to the light guide part **210**. The first support part **231** is provided under the light conversion member **400**. In addition, the first support part **231** supports the light conversion member **400**.

The first support part **231** constitutes the bottom surface of the groove **201**. The light guide part **210**, the spacer **220**, and the first support part **231** are integrally formed. In other words, the light guide part **210**, the spacer **220**, and the first support part **231** may include the same material.

The light conversion member **400** is provided inside the groove **201**. The light conversion member **400** is inserted into the groove **201**.

In addition, the fifth adhering member may be filled in the groove **201**. The fifth adhering member may include a filling member fully filled in the groove **201**.

For example, the fifth adhering member may be interposed between the light conversion member **400** and the inner lateral side of the groove **201**. In addition, the fifth adhering member closely makes contact with the light conversion member **400** and the inner lateral side of the groove **201**.

In order to form the fifth adhering member, after inserting the light conversion member **400** into the groove **201**, the photocurable resin composition may be injected into the groove **201**. Thereafter, the resin composition injected into the groove **201** is cured by the UV light to form the fifth adhering member.

Since the light conversion member **400** is inserted into the groove **201**, the liquid crystal display according to the embodiment can be easily manufactured. Especially, according to the liquid crystal display of the present embodiment, a process of attaching the light conversion member and the spacer to the light guide plate **200** is not required.

Therefore, the liquid crystal display according to the present embodiment can be manufactured through a simple process with the improved life span and the improved durability.

FIG. **10** is a view showing a light emitting diode, a light conversion member, and a light guide plate according to a fourth embodiment. FIG. **11** is a sectional view showing the light emitting diode, the light conversion member, and the light guide plate according to the fourth embodiment. Hereinafter, the present embodiment will be described by making reference to the description of the liquid crystal display according to the previous embodiment, and a light guide plate will be further described. In other words, the description of the previous embodiments will be incorporated in the description of the present embodiment except for the modification.

Referring to FIGS. **10** and **11**, a groove **202** is formed in the lateral side of the light guide plate **200**. The groove **202** extends along the incident surface of the light guide plate **200**.

Therefore, the light guide plate **200** includes a light guide part **210**, the spacer **220**, and first and second support parts **231** and **232**.

The second support part **232** extends from the spacer **220** to the light guide part **210**. The second support part **232** is provided on the light conversion member **400**. In addition, the second support part **232** faces the first support part **231** while interposing the light conversion member **400** therebetween. In other words, the light conversion member **400** is sandwiched between the first and second support parts **231** and **232**.

The spacer **220**, the light guide part **210**, and the first and second support parts **231** and **232** surround the light conversion member **400**. The light conversion member **400** may be firmly fixed into the inner part of the light guide plate **200**. In other words, the light conversion member **400** is fixed into the light guide plate **200** by the second support part **232** so that the light conversion member **400** is not separated from the light guide plate **200**.

In order to fix the light conversion member **400** into the light guide plate **200**, an adhesive such as the adhering member is not required. Nevertheless, the photocurable resin composition may be injected into the groove and cured to form an adhering member.

Accordingly, the liquid crystal display according to the present embodiment may be manufactured through a simple process with improved life span and improved durability.

FIG. **12** is an exploded perspective view showing a liquid display device according to a fifth embodiment, and FIG. **13** is a view showing the light emitting diode, the light conversion member, and the light guide plate according to the fifth embodiment. FIG. **14** is a view showing the light emitting diode, the light conversion member, and the light guide plate according to the fifth embodiment, and FIG. **15** is a sectional view showing the light conversion member according to the fifth embodiment. FIGS. **16** and **17** are sectional views showing the manufacturing process of the light guide plate according to the fifth embodiment, and FIG. **18** is a perspective view showing a bottom surface of the light guide plate according to the fifth embodiment. Hereinafter, the present embodiment will be described by making reference to the description of the liquid crystal display according to the previous embodiment, and a light guide plate will be further described. In other words, the description of the previous embodiments will be incorporated in the description of the present embodiment except for the modification.

Referring to FIGS. **12** to **18**, the liquid crystal display according to the embodiment includes the mold frame **10**, the backlight assembly **20**, and the liquid crystal panel **30**.

The light guide plate **200** is provided on the reflective sheet **100**. The light guide plate **200** receives the light emitted from the light emitting diode **300** to output the light upward through reflection, refraction, and scattering. The light guide plate **200** serves as a light guide member to guide the light emitted from the light emitting diode **300**.

The light guide plate **200** includes an incident surface facing the light emitting diode **300**. In addition, a lateral side of the light guide plate **200** facing the light emitting diode **300** serves as the incident surface.

As shown in FIG. **13**, the light guide plate **200** receives the light conversion member **400**. In detail, the light guide plate **200** may surround the light conversion member **400**. The light guide plate **200** may surround the whole outer surface of the light conversion member **400**. The light guide plate **200** may cover both ends of the light conversion member **400**. The light guide plate **200** may cover all of an incident surface **401**, an exit surface **402**, a top surface **404**, and a bottom surface **403** of the light conversion member **400**.

In addition, the light guide plate **200** may directly adhere to the light conversion member **400**. In detail, the light guide plate **200** may directly adhere to at least one surface of the light conversion member **400**. In detail, the light guide plate **200** may close make contact with the incident surface **401**, the exit surface **402**, the bottom surface **403**, and the top surface **404** of the light conversion member **400**. In this case, the incident surface **401** of the light conversion member **400** is provided in opposition to the light emitting diode **300**. In addition, the incident surface **401** of the light conversion member **400** is provided in opposition to the exit surface **402** of the light conversion member **400**.

In other words, the light guide plate **200** may be integrally formed with the light conversion member **400**.

As shown in FIG. **14**, the light guide plate **200** includes the light guide part **210**, a light incident part **220**, and the first and second support parts **231** and **232**.

The light guide part **210** guides the light converted by the light conversion member **400** and the light passing through the light conversion member **400** to emit the light upward. In other words, the light guide part **210** reflects, refracts, and scatters the incident light to output the light upward through the top surface thereof.

In addition, the light guide part **210** adheres to the exit surface **402** of the light conversion member **400**. In detail, the light guide part **210** directly adheres to the exit surface **402** of the light conversion member **400**. In other words, an air layer does not exist between the light guide part **210** and the light conversion member **400**.

The light incident part **220** is interposed between the light emitting diode **300** and the light conversion member **400**. The light incident part **220** receives a light emitted from the light emitting diode **300**. The light incident part **220** adheres to the incident surface **401** of the light conversion member **400**. In detail, the incident part **220** directly adheres to the incident surface **401** of the light conversion member **400**. The air layer does not exist between the light incident part **220** and the light conversion member **400**.

The light incident part **220** spaces the light emitting diode **300** apart from the light conversion member **400**. The light incident part **220** serves as a spacer to increase the interval between the light emitting diode **300** and the light conversion member **400**.

The interval between the light emitting diodes **300** and the light conversion member **400** may be greater than the width of the light incident part **220**. For example, the width of the light incident part **220** may be in the range of about 200 μm to about 2.5 mm. In more detail, the width of the light incident part **220** may be in the range of about 600 μm to about 2.5 mm.

The first support part **231** extends from the light incident part **220** to the light guide part **210**. The first support part **231** is provided under the light conversion member **400**. In addition, the first support part **231** supports the light conversion member **400**.

In addition, the first support part **231** may adhere to a bottom surface **403** of the light conversion member **400**.

The second support part **232** extends from the light incident part **220** to the light guide part **210**. The second support part **232** is provided on the light conversion member **400**. In addition, the second support part **232** faces the first support part **231** while interposing the light conversion member **400** therebetween. In other words, the light conversion member **400** is sandwiched between the first and second support parts **231** and **232**.

The second support part **232** may adhere to a top surface **404** of the light conversion member **400**.

The light incident part **220**, the light guide part **210**, and the first and second support parts **231** and **232** surround the light conversion member **400**. Therefore, the light conversion member **400** may be firmly fixed into the inner part of the light guide plate **200**. The light conversion member **400** is fixed into the light guide plate **200** by the second support part **232** so that the light conversion member **400** is not separated from the light guide plate **200**.

As shown in FIGS. **13** and **14**, the light conversion member **400** is provided in the light guide plate **200**. The light conversion member **400** may be integrally formed with the light guide plate **200**. The light conversion member **400** and the light guide plate **200** are integrally formed with each other to constitute a light conversion guide member to change the wavelength and the path of the incident light.

In other words, the light conversion guide member is one optical member. The light conversion guide member converts the wavelength of the light emitted from the light emitting diode **300** and changes the light into the surface light to be output upward.

In addition, the light emitting diode **300** may be attached to the light incident part **220**. In this case, the adhering member **303** may be interposed between the light emitting diode **300** and the light incident part **220**. The adhering member **303** may adhere to the light emitting diode **300** and the light incident part **220**.

Referring to FIGS. **16** and **17**, the light conversion member **400** may be inserted into the light guide plate **200** through the following process. The light guide plate **200** may be formed through a dual injection process.

As shown in FIG. **16**, the light conversion member **400** is provided in a first mold **40**. The first mold **40** may include a molding groove **42** having the shape corresponding to the shape of the light guide plate **200**.

In addition, the first mold **40** may include fixing protrusions **41** to fix the light conversion member **400**. The fixing protrusions **41** may support the lateral sides of the light conversion member **400**.

Referring to FIG. **17**, a material **209** is injected into the molding groove **42** in order to form the light guide plate **200**. The material **209** is fully filled in the molding groove **42** while surrounding the light conversion member **400**. In other words, the material **209** may be injected into the molding groove **42** in such a manner that the material **209** adheres to the whole outer surface of the light conversion member **400**.

Next, a second mold **50** presses the material **209** filled in the molding groove **42**, and the resultant structure is subject to a cooling process. Thereafter, the light guide plate **200** may be formed.

In addition, the light guide plate **200** may be formed through a photo curing process and/or a thermal curing process. The material **209** may include a photocurable material and/or a thermal curable material. In this case, the material filled in the molding groove **42** is cured by light and/or a heat to form the light guide plate **200**.

As shown in FIG. **18**, grooves **208** may be formed in the light guide plate **200** by the fixing protrusions **41**. In other words, the grooves **208** correspond to the fixing protrusions **41**. The grooves **208** may be formed in the bottom surface of the light guide plate **200**.

The light conversion member **400** is inserted into the light guide plate **200**. Therefore, the light guide plate **200** and the light conversion member **400** may be integrally formed with each other. Accordingly, the light conversion member **400** and the light guide plate **200** may be simply assembled in order to manufacture the liquid crystal display according to the embodiment.

In addition, the light conversion member **400** may directly adhere to the light guide plate **200**. Therefore, light loss between the light conversion member **400** and the light guide plate **200** can be minimized. Therefore, the liquid crystal display according to the embodiment can represent improved brightness and improved color representation.

In addition, since the light conversion member **400** is provided in the light guide plate **200**, the light conversion member **400** can be effectively protected by the light guide plate **200**. In particular, the light conversion member **400** can be effectively protected from external physical impact and external chemical impact by the light guide plate **200**. In particular, the light conversion particles **410** can be effectively protected from oxygen and/or moisture by the light guide plate **200**.

Therefore, the liquid crystal display according to the embodiment can represent improved reliability and improved durability.

In addition, as described above, the light emitting diode **300** is spaced apart from the light conversion member **400** by the light incident part **220**. Accordingly, the light emitting diode **300** is sufficiently spaced apart from the light conversion member **400**, so that the light emitted from the light emitting diode **300** can be incident into the light conversion member **400** in the sufficiently diffused state.

Therefore, the liquid crystal display according to the embodiment can inhibit the light emitted from the light emitting diode **300** from being intensively incident into a part of the light conversion member **400**. Therefore, since the liquid crystal display according to the embodiment allows the light to be uniformly incident into the light conversion member **400**, the denaturalization of the light conversion particles caused by the intensively incident light can be inhibited.

In other words, according to the liquid crystal display of the embodiment, a light is intensively irradiated onto a part of the light conversion particles, thereby inhibiting the denaturalization of the part of the light conversion particles.

Therefore, the display device according to the embodiment can represent improved life span and improved durability.

FIG. **19** is a perspective view showing a light conversion member and a light guide plate according to a sixth embodiment, and FIG. **20** is a sectional view showing the light emitting diode, the light conversion member, and the light guide plate according to the sixth embodiment. FIG. **21** is a sectional view showing a light emitting diode, a light guide plate, and a light conversion member according to a seventh embodiment. Hereinafter, the present embodiment will be described by making reference to the description of the liquid crystal display according to the previous embodiment, and a light guide plate will be additionally described. In other words, the description of the previous embodiment will be incorporated in the description of the present embodiments except for a modification.

Referring to FIGS. **19** and **20**, a part of the light conversion member **400** may be exposed out of the light guide plate **200**. In detail, the incident surface **401** of the light conversion member **400** may be exposed out of the light guide plate **200**.

The incident surface **401** of the light conversion member **400** is provided in opposition to the light emitting diode **300**. In other words, the incident surface of the light conversion member **400** faces the light emitting diode **300**.

Accordingly, the light emitted from the light emitting diode **300** can be directly incident onto the light conversion member **400**.

Therefore, the liquid crystal display according to the present embodiment can reduce light loss and represent more improved brightness.

Referring to FIG. **21**, the light emitting diode **300** may be inserted into the light guide plate **200**. In other words, the light guide plate **200** may adhere to the light emitting diode **300** and the light conversion member **400**. The light emitting diode **300** and the light conversion member **400** are integrally formed with the light guide plate **200**.

Therefore, the light emitted from the light emitting diode **300** is directly incident onto the light incident part **220**. Accordingly, the liquid crystal display according to the present embodiment can reduce light loss and represent more improved brightness.

In addition, since the light emitting diode **300**, the light conversion member **400**, and the light guide plate **200** are integrally formed with each other, the liquid crystal display according to the embodiment can be easily assembled.

FIG. **22** is a perspective view showing a light emitting diode, a light guide plate, and a light conversion member according to an eighth embodiment, and FIG. **23** is a sectional view showing the light emitting diode, the light guide plate, and the light conversion member according to the eighth embodiment. Hereinafter, the present embodiment will be described by making reference to the description of the liquid crystal display according to the previous embodiment, and a light guide plate will be further described. In other words, the description of the previous embodiments will be incorporated in the description of the present embodiment except for the modification.

Referring to FIGS. **22** and **23**, the groove **201** is formed in the light guide plate **200**. The groove **201** may be formed in the top surface of the light guide plate **200**. The groove **201** has a shape corresponding to a shape of the light conversion member **400**.

In other words, the depth of the groove **201** may correspond to the height of the light conversion member **400**. In addition, the width of the groove **201** may correspond to the width of the light conversion member **400**. In addition, the depth of the groove **201** may be greater than the height of the light conversion member **400**, and the width of the groove **201** may be greater than the width of the light conversion member **400**.

In addition, the light guide plate **200** may include the light guide part **210**, the light incident part **220**, and the first support part **231**.

The light guide part **210** guides the light converted by the light conversion member **400** and the light passing through the light conversion member **400** to emit the light upward. In other words, the light guide part **210** reflects, refracts, and scatters the incident light to output the light upward through the top surface thereof.

In addition, a part of the inner lateral sides of the groove **201** serves as an incident surface of the light guide part **210**.

The light incident part **220** is interposed between the light emitting diode **300** and the light conversion member **400**. The light incident part **220** spaces the light emitting diode **300** apart from the light conversion member **400**.

In other words, the interval between the light emitting diode **300** and the light conversion member **400** may be greater than the width of the light incident part **220**. For example, the width of the light incident part **220** may be in the range of about 200 μm to about 2.5 mm. In more particular, the width of the light incident part **220** may be in the range of about 600 μm to about 2.5 mm.

The first support part **231** extends from the light incident part **220** to the light guide part **210**. The first support part **231** is provided under the light conversion member **400**. In addition, the first support part **231** supports the light conversion member **400**.

The first support part **231** constitutes the bottom surface of the groove **201**. The light guide part **210**, the spacer **220**, and the first support part **231** are integrally formed with each other. In other words, the light guide part **210**, the spacer **220**, and the first support part **231** may include the same material.

The light conversion member **400** is provided inside the groove **201**. In an embodiment, the light conversion member **400** is inserted into the groove **201**.

In addition, the adhering member **350** may be filled in the groove **201**. In other words, the adhering member **350** may include a filling member fully filled in the groove **201**.

For example, the adhering member **350** may be interposed between the light conversion member **400** and the inner lateral side of the groove **201**. In addition, the adhering member **350** may adhere to the light conversion member **400** and the inner lateral side of the groove **201**.

In order to form the adhering member **350**, after inserting the light conversion member **400** into the groove **201**, the photocurable resin composition may be injected into the groove **201**. Thereafter, the resin composition injected into the groove **201** is cured by the UV light to form the adhering member **350**.

Since the light conversion member **400** is inserted into the groove **201**, the liquid crystal display according to the embodiment can be easily manufactured.

Therefore, the liquid crystal display according to the present embodiment can be manufactured through a simple process with improved life span and improved durability.

FIG. **24** is an exploded perspective view showing a liquid crystal display according to a ninth embodiment, FIG. **25** is a perspective view showing light emitting diodes, a light guide plate, and a light conversion member according to the ninth embodiment, FIG. **26** is a sectional view showing the liquid crystal display according to the ninth embodiment, and FIG. **27** is a sectional view showing the light conversion member according to the ninth embodiment. Hereinafter, the present embodiment will be described by making reference to the description of the liquid crystal display according to the previous embodiment, and a light guide plate will be further described. In other words, the description of the previous embodiments will be incorporated in the description of the present embodiment except for the modification.

Referring to FIGS. **24** to **27**, the liquid crystal display according to the embodiment includes the mold frame **10**, the backlight assembly **20**, and the liquid crystal panel **30**.

The light guide plate **200** has an incident surface facing the light emitting diode **300**. In other words, a lateral side of the light guide plate **200** facing the light emitting diode **300** serves as the incident surface.

The light guide plate **200** may be provided on the incident surface thereof with a lens pattern **240**. The lens pattern **240** may have the shape of a Fresnel lens. In addition, the lens pattern **240** may include a protrusion pattern or a stripe pattern.

In addition, the light guide plate **200** is an optical member. In detail, the light guide plate **200** serves as a light guide plate.

Referring to FIGS. **25** and **26**, the groove **201** is formed in the light guide plate **200**. The groove **201** may be formed in the top surface of the light guide plate **200**. The groove **201** has a shape corresponding to a shape of the light conversion member **400**. The groove **201** may include the bottom surface to support the light conversion member **400**. In addition, the groove **201** may be formed by perforating the entire portion of the light guide plate **200**.

The depth of the groove **201** may correspond to the height of the light conversion member **400**. In addition, the width of the groove **201** may correspond to the width of the light conversion member **400**. In addition, the depth of the groove **201** may be greater than the height of the light conversion member **400**, and the width of the groove **201** may be greater than the width of the light conversion member **400**.

In addition, the light guide plate **200** may include the light guide part **210**, the spacer **220**, and the support part **230**.

The light guide part **210** guides the light converted by the light conversion member **400** and the light passing through the light conversion member **400** to emit the light upward. In other words, the light guide part **210** reflects, refracts, and scatters the incident light to output the light upward through the top surface thereof.

In addition, a part of the inner lateral sides of the groove **201** serves as the incident surface of the light guide part **210**.

The spacer **220** is provided between the light emitting diodes **300** and the light conversion member **400**. The spacer **220** spaces the light emitting diodes **300** apart from the light conversion member **400**.

In other words, the interval between the light emitting diodes **300** and the light conversion member **400** may be greater than the width of the spacer **220**. For example, the width of the spacer **220** may be in the range of about 200 μm to about 2.5 mm. In more detail, the width of the spacer **220** may be in the range of about 600 μm to about 2.5 mm.

The support part **230** extends from the spacer **220** to the light guide part **210**. The support part **230** is provided under the light conversion member **400**. In addition, the support part **230** supports the light conversion member **400**.

The support part **230** constitutes the bottom surface of the groove **201**. The light guide part **210**, the spacer **220**, and the support part **230** are integrally formed with each other. In other words, the light guide part **210**, the spacer **220**, and the support part **230** may include the same material.

The light conversion member **400** is provided inside the groove **201**. In an embodiment, the light conversion member **400** is inserted into the groove **201**.

In addition, the adhering member **301** may be filled in the groove **201**. In other words, the adhering member **301** may include a filling member fully filled in the groove **201**. For example, the adhering member **301** may be interposed between the light conversion member **400** and the inner lateral side of the groove **201**. In addition, the adhering member **301** may adhere to the light conversion member **400** and the inner lateral side of the groove **201**.

In order to form the adhering member **301**, after inserting the light conversion member **400** into the groove **201**, the photocurable resin composition may be injected into the groove **201**. Thereafter, the resin composition injected into the groove **201** is cured by the UV light to form the adhering member **301**.

The light conversion member **400** extends in one direction. In detail, the light emitting diodes **300** are arranged in line with each other in one direction. In this case, the light conversion member **400** may extend in a direction in which the light emitting diodes **300** are arranged in line with each other.

The light emitting diodes **300** are arranged at the lateral side of the light guide plate **200**. In detail, the light emitting diodes **300** are provided at the incident surface. The light emitting diodes **300** serve as a light source to generate lights. In more detail, the light emitting diodes **300** emit lights toward the light conversion member **400**.

The light conversion member **400** is provided inside the groove **201**. In an embodiment, the light conversion member **400** is inserted into the groove **201**. In more detail, the light conversion member **400** is interposed between the spacer **220** and the light guide part **210**.

As described above, since the light conversion member **400** is inserted into the light guide plate **200**, the light emitting diodes **300** are spaced apart from the light conversion member **400**. Accordingly, the light emitting diodes **300** are sufficiently spaced apart from the light conversion member **400**, so that the lights emitted from the light emitting diodes **300** can be incident into the light conversion member **400** in the sufficiently diffused state.

Therefore, the liquid crystal display according to the embodiment can inhibit the light emitted from the light emitting diode **300** from being intensively incident into a part of the light conversion member **400**. Therefore, since the liquid crystal display according to the embodiment allows the light to be uniformly incident into the light conversion member **400**, the denaturalization of the light conversion particles caused by the intensively incident light can be inhibited.

In other words, the liquid crystal display according to the embodiment can inhibit a part of the light conversion particles from being degraded due to the intensive light irradiation onto the part of the light conversion particles.

In addition, the light conversion member **400** is spaced apart from the light emitting diodes **300**, thereby inhibiting the light conversion particles from being degraded due to the heat emitted from the light emitting diodes **300**.

Accordingly, the liquid crystal display according to the embodiment can represent improved life span and improved durability.

FIG. **28** is a sectional view showing a light emitting diode, a light guide plate, and a light conversion member according to a tenth embodiment. Hereinafter, the present embodiment will be described by making reference to the description of the liquid crystal display according to the previous embodiment, and the shape of the groove will be further described. In other words, the description of the previous embodiments will be incorporated in the description of the present embodiment except for the modification.

Referring to FIG. **28**, the groove **202** is formed in the top surface of the light guide plate **200**. The groove **202** includes a first inner lateral side **211** inclined with respect to the light guide plate **200**. In addition, the groove **202** includes a second inner lateral side **212** provided in opposition to the first inner lateral side **211**. The second inner lateral side **212** may be perpendicular to the top surface of the light guide plate **200**. In addition, the groove **202** may include a bottom surface extending from the first inner lateral surface **211** to the second inner lateral surface **212**.

A distance D1 from the first inner lateral side **211** to the light conversion member **400** may be gradually decreased as the groove **201** becomes deeper. In other words, the width of the groove **201** may be gradually increased toward the entrance of the groove **202**.

In addition, the adhering member **301** may be filled in the groove **202**. In detail, the adhering member **301** may be filled between the first inner lateral side **211** and the light conversion member **400**.

Since the first inner lateral side **211** is inclined with respect to the top surface of the light guide plate **200**, the groove **202** may have a wide entrance. Therefore, the light conversion member **400** may be easily inserted into the groove **202**.

The second inner lateral side **212** is a base to determine the position of the light conversion member **400**. That is, after inserting the light conversion member **400** into the groove **202**, a worker directly brings the light conversion member **400** into contact with the second inner lateral side **212**. Thereafter, resin composition is filled in the groove **202** to form the adhering member **301** and cured, so that the light conversion member **400** can be fixed into the groove **202**.

The light conversion member **400** can be fixed to the exact position in the groove **202**. Therefore, the liquid crystal display according to the embodiment can be easily manufactured and represent an improved optical characteristic.

FIG. **29** is a sectional view showing a light emitting diode, a light guide plate, and first and second light conversion members according to an eleventh embodiment. Hereinafter, the present embodiment will be described by making reference to the description of the liquid crystal display according to the previous embodiment, and the first and second light conversion members will be further described. In other words, the description of the previous embodiments will be incorporated in the description of the present embodiment except for the modification.

Referring to FIG. **29**, the liquid crystal display according to the present embodiment includes first and second light conversion members **401** and **402**.

The light guide plate **200** is provided therein with first and second grooves **203** and **204**.

The first groove **203** is formed in a top surface **207** of the light guide plate **200**. The second groove **204** is formed in a bottom surface **209** of the light guide plate **200**. In this case, the top surface **207** of the light guide plate **200** is provided in opposition to the bottom surface **209** of the light guide plate **200**. In addition, an incident surface **208** of the light guide plate **200** extends from the top surface **207** of the light guide plate **200** to the bottom surface **209** of the light guide plate **200**.

The first and second grooves **203** and **204** are deviated from each other. In other words, when viewed in a plan view, the first and second grooves **203** and **204** may be deviated from each other. In addition, the first groove **203** is overlapped with the second groove **204**. In addition, when viewed in a side view, the first and second grooves **203** and **204** are overlapped with each other. In more detail, when viewed from the light emitting diode, the first and second grooves **203** and **204** may be overlapped with each other.

The first light conversion member **401** is inserted into the first groove **203**, and the second light conversion member **402** is inserted into the groove **204**. Similarly, when viewed from the light emitting diode, the first and second grooves **203** and **204** may be overlapped with each other.

As described above, according to the liquid crystal display of the embodiment, at least two light conversion members **401** and **402** are inserted into the top and bottom surfaces of the light guide plate **200**. Therefore, almost all of lights emitted from the light emitting diodes **300** pass through the first light conversion member **401** or the second light conversion member **402**.

Therefore, the liquid crystal display according to the embodiment can represent improved color representation.

FIG. **30** is a sectional view showing a light emitting diode, a light guide plate, and first and second light conversion members according to a twelfth embodiment. Hereinafter, the present embodiment will be described by making reference to the description of the liquid crystal display according to the previous embodiment. In other words, the description of the previous embodiments will be incorporated in the description of the present embodiment except for the modification.

Referring to FIG. **30**, the first light conversion member **401** is inserted into the light guide plate **200** in a direction in which the first light conversion member **401** is inclined with respect to the top surface of the light guide plate **200**. In addition, the second light conversion member **402** is inserted into the light guide plate **200** in a direction in which the second light conversion member **402** is inclined with respect to the bottom surface of the light guide plate **200**.

The first groove **205** includes first and second inner lateral sides **213** and **214** inclined with respect to the top surface of the light guide plate **200**. The first inner lateral side **213** is provided in opposition to the second inner lateral side **214** while being parallel to the second inner lateral side **214**. Similarly, the second groove **206** includes third and fourth inner lateral sides **215** and **216** inclined with respect to the bottom surface of the light guide plate **200**. The third inner lateral side **215** is provided in opposition to the fourth inner lateral side **216** while being parallel to the fourth inner lateral side **216**.

The first and second light conversion members **401** and **402** are inserted into the first and second grooves **205** and **206**, respectively, in such a manner that the first and second light conversion members **401** and **402** are inclined with respect to the first and second grooves **205** and **206**, respectively.

The first and second light conversion members **401** and **402** may be inclined toward the light emitting diode **300**. Therefore, as the first groove **205** becomes deeper, a distance D2 between the light emitting diode **300** and the first light conversion member **401** may be gradually increased. In addition, as the second groove **206** becomes deeper, a distance D3 between the light emitting diode **300** and the second light conversion member **402** may be gradually increased.

As described above, the first and second light conversion members **401** and **402** are inserted into the light guide plate **200** in the direction in which the first and second light conversion members **401** and **402** are inclined with respect to the light guide plate **200**. Therefore, the light emitted from the light emitting diode **300** may pass through the first and second light conversion members **401** and **402** on a longer path.

Therefore, the liquid crystal display according to the present embodiment can represent improved color representation.

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, 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 effects such feature, structure, or characteristic in connection with other ones of the embodiments.

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 spirit and scope of the principles of 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.

What is claimed is:

[1. A display device comprising:

a light source;

a light guide part to receive a light emitted from the light source;

a light conversion member between the light source and the light guide part;

a spacer between the light source and the light conversion member;

a first support part extending from the spacer to the light guide part while supporting the light conversion member; and

a second support part facing the first support part while interposing the light conversion member therebetween.**]**

[2. The display device of claim **1**, wherein the spacer has a width in a range of about 200 μm to about 2.5 mm.**]**

[3. The display device of claim **2**, wherein the spacer adheres to the light conversion member and the light source.**]**

[4. The display device of claim **1**, wherein the spacer has a refractive index corresponding to a refractive index of the light guide plate.**]**

[5. The display device of claim **1**, wherein the spacer, the first support part, the second support part and the light guide part are integrally formed with each other.**]**

[6. A display device comprising:

a light guide plate;

a light source at one side of the light guide plate;

a light conversion member in a groove defined in the light guide plate; and

a display panel on the light guide plate,

wherein the groove comprises a first inner lateral side inclined with respect to a top surface of the light guide plate, and a distance between the first inner lateral side and the light conversion member is gradually decreased as the groove becomes deeper.**]**

[7. The display device of claim **6**, wherein

an effective display region to display an image is defined in the display panel provided on the light guide plate,

a central region corresponding to the effective display region and an outer region around the central region are defined in the light guide plate, and

the light conversion member is provided in the outer region.**]**

[8. The display device of claim **6**, wherein the light guide plate comprises:

a spacer between the light source and the light conversion member; and

a light guide part in which the light conversion member is sandwiched between the spacer and the light guide part.**]**

[9. The display device of claim **8**, wherein the light guide plate further comprises a first support part extending from the spacer to the light guide part while supporting the light conversion member.**]**

[10. The display device of claim **9**, wherein the light guide plate further comprises a second support part facing the first support part while interposing the light conversion member therebetween.**]**

[11. The display device of claim **6**, further comprising an adhering member filled in the groove to adhere to the light conversion member and an inner lateral side of the groove.**]**

[12. The display device of claim **6**, wherein a first groove is formed in a top surface of the light guide plate, and

a second groove is formed in a bottom surface provided in opposition to the top surface of the light guide plate, and

wherein the light conversion member comprises:

a first light conversion member in the first groove; and

a second light conversion member in the second groove.**]**

[**13**. The display device of claim **12**, wherein the first and second light conversion members are overlapped with each other when viewed from the light source.]

[**14**. A display device comprising:

a light guide plate;

a light source to emit a light to the light guide plate;

a light conversion member in the light guide plate; and

a display panel on the light guide plate, wherein a first groove is formed in a top surface of the light guide plate, and

a second groove is formed in a bottom surface provided in opposition to the top surface of the light guide plate, and

wherein the light conversion member comprises:

a first light conversion member in the first groove; and

a second light conversion member in the second groove.]

[**15**. The display device of claim **14**, wherein the first and second light conversion members are overlapped with each other when viewed from the light source.]

[**16**. The display device of claim **14**, wherein

an effective display region to display an image is defined in the display panel provided on the light guide plate,

a central region corresponding to the effective display region and an outer region around the central region are defined in the light guide plate, and

the light conversion member is provided in the outer region.]

17. A display device comprising:

a light source;

a light guide part to receive a light emitted from the light source;

a light conversion member between the light source and the light guide part;

a spacer disposed on an incident surface of the light conversion member;

a first support part disposed under the light conversion member; and

a second support part facing the first support part while interposing the light conversion member therebetween,

wherein the light conversion member comprises:

a tube;

a plurality of quantum dots in the tube; and

a matrix in the tube,

wherein the light conversion member is between the spacer and the light guide part,

wherein the light source includes a plurality of LEDs arranged in line with each other in a direction,

wherein the tube extends in the direction in which the plurality of LEDs are arranged,

wherein the plurality of LEDs are spaced apart from the light conversion member by the spacer, and

wherein the spacer, the first support part, and the second support part include the same material and are directly in contact with the light conversion member.

18. The display device of claim 17, wherein the tube includes a capillary glass.

19. The display device of claim 17, wherein the spacer has a width in a range of 200 μm to 2.5 mm.

20. The display device of claim 17, wherein the tube extends in the direction along a length of the tube.

21. The display device of claim 17, wherein the matrix includes polymer.

22. The display device of claim 17, further comprising an air layer in the tube.

23. The display device of claim 17, further comprising a circuit board mounting the plurality of LEDs.

24. The display device of claim 17, wherein the tube is sealed at at least one end of the tube.

25. The display device of claim 24, wherein the tube is sealed by a sealing part.

26. The display device of claim 17, wherein the spacer is between the light source and the light conversion member.

27. A display device comprising:

a light source;

a light guide part to receive a light emitted from the light source;

a light conversion member between the light source and the light guide part;

a spacer disposed on an incident surface of the light conversion member;

a first support part extending from the spacer toward the light guide part while supporting the light conversion member; and

a second support part facing the first support part while interposing the light conversion member therebetween,

wherein the light conversion member comprises:

a tube;

a plurality of quantum dots in the tube; and

a matrix in the tube,

wherein the light conversion member is between the spacer and the light guide part,

wherein the light source includes a plurality of LEDs arranged in line with each other in a direction,

wherein the tube extends in the direction in which the plurality of LEDs are arranged, and

wherein the plurality of LEDs are spaced apart from the light conversion member by the spacer.

28. The display device of claim 27, wherein the tube include a capillary glass.

29. The display device of claim 27, wherein the first support part is provided under the light conversion member.

30. The display device of claim 27, wherein the second support part is provided on the light conversion member.

31. The display device of claim 27, wherein the light conversion member is sandwiched between the first and second support part.

32. The display device of claim 27, wherein the spacer, the first support part, and the second support part include the same material.

33. The display device of claim 27, wherein the tube extends in the direction along a length of the tube.

34. The display device of claim 27, further comprising an air layer in the tube.

35. The display device of claim 27, wherein the tube is sealed at at least one end of the tube.

36. The display device of claim 27, wherein the spacer is between the light source and the light conversion member.

* * * * *