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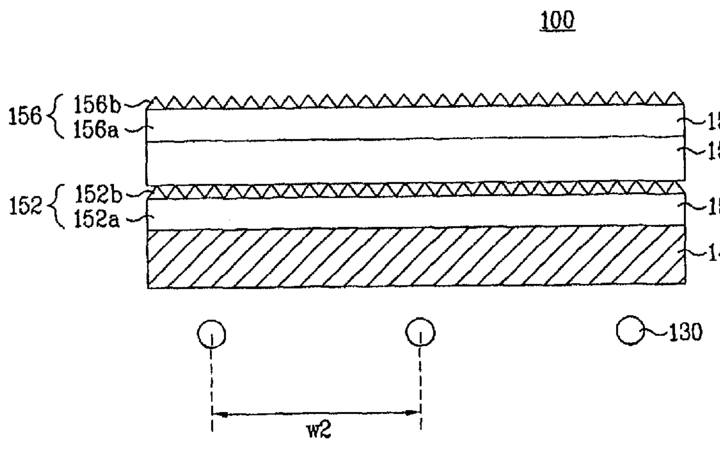
(54) **Title:** BACK LIGHT UNIT AND LIQUID CRYSTAL DISPLAY MODULE USING THE SAME

【Figure 6】



(57) Abstract: A back light unit capable of achieving a reduction in thickness and manufacturing costs is disclosed. The back light unit includes light sources arranged in parallel, to emit light, a case receiving the light sources, a diffuser plate diffusing the light from the light sources, condensers laminated on the diffuser plate and having predetermined thicknesses, and a diffuser interposed between the adjacent condensers. The distance from the lamps to the diffuser plate is reduced by the diffuser plate and the optical sheets (three or four sheets) laminated over the diffuser plate, to reduce the total thickness of the back light unit. Also, the number of lamps is reduced by 2 to 4, as compared to the conventional back light unit, so that the manufacturing costs of the back light unit is reduced. The brightness difference exhibited on the display screen is also reduced, so that a brightness uniformity is achieved.

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【DESCRIPTION】

【Invention Title】

BACK LIGHT UNIT AND LIQUID CRYSTAL DISPLAY MODULE USING THE SAME

【Technical Field】

The present invention relates to a back light unit and a liquid crystal display module using the same, and more particularly, to a back light unit capable of achieving a reduction in thickness and a reduction in manufacturing costs, and a liquid crystal display module using the same.

【Background Art】

Recently, various flat panel display devices have been developed which can eliminate disadvantages of cathode ray tubes (CRTs) caused by bulky and heavy structures thereof. Such flat panel display devices include a liquid crystal display (LCD), a field emission display (FED), a plasma display panel (PDP), and a light emitting display (LED).

Recently, the importance of display devices as visual information media has been emphasized, so various flat panel display devices have been developed.

Such flat panel display devices include a liquid crystal display (LCD), a field emission display (FED), a plasma display panel (PDP), an electroluminescence (EL), etc.

Of such flat panel display devices, the LCD exhibits an expanded application range by virtue of lightness, thinness, low power consumption, etc. In accordance with the expanded application range, the LCD is used for a portable computer such as a notebook PC, an office automation appliance, an audio/video appliance, an indoor/outdoor advertising display, etc. The LCD has also been rapidly developed toward a large size and a high resolution, by virtue of the development of techniques for mass production and the results of research and development.

A general LCD device includes an LCD module, and a driving circuit for driving the LCD module.

In detail, the LCD device includes a liquid crystal panel having liquid crystal cells arranged in the form of a matrix between two glass substrates, a back light unit for irradiating light to the liquid crystal panel, and a driving circuit for driving the liquid crystal panel and back light unit.

In the LCD module, a plurality of optical sheets are arranged to change the travel direction of light traveling from the back light unit toward the liquid crystal panel such that the light is directed in a direction perpendicular to the liquid crystal panel. The liquid crystal panel, back light unit, and optical sheets should be coupled together to form an integrated structure, in order to avoid optical loss. They should also be protected from damage caused by an external impact. To this end, a case for the LCD device, which is formed to enclose the periphery of the liquid crystal panel, back light unit, and optical sheets, is provided.

FIG. 1 is a cross-sectional view illustrating a general LCD module using a direct type back light unit.

Referring to FIG. 1, the back light unit 10 of the LCD device includes a plurality of lamps 30 for irradiating light to a liquid crystal panel (not shown) as a display screen, a diffuser plate 40 for diffusing the light incident from the lamps 30, thereby causing the diffused light to be irradiated to the liquid crystal panel, a lamp housing 20 arranged at the backside of the lamps 30, and a plurality of optical sheets 50 laminated on the diffuser plate 40.

For each lamp 30, a cold cathode fluorescent lamp is mainly used. Each lamp 30 includes a glass tube, an inert gas contained in the glass tube, and a cathode and an anode respectively mounted to opposite ends of the glass tube. Light emitted from each lamp 30 is incident to the diffuser plate 40.

The number of required lamps 30 increases in proportion to the size of the display screen. In the case of an LCD device having a screen size of 40 to 42 inches, 14 to 16 lamps are mounted. Also, the lamps 30 are arranged such that the adjacent lamps 30 are spaced apart from each other by a distance "W1 (22mm)".

In the lamp housing 20, a reflection sheet or a reflection plate is mounted to reflect light toward the diffuser plate 40. The lamps 30 are also mounted in the lamp housing 20. The reflection sheet or reflection plate is made of a material capable of reflecting light. The reflection sheet or reflection plate is formed to correspond to the bottom surface and inclined side surfaces of the lamp housing 20. Accordingly, the reflection sheet or reflection plate reflects light toward the diffuser plate 40, thereby enhancing the efficiency of light irradiated to the liquid crystal panel. Here, the lamp housing means a bottom chassis of the LCD device.

The diffuser plate 40 causes incident light from the lamps 30 to be directed to the front of the display surface while diffusing the light such that the light is uniformly distributed over a wide range. The diffuser plate 40 irradiates the diffused light to the liquid crystal panel.

The light emitted from each lamp 30 is incident to the display screen via the diffuser plate 40 and optical sheets 50. The light emerging from the diffuser plate 40 is diffused light having a large viewing angle. The light incident to the display screen exhibits an increased light efficiency when it is perpendicular to the display screen. In order to enhance the efficiency of the light emerging from the diffuser plate 40, a plurality of optical sheets 50 are arranged on the diffuser plate 40.

FIG. 2 is an enlarged sectional view of a part of the back light unit shown in FIG. 1.

Referring to FIG. 2, the plurality of optical sheets 50, for example, first to third optical sheets, change the direction of the light emerging from the diffuser plate 40 such that the light is directed in a direction perpendicular to a display screen, to achieve an enhancement in light efficiency. To this end, the back light unit includes a first diffuser sheet 52 for diffusing light emerging from the diffuser plate 40 over the overall region of the display screen, a prism sheet 54 for changing the traveling angle of the light diffused by the first diffuser sheet 52 such that the diffused light is directed in a direction perpendicular to the display screen, and a second diffuser sheet 56 for diffusing the light emerging from the prism sheet 54 over the overall region of the liquid crystal panel while enhancing the efficiency of the light.

The second optical sheet may be substituted by a diffuser sheet. If necessary, the third optical sheet may be substituted by a dual brightness enhancement film (DBEF), in order to achieve a further increase in brightness. Accordingly, the light emerging from the diffuser plate 40 is incident to the display screen via the plurality of optical sheets 50.

However, the conventional back light unit 10, which has a general configuration as described above, requires a certain distance from the plurality of lamps 30 to the diffuser plate 40, in order to obtain a uniform brightness at the display screen.

As shown in FIG. 1, the conventional back light unit 10 has a large thickness "d1 (37mm)" because the distance from the plurality of lamps 30 to the diffuser plate 40 is long. Since the back light unit 10 has a large thickness of 37mm, there is a drawback in terms of an important factor of the flat panel display device, namely, thinness.

In addition, although the conventional back light unit 10 uses a plurality of optical sheets 50 to achieve an enhancement in the uniformity of light irradiated to the display screen, a brightness difference corresponding to a value "A" is generated on the display screen because the brightness at a portion of the display screen arranged directly over each lamp 30 is high, whereas the brightness at a portion of the display screen arranged between the adjacent lamps 30 is low, as shown in FIG. 3. Such a brightness difference causes a degradation in the display quality of the display device.

In order to reduce the brightness difference, it is necessary to increase the distance from the plurality of lamps 30 to the diffuser plate 40. In this case, however, the LCD device has a further increased thickness. Meanwhile, an auxiliary light source may be mounted between the adjacent lamps, to achieve an enhancement in brightness uniformity. In this case, however, an increase in manufacturing costs occurs because the total number of light sources increases due to the provision of the auxiliary light source.

【Disclosure】

【Technical Problem】

It is an object of the present invention is to provide a back light unit having a reduced thickness without a degradation in brightness. Another object of the present invention is to provide a liquid crystal display device which achieves an enhancement in display quality, using the back light unit. Still another object of the present invention is to provide a liquid crystal display device which achieves a reduction in manufacturing costs, using the back light unit.

【Technical Solution】

In one aspect of the present invention, a back light unit comprises: a plurality of light sources arranged in parallel, to emit light; a case for receiving the light sources; a diffuser plate for diffusing the light from the light sources; a plurality of condensers laminated on the diffuser plate, the condensers having predetermined thicknesses, respectively; and a diffuser interposed between adjacent ones of the condensers.

In another aspect of the present invention, a back light unit comprises: a plurality of light sources arranged in parallel, to emit light; a case for receiving the light sources; a diffuser plate arranged to cover a front side of the case opposite to the light sources, the diffuser plate diffusing the light from the light sources; a first condenser arranged on the diffuser plate, to condense the light emerging from the diffuser plate; a first diffuser arranged on the first condenser, to diffuse the condensed light; a second condenser arranged on the first diffuser, to re-condense the light diffused by the first diffuser; and a second diffuser arranged on the second condenser, to re-diffuse the re-condensed light.

In still another aspect of the present invention, a back light unit comprises: a plurality of light sources arranged in parallel, to emit light; a case for receiving the light sources; a diffuser plate arranged to cover a front side of the case opposite to the light sources, the diffuser plate diffusing the light from the light sources; a first condenser arranged on the diffuser plate, to condense the light emerging from the diffuser plate; a first diffuser arranged on the first condenser, to diffuse the light condensed by the first condenser; a second condenser arranged on the first diffuser, to re-condense the light diffused by the first diffuser; and a reflective polarizer arranged on the second condenser, to selectively polarize light received from the second condenser.

【Advantageous Effects】

In the back light unit according to an embodiment of the present invention, it is possible to reduce the distance from the lamps to the diffuser plate, using the diffuser plate and the optical sheets (three or four sheets) sequentially laminated over the diffuser plate, as described above, and thus to reduce the total thickness of the back light unit. Accordingly, it is possible to reduce the total thickness of the back light unit, and thus to reduce the total thickness of the display device.

Also, the number of lamps mounted in the back light unit according to the embodiment of the present invention is reduced by 2 to 4, as compared to that of the conventional back light unit. Accordingly, it is possible to reduce the manufacturing costs of the back light unit.

Although the thickness and the number of lamps in the back light unit according to the embodiment of the present invention is reduced by 20mm and 2 to 4, respectively, as compared to the conventional case, the brightness difference exhibited on the display screen is reduced. Accordingly, it is possible to achieve a brightness uniformity, and thus to achieve an enhancement in the display quality of the display device.

【Description of Drawings】

The accompanying drawings, which are included to provide a further understanding of the invention, illustrate embodiments of the invention and together with the description serve to explain the principle of the invention.

In the drawings:

FIG. 1 is a cross-sectional view illustrating a general liquid crystal display (LCD) module using a direct type back light unit;

FIG. 2 is an enlarged sectional view of a part of the back light unit shown in FIG. 1;

FIG. 3 is a graph depicting the results of a brightness measuring simulation for the LCD module using the back light unit shown in FIG. 1;

FIG. 4 is an exploded perspective view illustrating a back light unit according to a first embodiment of the present invention;

FIG. 5 is a cross-sectional view of the back light unit taken along the line

A – A' of FIG. 4;

FIG. 6 is an enlarged cross-sectional view partially illustrating the back light unit according to the first embodiment of the present invention;

FIGs. 7 and 8 are enlarged cross-sectional views illustrating a first prism sheet shown in FIG. 6;

FIGs. 9 and 10 are enlarged cross-sectional views illustrating a second prism sheet shown in FIG. 6;

FIG. 11 is a graph depicting the results of a brightness measuring simulation for an LCD module using a back light unit according to an embodiment of the present invention;

FIG. 12 is an enlarged cross-sectional view partially illustrating a back light unit according to a second embodiment of the present invention;

FIG. 13 is an enlarged cross-sectional view partially illustrating a back light unit according to a third embodiment of the present invention; and

FIG. 14 is a cross-sectional view illustrating an LCD module using a back light unit according to an embodiment of the present invention.

【Best Mode】

Hereinafter, preferred embodiments of the present invention will be described with reference to the accompanying drawings.

FIG. 4 is an exploded perspective view illustrating a back light unit according to a first embodiment of the present invention.

Referring to FIG. 4, the back light unit 100 according to the first embodiment of the present invention includes a lamp housing 120, a plurality of lamps 30 mounted in the lamp housing 120, to irradiate light, and side supports 110 respectively mounted to opposite side walls of the lamp housing 120 in the lamp housing 120, to support each lamp 130 at opposite ends of the lamp 130 such that the plurality of lamps 130 can be uniformly spaced apart from one another. The back light unit 100 also includes a diffuser plate 140 made of a transparent material to diffuse light incident from the lamps 130, and a plurality of optical sheets (optical films) 150 for condensing and diffusing light emerging from the diffuser plate 140 before the light is incident to a front side of a display device, to achieve an enhancement in the efficiency of the light.

A reflection sheet or reflection plate 122 for the reflection of light is also mounted in the lamp housing 120, in which the plurality of lamps 130 are mounted. The reflection sheet or reflection plate 122 is made of a material capable of reflecting light. The reflection sheet or reflection plate 122 is formed to correspond to the bottom surface and inclined side surfaces of the lamp housing 120. Accordingly, the reflection sheet or reflection plate 122 reflects light emitted from the lamps 130 toward the diffuser plate 140, thereby enhancing the efficiency of the light. Here, the lamp housing 120 means a bottom chassis of an LCD device.

For each lamp 130, a cold cathode fluorescent lamp is mainly used. Each lamp 30 includes a glass tube, an inert gas contained in the glass tube, and a cathode and an anode respectively mounted to opposite ends of the glass tube. Phosphors are coated over the inner wall surface of the glass tube, in which the inert gas is filled. Light emitted from each lamp 130 mounted in the lamp housing 120 is incident to the diffuser plate 140.

The number of required lamps 130 increases in proportion to the size of the display screen. The conventional back light unit, which has a general configuration, typically requires 14 to 16 lamps where the back light unit is used in a display device having a screen size of 40 to 42 inches. However, the back light unit 100 according to the first embodiment of the present invention can obtain a display quality enhanced over the conventional case, for the same screen size, even when 12 lamps are mounted. In accordance with the first embodiment of the present invention, the lamps 130 are arranged such that the adjacent lamps 130 are spaced apart from each other by a distance “W2 (30mm ± 2mm)”.

The diffuser plate 140 diffuses light incident from the lamps 130, and emits the diffused light toward a front side of the display screen, thereby causing the light to exhibit a uniform brightness and a uniform distribution on the overall surface of the display screen.

The diffuser plate 140 has a thickness of 0.5 to 3.0mm. A scattering material (SiO_2 or TiO_2) may be coated over a back surface of the diffuser plate 140, in order to scatter the light incident from the lamps 130 to the diffuser plate 140. Also, although not shown, a mountain pattern having a “▲” shape or a lens pattern having a lenticular shape may be formed in the diffuser plate 140, in order to achieve an enhancement in extraction efficiency for the incident light. The light emerging from the diffuser plate 140 is incident to the plurality of optical sheets 150.

When light is incident to the display screen in a direction perpendicular to the display screen, the efficiency of the light increases. To this end, in the back light unit 100 according to the first embodiment of the present invention, three optical sheets 150 having different thicknesses and different optical characteristics are arranged on the diffuser plate 140.

FIG. 5 is a cross-sectional view of the back light unit taken along the line A – A' of FIG. 4.

Referring to FIG. 5, the optical sheets 150 of the back light unit 100 according to the first embodiment of the present invention comprise three optical sheets having different thicknesses and different optical characteristics, namely, first to third optical sheets 152, 154, and 156.

The first optical sheet 152, which is included in the optical sheets 150, comprises a first condensing sheet (prism sheet). The first prism sheet 152 is laminated over the diffuser plate 140. The first prism sheet 152 condenses light emerging from the diffuser plate 140 in a diffused state, to enhance the efficiency of the light, which will be incident to the display screen.

As shown in FIG. 6, the first prism sheet 152 includes a base film 152a for condensing incident light, and a prism pattern layer 152b having a plurality of "▲"-shaped prism patterns. The "▲"-shaped prism patterns of the prism pattern layer 152b function to enhance the condensing efficiency of the light emerging from the base film 152a. The prism pattern layer 152b is formed to extend in the same direction as the longitudinal direction of the lamps 130. That is, the longitudinal direction of the prism patterns in the prism pattern layer 152b forms an angle of 0° with respect to the longitudinal direction of the lamps 130.

The first prism sheet 152 has a thickness of "P1" (200 to 370μm). In this case, the base film 152a has a thickness of "P2" (180 to 300μm), and the prism pattern layer 152b has a thickness of "P3" (20 to 70μm). The "▲"-shaped prism patterns of the prism pattern layer 152b have a distance of "P4" (10 to 100μm) between the summits of the adjacent prism patterns.

Typically, for the base film 152a, which is included in the first prism sheet 152, three kinds of standard products respectively having thicknesses of 125, 188, and 250μm are commercially available. All the three products, which have thicknesses of 125, 188, and 250μm, respectively, are applicable to the base film 152a of the first prism sheet 152 included in the back light unit 100 according to the first embodiment of the present invention. Preferably, the product having a thickness of 188μm is applied to the base film 152a in the first embodiment of the present invention.

The first prism sheet 152, which is included in the back light unit 100 according to the first embodiment of the present invention, may include prism patterns different from the "▲"-shaped prism patterns. For example, the first prism sheet 152 may include a prism pattern layer 152c having lenticular prism patterns formed on the base film 152a, as shown in FIG. 8.

Where the lenticular prism pattern layer 152c is formed, the first prism sheet 152 has a thickness of "L1" (175 to 350μm). In this case, the base film 152a has a thickness of "L2" (125 to 250μm), and the lenticular prism pattern layer 152c has a thickness of "L3" (50 to 100μm). Each lenticular prism pattern of the lenticular prism pattern layer 152c has a width of "L4" (70 to 200μm).

The second optical sheet 154, which is included in the optical sheets 150, comprises a diffuser sheet. The diffusion sheet 154 is made of a polyethylene terephthalate (PET) resin or a polymethyl methacrylate (PMMA)-based material. The diffuser sheet 154 is laminated over the first prism sheet 152. The diffuser sheet 154 diffuses light emerging from the first prism sheet 152 in a condensed state, and emits the diffused light toward the display screen.

The third optical sheet 156, which is included in the optical sheets 150, comprises a second condensing sheet (prism sheet). The second prism sheet 156 is laminated over the diffuser sheet 154. The second prism sheet 156 condenses light emerging from the diffuser sheet 154 in a diffused state, to enhance the efficiency of the light, which will be incident to the display screen.

As shown in FIG. 9, the second prism sheet 156 includes a base film 156a for condensing incident light, and a prism pattern layer 156b having a plurality of "▲"-shaped prism patterns. The "▲"-shaped prism patterns of the prism pattern layer 156b function to enhance the condensing efficiency of the light emerging from the base film 156a. The prism pattern layer 156b is formed to extend in the same direction as the longitudinal direction of the lamps 130. That is, the longitudinal direction of the prism patterns in the prism pattern layer 156b forms an angle of 0° with respect to the longitudinal direction of the lamps 130.

The second prism sheet 156 has a thickness of "P1" (200 to 370μm). In this case, the base film 156a has a thickness of "P2" (180 to 300μm), and the prism pattern layer 156b has a thickness of "P3" (20 to 70μm). The "▲"-shaped prism patterns of the prism pattern layer 156b have a distance of "P4" (10 to 100μm) between the summits of the adjacent prism patterns.

Typically, for the base film 156a, which is included in the second prism sheet 156, three kinds of standard products respectively having thicknesses of 125, 188, and 250μm are commercially available. All the three products, which have thicknesses of 125, 188, and 250μm, respectively, are applicable to the base film

156a of the second prism sheet 156 included in the back light unit 100 according to the first embodiment of the present invention. Preferably, the product having a thickness of 250μm is applied to the base film 156a in the first embodiment of the present invention.

The second prism sheet 156, which is included in the back light unit 100 according to the first embodiment of the present invention, may include prism patterns different from the "▲"-shaped prism patterns. For example, the second prism sheet 156 may include a prism pattern layer 156c having lenticular prism patterns formed on the base film 156a, as shown in FIG. 10.

Where the lenticular prism pattern layer 156c is formed, the second prism sheet 156 has a thickness of "L1" (175 to 350μm). In this case, the base film 156a has a thickness of "L2" (125 to 250μm), and the lenticular prism pattern layer 156c has a thickness of "L3" (50 to 100μm). Each lenticular prism pattern of the lenticular prism pattern layer 156c has a width of "L4" (70 to 200μm).

In the back light unit 100 according to the first embodiment of the present invention, the first prism sheet 152, diffuser sheet 154, and second prism sheet 156 are sequentially laminated over the diffuser plate 140. In this case, the base film 152a of the first prism sheet 152 has a thickness of 188μm, and the prism pattern layer 152b of the first prism sheet 152 has a thickness of 25μm. Also, the base film 156a of the second prism sheet 156 has a thickness of 250μm, and the prism pattern layer 156b of the second prism sheet 156 has a thickness of 25μm.

In the back light unit 100 according to the first embodiment of the present invention, it is possible to reduce the distance from the lamps 130 to the diffuser plate 140, using the diffuser plate 140 and the three optical sheets sequentially laminated over the diffuser plate 140, namely, the two prism sheets 152 and 156 laminated over the diffuser plate 140 and the diffuser sheet 154 interposed between the two prism sheets 152 and 156, as described above, and thus to reduce the total thickness “d2” (17mm). Accordingly, it is possible to reduce the thickness of the back light unit by 20mm, as compared to the thickness of the general back light unit shown in FIG. 1, and thus to reduce the total thickness of the flat panel display device.

Also, the number of lamps mounted in the back light unit 100 according to the first embodiment of the present invention is reduced by 2 to 4, as compared to that of the conventional back light unit. Accordingly, it is possible to reduce the manufacturing costs of the back light unit.

Although the thickness and the number of lamps in the back light unit 100 according to the first embodiment of the present invention is reduced by 20mm and 2 to 4, respectively, as compared to the conventional case, the brightness difference exhibited on the display screen is reduced, as shown in FIG. 11. Accordingly, it is possible to achieve a brightness uniformity, and thus to achieve an enhancement in the display quality of the flat panel display device.

【Mode for Invention】

FIG. 12 is an enlarged cross-sectional view partially illustrating a back light unit according to a second embodiment of the present invention.

The back light unit 200 according to the second embodiment of the present invention has constituent elements identical to those of the back light unit 200 according to the first embodiment of the present invention, except for the configurations of optical sheets laminated over a diffuser plate.

Referring to FIG. 12, the back light unit 200 according to the second embodiment of the present invention includes a diffuser plate 240, and a plurality of optical sheets 250 laminated over the diffuser plate 240. The optical sheets 250 comprise four optical sheets, namely, first to fourth optical sheets 252, 254, 256, and 258.

The first optical sheet 252, which is included in the optical sheets 250, comprises a first condensing sheet (prism sheet). The first prism sheet 252 is laminated over the diffuser plate 240. The first prism sheet 252 condenses light emerging from the diffuser plate 240 in a diffused state, to enhance the efficiency of the light, which will be incident to the display screen.

The first prism sheet 252 have the same configuration and optical characteristics as those of the first prism sheet 152 of the back light unit 200 according to the first embodiment of the present invention.

The prism pattern layer 252b of the first prism sheet 252 is formed to extend in the same direction as the longitudinal direction of lamps 230. That is, the longitudinal direction of the prism patterns in the prism pattern layer 252b forms an angle of 0° with respect to the longitudinal direction of the lamps 230.

The first prism sheet 252 has a thickness of 200 to 370μm. In this case, the base film 252a has a thickness of 180 to 300μm, and the prism pattern layer 252b has a thickness of 20 to 70μm. The "▲"-shaped prism patterns of the prism pattern layer 252b have a distance of 10 to 100μm between the summits of the adjacent prism patterns.

Three thicknesses of 125, 188, and 250μm are applicable to the base film

252a of the first prism sheet 252 included in the back light unit 200 according to the second embodiment of the present invention. Preferably, the thickness of 188μm is applied to the base film 252a in the second embodiment of the present invention.

The first prism sheet 252, which is included in the back light unit 200 according to the second embodiment of the present invention, may include prism patterns different from the "▲"-shaped prism patterns. For example, the first prism sheet 252 may include a prism pattern layer having lenticular prism patterns formed on the base film 252a, as shown in FIG. 8.

Where the lenticular prism pattern layer is formed, the first prism sheet 252 has a thickness of 175 to 350μm. In this case, the base film 252a has a thickness of 125 to 250μm, and the lenticular prism pattern layer has a thickness of 50 to 100μm. Each lenticular prism pattern of the lenticular prism pattern layer has a width of 70 to 200μm.

The second optical sheet 254, which is included in the optical sheets 250, comprises a first diffuser sheet. The first diffuser sheet 254 is laminated over the first prism sheet 252. The first diffuser sheet 254 diffuses light emerging from the first prism sheet 252 in a condensed state, and emits the diffused light toward the display screen.

The third optical sheet 256, which is included in the optical sheets 250, comprises a second condensing sheet (prism sheet). The second prism sheet 256 is laminated over the first diffuser sheet 254. The second prism sheet 256 condenses light emerging from the first diffuser sheet 254 in a diffused state, to enhance the efficiency of the light, which will be incident to the display screen.

The second prism sheet 256 has the same configuration and optical characteristics as those of the second prism sheet 156 of the back light unit 100 according to the first embodiment of the present invention. The prism pattern layer 256b is formed to extend in the same direction as the longitudinal direction of the lamps 230. That is, the longitudinal direction of the prism patterns in the prism pattern layer 256b forms an angle of 0° with respect to the longitudinal direction of the lamps 230.

The second prism sheet 256 has a thickness of 200 to 370μm. In this case, the base film 256a has a thickness of 180 to 300μm, and the prism pattern layer 256b has a thickness of 20 to 70μm. The "▲"-shaped prism patterns of the prism pattern layer 256b have a distance of 10 to 100μm between the summits of the adjacent prism patterns.

Three thicknesses of 125, 188, and 250μm are applicable to the base film 256a of the second prism sheet 256 included in the back light unit 200 according to the second embodiment of the present invention. Preferably, the thickness of 250μm is applied to the base film 256a in the second embodiment of the present invention.

The second prism sheet 256, which is included in the back light unit 200 according to the second embodiment of the present invention, may include prism patterns different from the "▲"-shaped prism patterns. For example, the second prism sheet 256 may include a prism pattern layer having lenticular prism patterns formed on the base film 256a, as shown in FIG. 10.

Where the lenticular prism pattern layer is formed, the second prism sheet 256 has a thickness of 175 to 350μm. In this case, the base film 256a has a thickness of 125 to 250μm, and the lenticular prism pattern layer has a thickness of 50 to 100μm. Each lenticular prism pattern of the lenticular prism pattern layer has a width of 70 to 200μm.

The fourth optical sheet 258, which is included in the optical sheets 250, comprises a second diffuser sheet. The second diffuser sheet 258 is laminated over the second prism sheet 256. The second diffuser sheet 258 diffuses light emerging from the second prism sheet 256 in a condensed state, and emits the diffused light toward the display screen.

In the back light unit 200 having the above-described configuration according to the second embodiment of the present invention, the first prism sheet 252, first diffuser sheet 254, second prism sheet 256, and second diffuser sheet 258 are sequentially laminated over the diffuser plate 240.

In this case, the base film 252a of the first prism sheet 252 has a thickness of 188μm, and the prism pattern layer 252b of the first prism sheet 252 has a thickness of 25μm. Also, the base film 256a of the second prism sheet 256 has a thickness of 250μm, and the prism pattern layer 256b of the second prism sheet 256 has a thickness of 25μm.

In the back light unit 200 according to the second embodiment of the present invention, it is possible to reduce the distance from the lamps 230 to the diffuser plate 240, using the diffuser plate 240 and the four optical sheets 252, 254, 256, and 258 sequentially laminated over the diffuser plate 240, as described above, and thus to reduce the total thickness of the back light unit 200 (17mm). Accordingly, it is possible to reduce the thickness of the back light unit by 20mm, as compared to the thickness of the general back light unit shown in FIG. 1, and thus to reduce the total thickness of the flat panel display device.

Also, the number of lamps mounted in the back light unit 200 according to the second embodiment of the present invention is reduced by 2 to 4, as compared to that of the conventional back light unit. Accordingly, it is possible to reduce the manufacturing costs of the back light unit.

Although the thickness and the number of lamps in the back light unit 200 according to the second embodiment of the present invention is reduced by 20mm and 2 to 4, respectively, as compared to the conventional case, the brightness difference exhibited on the display screen is reduced, as shown in FIG. 11. Accordingly, it is possible to achieve a brightness uniformity, and thus to achieve an enhancement in the display quality of the flat panel display device.

FIG. 13 is an enlarged cross-sectional view partially illustrating a back light unit according to a third embodiment of the present invention.

The back light unit 300 according to the third embodiment of the present invention has constituent elements identical to those of the back light units 100 and 200 according to the first and second embodiment of the present invention, except for the configurations of optical sheets laminated over a diffuser plate.

Referring to FIG. 14, the back light unit 300 according to the third embodiment of the present invention includes a diffuser plate 340, and a plurality of optical sheets 350 laminated over the diffuser plate 340. The optical sheets 350 comprise four optical sheets, namely, first to fourth optical sheets 352, 354, 356, and 358.

The first optical sheet 352, which is included in the optical sheets 350, comprises a first condensing sheet (prism sheet). The first prism sheet 352 is laminated over the diffuser plate 340. The first prism sheet 352 condenses light emerging from the diffuser plate 340 in a diffused state, to enhance the efficiency of the light, which will be incident to the display screen.

The first prism sheet 352 have the same configuration and optical characteristics as those of the first prism sheet 152 of the back light unit 100 according to the first embodiment of the present invention.

The prism pattern layer 352b of the first prism sheet 352 is formed to extend in the same direction as the longitudinal direction of lamps 330. That is, the longitudinal direction of the prism patterns in the prism pattern layer 352b forms an angle of 0° with respect to the longitudinal direction of the lamps 330.

The first prism sheet 352 has a thickness of 200 to 370μm. In this case, the base film 352a has a thickness of 180 to 300μm, and the prism pattern layer 352b has a thickness of 20 to 70μm. The "▲"-shaped prism patterns of the prism pattern layer 352b have a distance of 10 to 100μm between the summits of the adjacent prism patterns.

Three thicknesses of 125, 188, and 250μm are applicable to the base film 352a of the first prism sheet 352 included in the back light unit 300 according to the third embodiment of the present invention. Preferably, the thickness of 188μm is applied to the base film 352a in the third embodiment of the present invention.

The first prism sheet 352, which is included in the back light unit 300 according to the third embodiment of the present invention, may include prism patterns different from the "▲"-shaped prism patterns. For example, the first prism sheet 352 may include a prism pattern layer having lenticular prism patterns formed on the base film 352a, as shown in FIG. 8.

Where the lenticular prism pattern layer is formed, the first prism sheet 352 has a thickness of 175 to 350μm. In this case, the base film 352a has a thickness of 135 to 250μm, and the lenticular prism pattern layer has a thickness of 50 to 100μm. Each lenticular prism pattern of the lenticular prism pattern layer has a width of 70 to 200μm.

The second optical sheet 354, which is included in the optical sheets 350, comprises a diffuser sheet. The diffuser sheet 354 is laminated over the first prism sheet 352. The diffuser sheet 354 diffuses light emerging from the first prism sheet 352 in a condensed state, and emits the diffused light toward the display screen.

The third optical sheet 356, which is included in the optical sheets 350, comprises a second condensing sheet (prism sheet). The second prism sheet 356 is laminated over the diffuser sheet 354. The second prism sheet 356 condenses light emerging from the diffuser sheet 354 in a diffused state, to enhance the efficiency of the light, which will be incident to the display screen.

The second prism sheet 356 has the same configuration and optical characteristics as those of the second prism sheet 156 of the back light unit 100 according to the first embodiment of the present invention. The prism pattern layer 356b is formed to extend in the same direction as the longitudinal direction of the lamps 330. That is, the longitudinal direction of the prism patterns in the prism pattern layer 356b forms an angle of 0° with respect to the longitudinal direction of the lamps 330.

The second prism sheet 356 has a thickness of 200 to 370μm. In this case, the base film 356a has a thickness of 180 to 300μm, and the prism pattern layer 356b has a thickness of 20 to 70μm. The "▲"-shaped prism patterns of the prism pattern layer 356b have a distance of 10 to 100μm between the summits of the adjacent prism patterns.

Three thicknesses of 135, 188, and 350μm are applicable to the base film 356a of the second prism sheet 356 included in the back light unit 300 according to the third embodiment of the present invention. Preferably, the thickness of 350μm is applied to the base film 356a in the third embodiment of the present invention.

The second prism sheet 356, which is included in the back light unit 300 according to the third embodiment of the present invention, may include prism patterns different from the "▲"-shaped prism patterns. For example, the second prism sheet 356 may include a prism pattern layer having lenticular prism patterns formed on the base film 356a, as shown in FIG. 10.

Where the lenticular prism pattern layer is formed, the second prism sheet 356 has a thickness of 175 to 350μm. In this case, the base film 356a has a thickness of 125 to 250μm, and the lenticular prism pattern layer has a thickness of 50 to 100μm. Each lenticular prism pattern of the lenticular prism pattern layer has a width of 70 to 200μm.

The fourth optical sheet 358, which is included in the optical sheets 350, comprises a reflective polarizing sheet, to selectively polarize the light re-condensed by the second prism sheet 356. The reflective polarizing sheet 358 is laminated over the second prism sheet 356. The reflective polarizing sheet 358 selectively polarizes light emerging from the second prism sheet 356 in a condensed state, and emits the polarized light toward the display screen.

In the back light unit 300 having the above-described configuration according to the third embodiment of the present invention, the first prism sheet 352, diffuser sheet 354, second prism sheet 356, and reflective polarizing sheet 358 are sequentially laminated over the diffuser plate 340.

In this case, the base film 352a of the first prism sheet 352 has a thickness of 188μm, and the prism pattern layer 352b of the first prism sheet 352 has a thickness of 35μm. Also, the base film 356a of the second prism sheet 356 has a thickness of 250μm, and the prism pattern layer 356b of the second prism sheet 356 has a thickness of 25μm.

In the back light unit 300 according to the third embodiment of the present invention, it is possible to reduce the distance from the lamps 330 to the diffuser plate 340, using the diffuser plate 340 and the four optical sheets 352, 354, 356, and 358 sequentially laminated over the diffuser plate 340, as described above, and thus to reduce the total thickness of the back light unit 300 to 17mm. Accordingly, it is possible to reduce the thickness of the back light unit by 20mm, as compared to the thickness of the general back light unit shown in FIG. 1, and thus to reduce the total thickness of the flat panel display device.

Also, the number of lamps mounted in the back light unit 300 according to the third embodiment of the present invention is reduced by 2 to 4, as compared to that of the conventional back light unit. Accordingly, it is possible to reduce the manufacturing costs of the back light unit.

Although the thickness and the number of lamps in the back light unit 300 according to the third embodiment of the present invention is reduced by 20mm and 2 to 4, respectively, as compared to the conventional case, the brightness difference exhibited on the display screen is reduced, as shown in FIG. 11. Accordingly, it is possible to achieve a brightness uniformity, and thus to achieve an enhancement in the display quality of the flat panel display device.

FIG. 14 is a cross-sectional view illustrating an LCD module, to which the back light unit according to an embodiment of the present invention is applied.

Referring to FIG. 14, the LCD module 400 includes a liquid crystal panel 410 having liquid crystal cells (not shown) arranged in the form of a matrix between two glass substrates 412 and 414, a back light unit for irradiating light to the liquid crystal panel 410, and a panel guard 420 for supporting the liquid crystal panel 410 such that the liquid crystal panel 410 is seated on the panel guard 420, and enclosing the back light unit.

In the LCD module 400, a plurality of optical sheets are arranged to change the travel direction of light traveling from the back light unit toward the liquid crystal panel 410 such that the light is directed in a direction perpendicular to the liquid crystal panel 410. The constituent elements of the LCD module 400 should be coupled together to form an integrated structure, in order to avoid optical loss. The LCD module 400 should also be protected from a damage caused by an external impact.

To this end, a case for the LCD device, which is formed to enclose the periphery of the liquid crystal panel and the back light unit, is provided.

The liquid crystal panel 410 includes upper and lower substrates 412 and 414, between which liquid crystals are filled, and spacers (not shown) for maintaining the upper and lower substrates 412 in a spaced state. Although not shown, color filters, common electrodes, a black matrix are formed on the upper substrate 412 of the liquid crystal panel 410. Although not shown, signal lines such as data lines and gate lines are formed on the lower substrate 414 of the liquid crystal panel 410. Thin film transistors (TFTs) are formed at respective intersections of the data lines and gate lines. In response to a scan signal (gate driving signal) from one gate line, the corresponding TFT supplies an analog video signal from the corresponding line to a liquid crystal cell.

Pixel electrodes are formed in pixel regions defined between the data lines and the gate lines, respectively. At one lateral end of the lower substrate 414, pad regions are formed. The data lines and gate lines are connected to the pad regions. Although not shown, a tape carrier package (TCP) is attached to each pad region. A driver IC is mounted to the TCP, to apply a drive signal to the corresponding TFTs. The TCP supplies a data signal from the drive IC to the corresponding data lines, and supplies a scan signal from the drive IC to the corresponding gate lines. An upper polarizing sheet is attached to the upper substrate 412 of the liquid crystal panel 410. A lower polarizing sheet is attached to a back surface of the lower substrate 414.

As described above, the LCD module 400 according to the illustrated embodiment of the present invention includes the liquid crystal panel 410, and the back light unit for irradiating light to the liquid crystal panel 410. In this case, for the back light unit, which irradiates light to the liquid crystal panel 410, one of the back light units according to the first to third embodiments of the present invention is usable.

The LCD module 400 having the above-described configuration can display an image through the liquid crystal panel 410 by controlling the transmittance of light irradiated from the back light unit.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

【Industrial Applicability】

The present invention, which relates to a back light unit and an LCD module using the same, not only can reduce the thickness of the LCD module, using the back light unit according to the embodiment of the present invention, but also can reduce the manufacturing costs. The present invention can also achieve an enhancement in the display quality of the LCD device, using the back light unit according to the embodiment of the present invention.

【CLAIMS】

【Claim 1】 A back light unit comprising:

a plurality of light sources arranged in parallel, to emit light;

a case for receiving the light sources;

a diffuser plate for diffusing the light from the light sources;

a plurality of condensers laminated on the diffuser plate, the condensers having predetermined thicknesses, respectively; and

a diffuser interposed between adjacent ones of the condensers.

【Claim 2】 The back light unit according to claim 1, wherein each of the condensers comprises:

a base film; and

a plurality of condensing patterns formed on the base film, to condense light incident to the condenser.

【Claim 3】 The back light unit according to claim 2, wherein the condensing patterns of the condensers are formed to extend in the same direction.

【Claim 4】 The back light unit according to claim 3, wherein the condensing patterns are formed to extend in a direction identical to a longitudinal direction of the light sources.

【Claim 5】 The back light unit according to claim 4, wherein each of the condensers has a thickness of 200 to 370μm.

【Claim 6】 The back light unit according to claim 5, wherein the base film of a first one of the condensers has a thickness of 188μm.

【Claim 7】 The back light unit according to claim 6, wherein each of the condensing patterns of the first condenser has a "▲" shape or a lenticular shape having a predetermined curvature.

【Claim 8】 The back light unit according to claim 7, wherein each of the "▲"-shaped condensing patterns of the first condenser has a thickness of 20 to 70μm.

【Claim 9】 The back light unit according to claim 8, wherein the "▲"-shaped condensing patterns of the first condenser have a distance of 10 to 100μm between summits of adjacent ones of the condensing patterns.

【Claim 10】 The back light unit according to claim 7, wherein each of the lenticular condensing patterns of the first condenser has a thickness of 50 to 100μm.

【Claim 11】 The back light unit according to claim 10, wherein each of the lenticular condensing patterns has a width of 70 to 200μm.

【Claim 12】 The back light unit according to claim 5, wherein the base film of a second one of the condensers has a thickness of 250μm.

【Claim 13】 The back light unit according to claim 12, wherein each of the condensing patterns of the second condenser has a "▲" shape or a lenticular shape having a predetermined curvature.

【Claim 14】 The back light unit according to claim 13, wherein each of the "▲"-shaped condensing patterns of the second condenser has a thickness of 20 to 70μm.

【Claim 15】 The back light unit according to claim 14, wherein the "▲"-shaped condensing patterns of the second condenser have a distance of 10 to 100μm between summits of adjacent ones of the condensing patterns.

【Claim 16】 The back light unit according to claim 13, wherein each of the lenticular condensing patterns of the second condenser has a thickness of 50 to 100μm.

【Claim 17】 The back light unit according to claim 16, wherein each of the lenticular condensing patterns of the second condenser has a width of 70 to 200μm.

【Claim 18】 The back light unit according to claim 1, further comprising:

a diffuser sheet arranged on the second condenser, to diffuse light received from the second condenser.

【Claim 19】 The back light unit according to claim 1, further comprising:

a reflective polarizer arranged on the second condenser, to selectively polarize light received from the second condenser.

【Claim 20】 The back light unit according to claim 1, wherein first and second ones of the condensers have the same thickness or different thicknesses.

【Claim 21】 A back light unit comprising:

a plurality of light sources arranged in parallel, to emit light;

a case for receiving the light sources;

a diffuser plate arranged to cover a front side of the case opposite to the light sources, the diffuser plate diffusing the light from the light sources;

a first condenser arranged on the diffuser plate, to condense the light emerging from the diffuser plate;

a first diffuser arranged on the first condenser, to diffuse the condensed light;

a second condenser arranged on the first diffuser, to re-condense the light diffused by the first diffuser; and

a second diffuser arranged on the second condenser, to re-diffuse the re-condensed light.

【Claim 22】 The back light unit according to claim 21, wherein each of the first and second condensers comprises:

a base film; and

a plurality of condensing patterns formed on the base film, to condense light incident to the condenser.

【Claim 23】 The back light unit according to claim 22, wherein the condensing patterns of the first and second condensers are formed to extend in the same direction.

【Claim 24】 The back light unit according to claim 23, wherein the condensing patterns of the first and second condensers are formed to extend in a direction identical to a longitudinal direction of the light sources.

【Claim 25】 The back light unit according to claim 24, wherein each of the first and second condensers has a thickness of 200 to 370μm.

【Claim 26】 The back light unit according to claim 25, wherein the base film of the first condenser has a thickness of 188μm.

【Claim 27】 The back light unit according to claim 26, wherein each of the condensing patterns of the first condenser has a "▲" shape or a lenticular shape having a predetermined curvature.

【Claim 28】 The back light unit according to claim 27, wherein each of the "▲"-shaped condensing patterns of the first condenser has a thickness of 20 to 70μm.

【Claim 29】 The back light unit according to claim 28, wherein the "▲"-shaped condensing patterns of the first condenser have a distance of 10 to 100μm between summits of adjacent ones of the condensing patterns.

【Claim 30】 The back light unit according to claim 27, wherein each of the lenticular condensing patterns of the first condenser has a thickness of 50 to 100μm.

【Claim 31】 The back light unit according to claim 30, wherein each of the lenticular condensing patterns of the first condenser has a width of 70 to 200μm.

【Claim 32】 The back light unit according to claim 25, wherein the base film of the second condenser has a thickness of 250μm.

【Claim 33】 The back light unit according to claim 32, wherein each of the condensing patterns of the second condenser has a "▲" shape or a lenticular shape having a predetermined curvature.

【Claim 34】 The back light unit according to claim 33, wherein each of the "▲"-shaped condensing patterns of the second condenser has a thickness of 20 to 70μm.

【Claim 35】 The back light unit according to claim 34, wherein the "▲"-shaped condensing patterns of the second condenser have a distance of 10 to 100μm between summits of adjacent ones of the condensing patterns.

【Claim 36】 The back light unit according to claim 33, wherein each of the lenticular condensing patterns of the second condenser has a thickness of 50 to 100μm.

【Claim 37】 The back light unit according to claim 36, wherein each of the lenticular condensing patterns of the second condenser has a width of 70 to 200μm.

【Claim 38】 A back light unit comprising:

a plurality of light sources arranged in parallel, to emit light;

a case for receiving the light sources;

a diffuser plate arranged to cover a front side of the case opposite to the light sources, the diffuser plate diffusing the light from the light sources;

a first condenser arranged on the diffuser plate, to condense the light emerging from the diffuser plate;

a first diffuser arranged on the first condenser, to diffuse the light condensed by the first condenser;

a second condenser arranged on the first diffuser, to re-condense the light diffused by the first diffuser; and

a reflective polarizer arranged on the second condenser, to selectively polarize light received from the second condenser.

【Claim 39】 The back light unit according to claim 38, wherein each of the first and second condensers comprises:

a base film; and

a plurality of condensing patterns formed on the base film, to condense light incident to the condenser.

【Claim 40】 The back light unit according to claim 39, wherein the condensing patterns of the first and second condensers are formed to extend in the same direction.

【Claim 41】 The back light unit according to claim 40, wherein the condensing patterns of the first and second condensers are formed to extend in a direction identical to a longitudinal direction of the light sources.

【Claim 42】 The back light unit according to claim 41, wherein each of the first and second condensers has a thickness of 200 to 370μm.

【Claim 43】 The back light unit according to claim 42, wherein the base film of the first condenser has a thickness of 188μm.

【Claim 44】 The back light unit according to claim 43, wherein each of the condensing patterns of the first condenser has a "▲" shape or a lenticular shape having a predetermined curvature.

【Claim 45】 The back light unit according to claim 44, wherein each of the "▲"-shaped condensing patterns of the first condenser has a thickness of 20 to 70μm.

【Claim 46】 The back light unit according to claim 45, wherein the "▲"-shaped condensing patterns of the first condenser have a distance of 10 to 100μm between summits of adjacent ones of the condensing patterns.

【Claim 47】 The back light unit according to claim 44, wherein each of the lenticular condensing patterns of the first condenser has a thickness of 50 to 100μm.

【Claim 48】 The back light unit according to claim 47, wherein each of the lenticular condensing patterns of the first condenser has a width of 70 to 200μm.

【Claim 49】 The back light unit according to claim 42, wherein the base film of the second condenser has a thickness of 250μm.

【Claim 50】 The back light unit according to claim 49, wherein each of the condensing patterns of the second condenser has a "▲" shape or a lenticular shape having a predetermined curvature.

【Claim 51】 The back light unit according to claim 50, wherein each of the "▲"-shaped condensing patterns of the second condenser has a thickness of 20 to 70μm.

【Claim 52】 The back light unit according to claim 51, wherein the "▲"-shaped condensing patterns of the second condenser have a distance of 10 to 100μm between summits of adjacent ones of the condensing patterns.

【Claim 53】 The back light unit according to claim 50, wherein each of the lenticular condensing patterns of the second condenser has a thickness of 50 to 100μm.

【Claim 54】 The back light unit according to claim 53, wherein each of the lenticular condensing patterns of the second condenser has a width of 70 to 200μm.

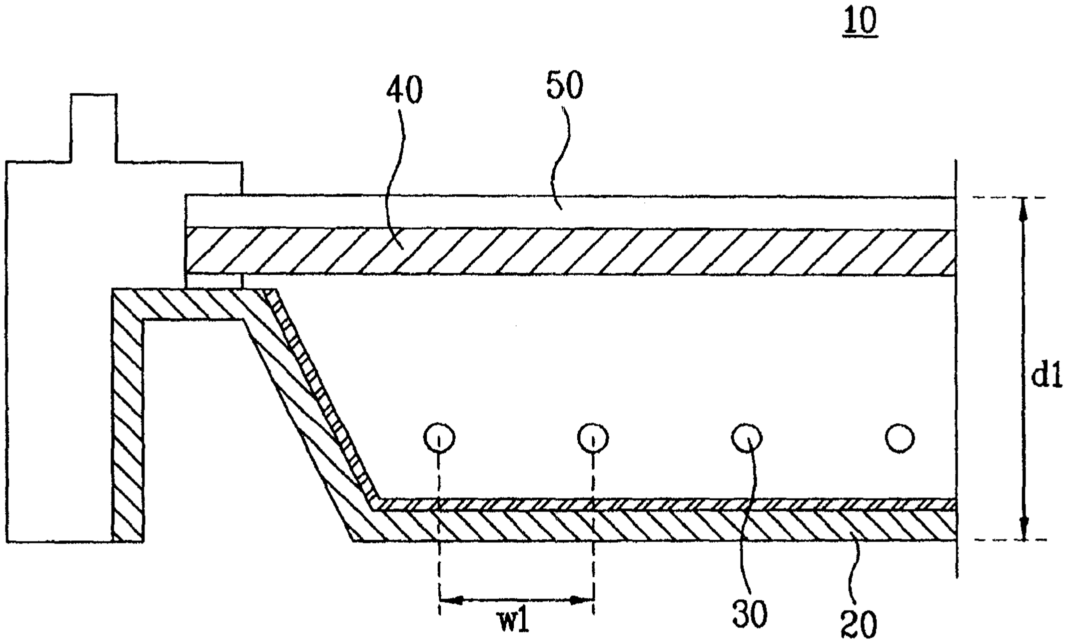
【Claim 55】 A liquid crystal display module comprising:

a liquid crystal panel for displaying an image by controlling a transmittance of light, based on external input image data; and

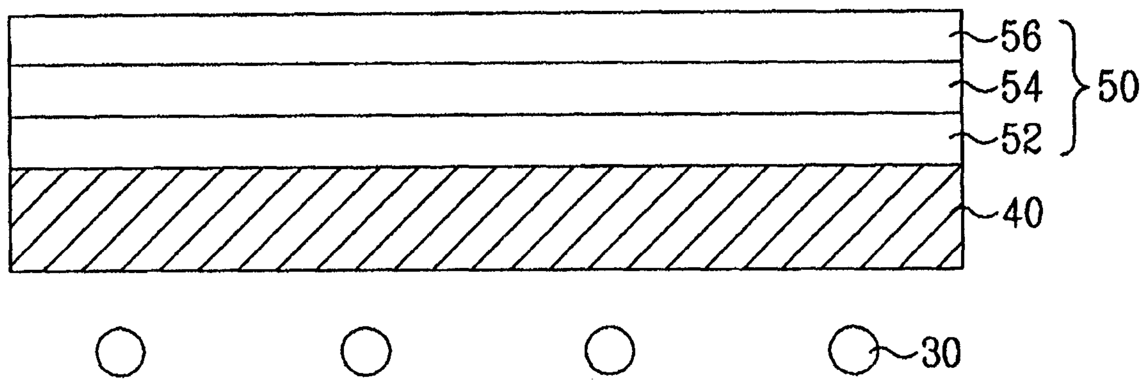
a back light unit according to any one of claims 1 to 53, the back light unit irradiating light to the liquid crystal panel.

【DRAWINGS】

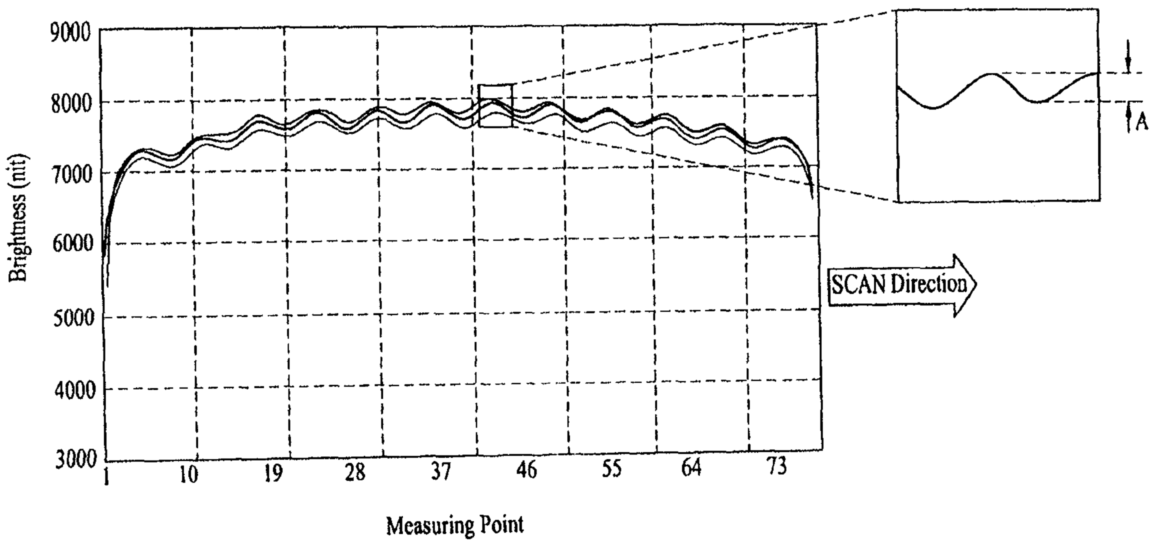
【Figure 1】



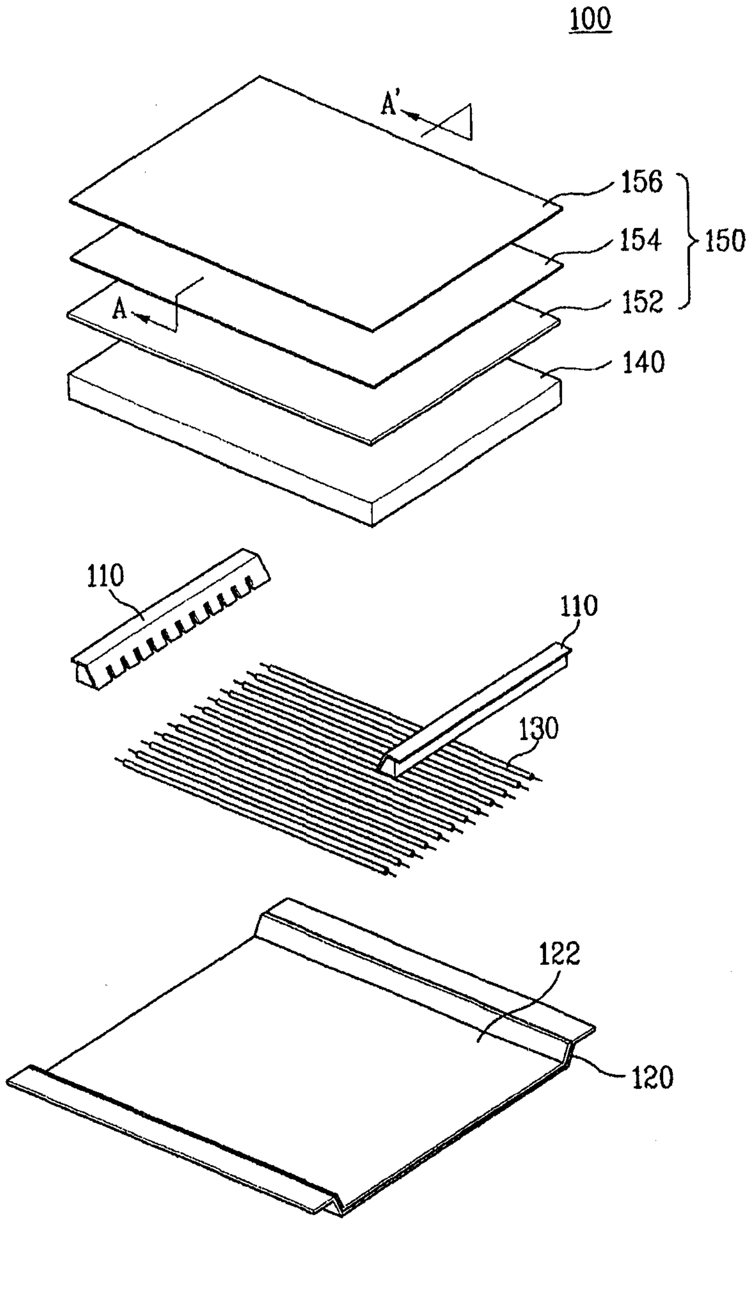
【Figure 2】



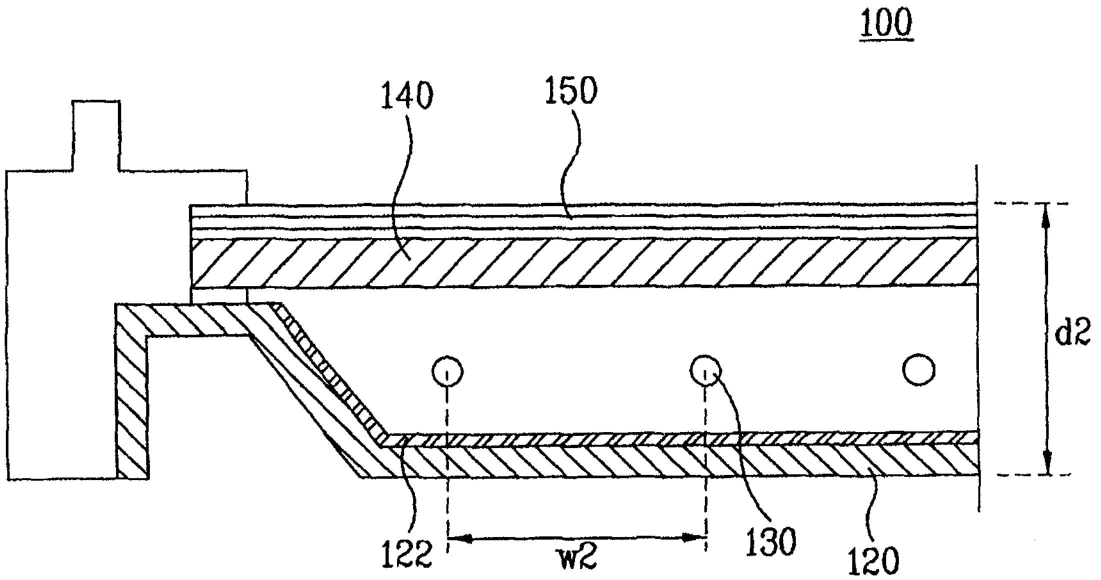
【Figure 3】


9000
8000
7000
6000
5000
4000
3000
Brightness (nit)
1
10
19
28
37
46
55
64
73
Measuring Point
SCAN Direction
A

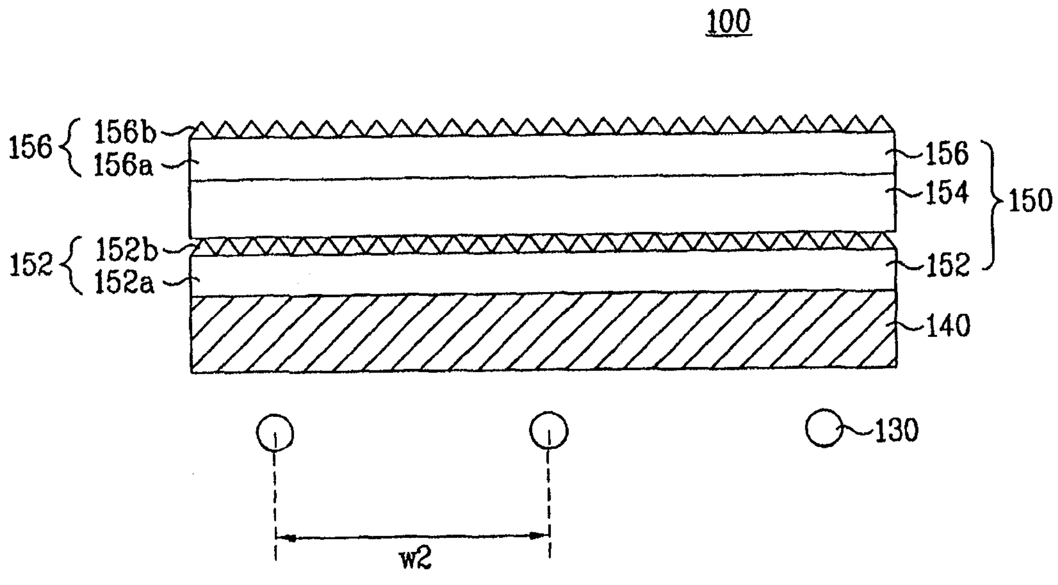
【Figure 4】



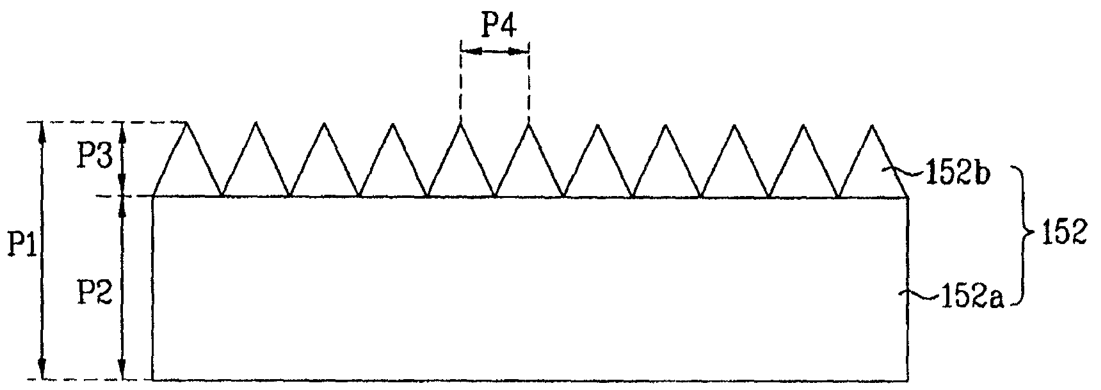
【Figure 5】



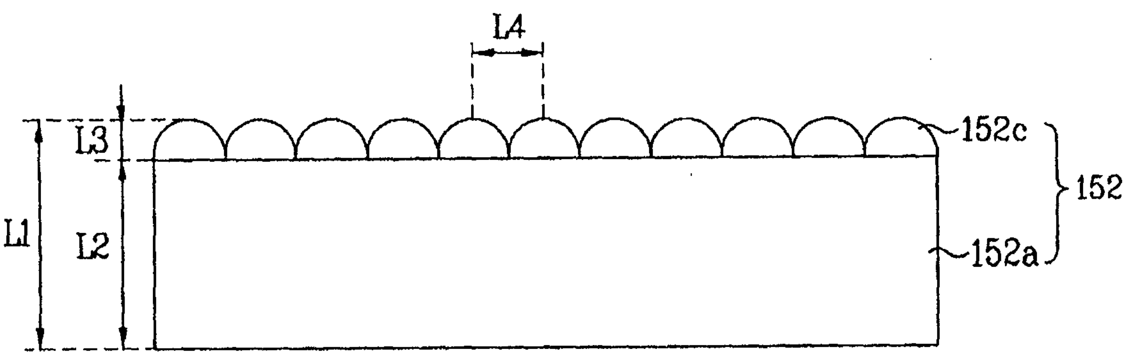
【Figure 6】



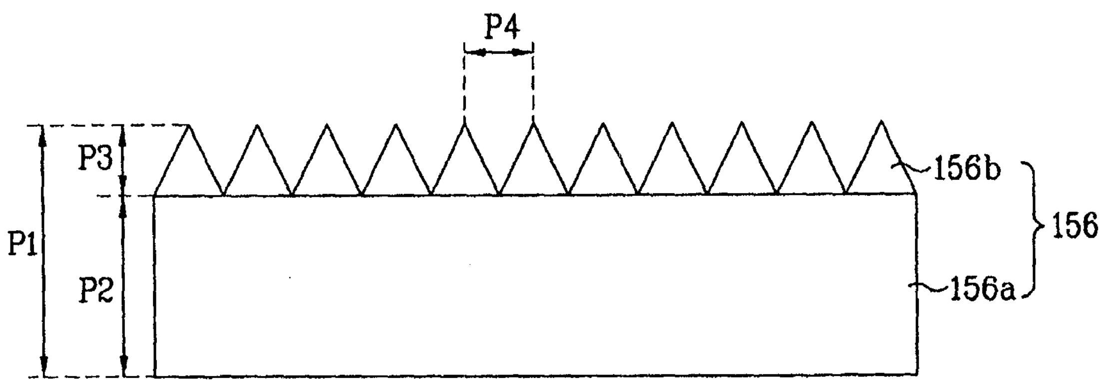
【Figure 7】



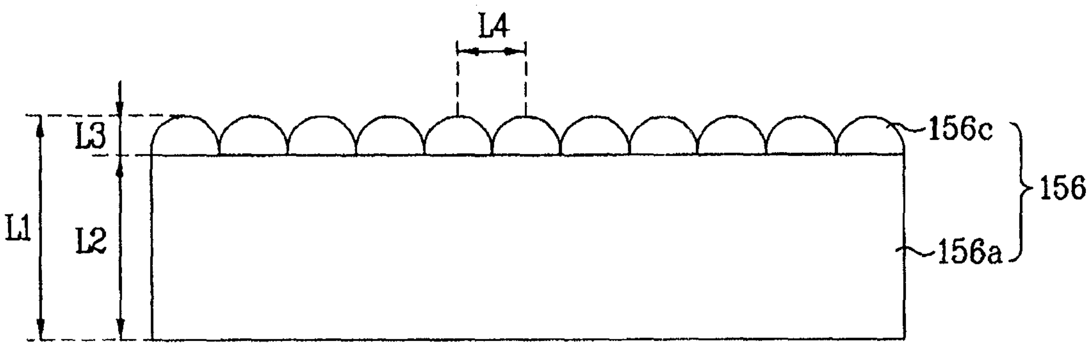
【Figure 8】



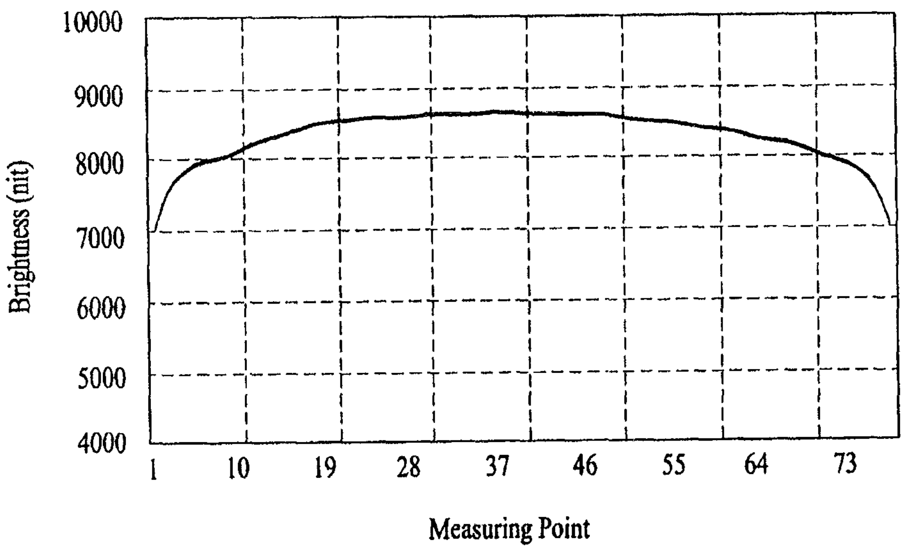
【Figure 9】



【Figure 10】

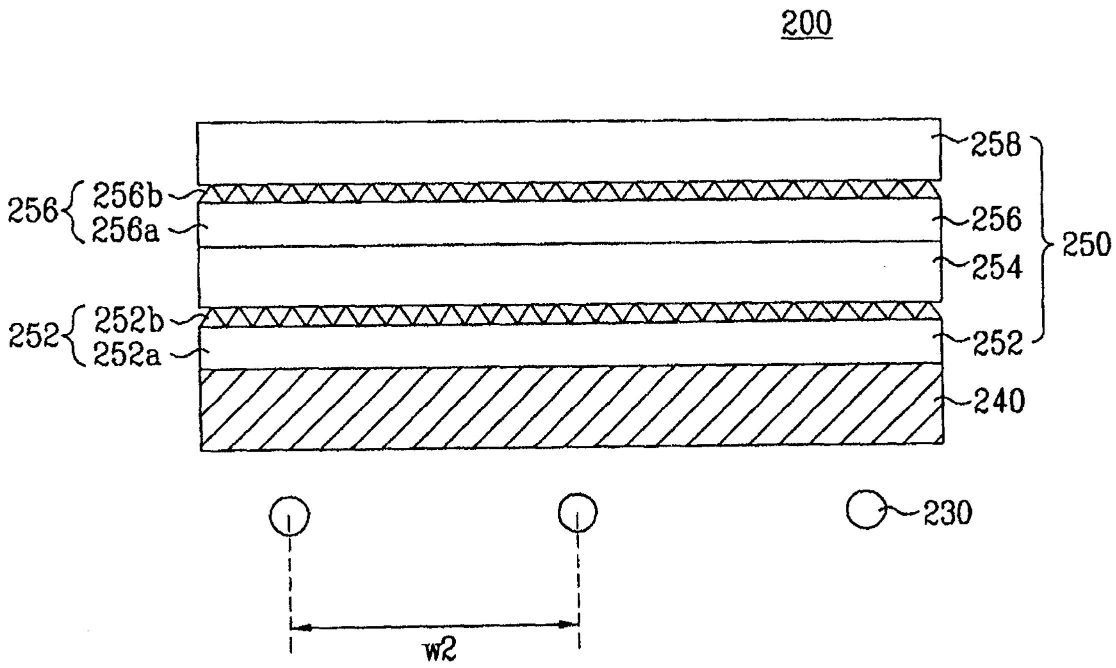


【Figure 11】

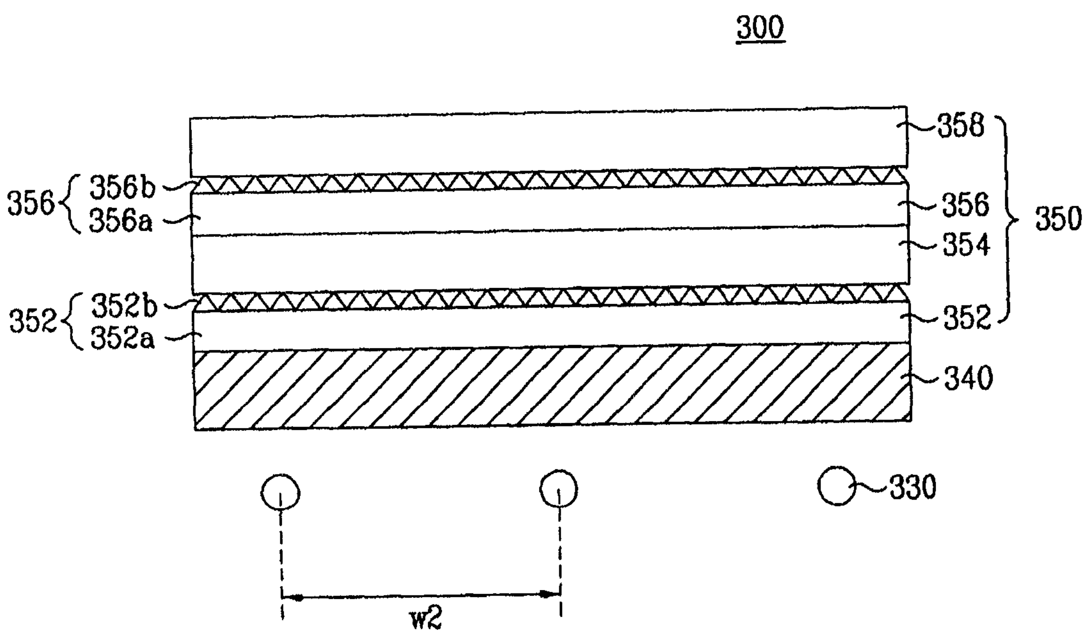


Base Film Thickness 188 μm + Pattern Thickness 25 μm = 213 μm (Seat Thickness)
Base Film Thickness 250 μm + Pattern Thickness 25 μm = 275 μm (Seat Thickness)

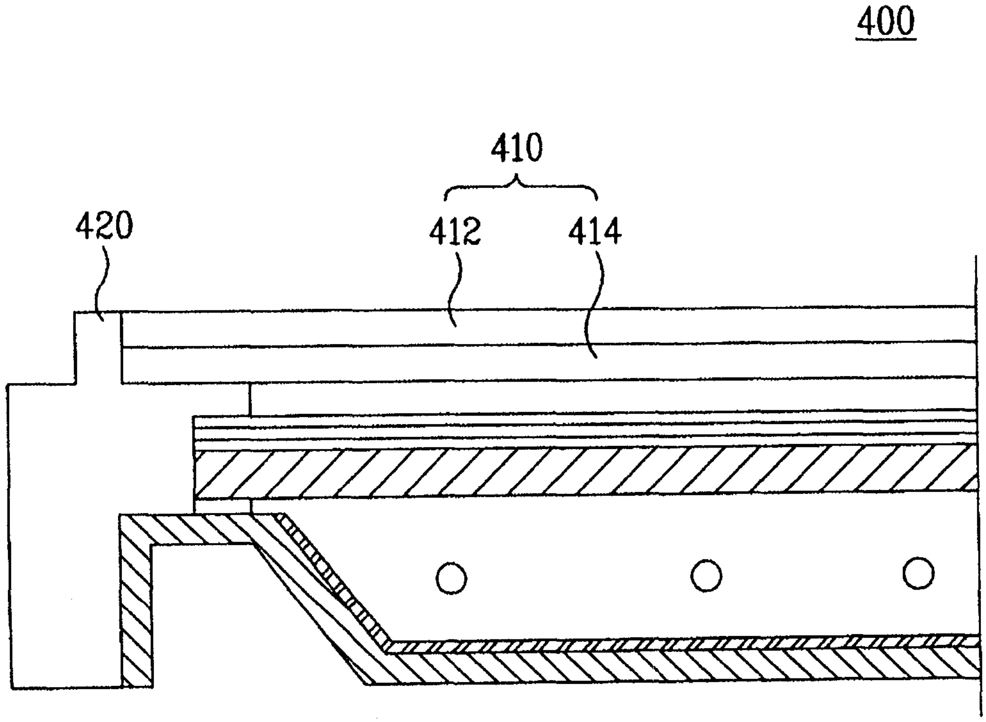
【Figure 12】



【Figure 13】



【Figure 14】



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2008/001541

A. CLASSIFICATION OF SUBJECT MATTER

G02F 1/13357(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 8 : G02F, G02B, F21V

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models since 1975
Japanese Utility models and applications for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS (KIPO internal) & keywords : "diffuse", "condenser", "prism"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2007-004104 A (SONY CORP.) 11 January 2007 abstract; paragraphs 40-44; claims 15-20; figure 1.	1-55
A	JP 2007-059122 A (FUJIFILM CORP.) 08 March 2007 abstract; paragraphs 23-34; claims 1-6; figures 1-4.	1-55
A	JP 2006-351540 A (LG PHILLIPS LCD CO., LTD.) 28 December 2006 abstract; paragraphs 31-43; claim 1; figures 3-4.	1-55
A	JP 2002-196312 A (HITACHI CO., LTD.) 12 July 2002 abstract; paragraphs 66-69; claims 1-2; figures 1-2.	1-55

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search
30 JUNE 2008 (30.06.2008)

Date of mailing of the international search report
30 JUNE 2008 (30.06.2008)

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