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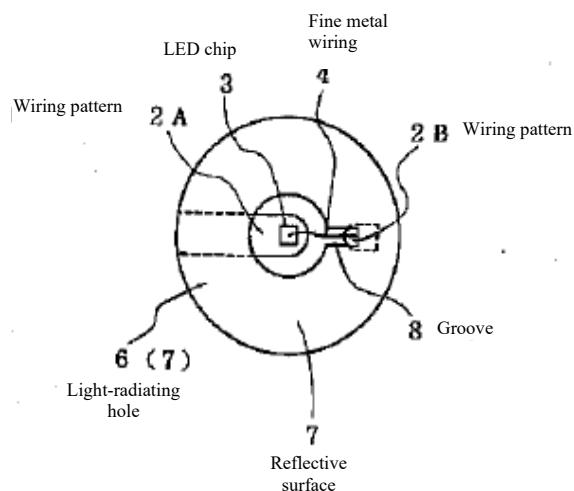
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(54) [Title of the Invention] Light-emitting unit, display device, and lighting system**(57) [Abstract]**

[Purpose] The objective is to efficiently emit light incident from an LED chip onto a reflective surface from the opening of the housing in order to increase the brightness and luminance.

[Constitution] Light-emitting unit U that is equipped with circuit board 1 on which a plurality of LED chips 3 and 3 ... have been arranged in a linear shape or matrix shape on wiring pattern 2A and housing 5 provided with light-radiating hole 6 corresponding to each LED chip 3 and 3 ..., wherein said light-radiating hole 6 forms a truncated conical shape or a truncated pyramid shape, while opening part 6b of the side of that substrate 1 has a size to enclose LED chip part 3 and consecutively connects groove 8 for use in the arrangement of fine metal wiring 4 that is connected to the other wiring pattern 2B, and a display device or lighting system using light-emitting unit U.

[Effect] By using a configuration that has reduced the losses that may occur during the repeated reflection of the light that is emitted from the LED chip on the peripheral wall surface of the light-radiating hole, it will be possible to increase the luminance or amount of light that is emitted from the light-radiating hole or light-radiating unit.



[Scope of Patent Claims]

[Claim 1] A light-emitting unit that is characterized by the fact that it is equipped with a circuit board on which a plurality of LED chips have been arranged in a linear shape or matrix shape on a wiring pattern and a housing provided with light-radiating holes corresponding to each LED chip, wherein said light-radiating hole forms a truncated conical shape or a truncated pyramid shape, while the opening part of the side of that substrate has a size to enclose the LED chip part and consecutively connects the groove for use in the arrangement of the fine metal wiring that is connected to the other wiring pattern.

[Claim 2] A light-emitting unit that is characterized by the fact that it is equipped with a circuit board on which a plurality of LED chips have been arranged in a linear shape or matrix shape on a wiring pattern and a housing provided with trough-shaped light-radiating units corresponding to each LED chip arranged in series on this circuit board, wherein the cross-section of the narrow side of said light-radiating unit forms a truncated conical shape or a truncated pyramid shape, while the width of the opening part of the side of that substrate on the consecutive long side has a size to enclose the LED chip part and consecutively connects the groove for use in the arrangement of the fine metal wiring that is connected to the other wiring pattern from each LED chip to the vicinity of each LED chip.

[Claim 3] A light-emitting unit that is characterized by the fact that the expanded angle of the opening of the truncated conical or truncated pyramid-shaped light-radiating holes formed on said housing is 20 to 100 degrees.

[Claim 4] A display device that is characterized by the fact that it is equipped with one set or a plurality of sets of the light-emitting unit described in any one of Claims 1 to 3 and a current limiting circuit that is connected in series to this light-emitting unit.

[Claim 5] A display device that is characterized by the fact that it is equipped with one set or a plurality of sets of the light-emitting unit described in any one of Claims 1 to 3 and a flicker drive circuit to selectively illuminate a plurality of LED chips that is connected to the output side of this light-emitting unit.

[Claim 6] A lighting system that is characterized by the fact that it is equipped with one set or a plurality of sets of the light-emitting unit described in any one of Claims 1 to 3 and a current limiting circuit that is connected in series to this light-emitting unit.

[Claim 7] A lighting system that is characterized by the fact that it is equipped with one set or a plurality of sets of the light-emitting unit described in any one of Claims 1 to 3 and a flicker drive circuit to selectively illuminate a plurality of LED chips that is connected to the output side of this light-emitting unit.

[Detailed Description of the Invention]

【0001】

[Field of Industrial Application] The present invention relates to a light-emitting unit to perform illumination or display of text, numerical characters, or images, etc., using a light-emitting diode, and to a display device and lighting system that uses this light-emitting unit.

【0002】

[Prior Art] For instance, in lieu of the electric lamps that may be used as the light source for an electrical display device, it is increasingly common to use light-emitting diodes (hereinafter to be abbreviated as LED) that are compact (thin) size, light-weight, low power, low heat, and low-cost while also boasting impressive vibration resistance and long lifespans.

【0003】 For example, in an electrical display device using this type of LED, such as a road message sign, a light-emitting unit may be constructed of a single module

that consists of a total of 81 LED chips arranged in a matrix shape in 9 rows and 9 columns lengthwise and breadth-wise on a circuit board that may have dimensions of approximately 5 cm in length and approximately 5 cm in width. Further, by attaching these modular light-emitting units to a frame in a matrix shape with, for instance, 10 modules x 20 modules lengthwise and breadth-wise, and electrifying specific LED chips via a lighting control circuit in order to illuminate them, it is possible to display and provide the road information that may be required by the passing traffic.

【0004】 Further, the conventional structure of this type of light-emitting unit U has been as shown in Figure 1 [Fig. 1 is an example of embodiment of the present invention, but the external appearance is the same as the conventional unit) and in Figure 9. In other words, in Figure 1 and Figure 9, 1 is a circuit board that is constructed of an electric insulating synthetic resin, while 2A and 2B are wiring patterns formed on this circuit board 1, 3 and 3 are LED chips that are formed at specific intervals on this wiring pattern 2A [Fig. 9 shows only a single LED chip], and 4 is the fine metal wiring that connects the top surface of this LED chip with anode wiring pattern 2B.

【0005】 Additionally, 5 is the housing that is anchored on this circuit board 1, and penetrating light-radiating hole 6 is formed to be divided by partitions 6c and 6c ... in the portion that faces each LED chip 3 and 3 formed on wiring pattern 2A of said circuit board 1, wherein the peripheral wall of this light-radiating hole 6 is an inclined surface forming a truncated conical shape for which the diameter of the upper opening part 6a side is larger than the circuit board 1 side, and this inclined surface is reflective surface 7 that has undergone whitening or the like. Further, each of said LED chips 3 and 3 ... are positioned in the central axis of each light-radiating hole 6 and 6 ... such that, when LED chip 3 is illuminated, that radiated light will be efficiently irradiated outside of housing 5 via reflective surface 7.

【0006】 Light-emitting unit U that has this type of structure has the advantage of low power consumption, vibration resistance, and a long lifespan, facilitating maintenance and management, but there is a need to further increase the luminance to enable easier identification by the drivers of motor vehicles or the like.

【0007】 While this may be said to be true of display boards in general, in the case of information display boards that are installed outdoors in particular, when sunlight hits the display surface in a bright environment on a sunny day, there may be a decrease in the luminance ratio of the display surface due to the incident sunlight, making the display difficult to see, and viewers such as the drivers of motor vehicles may no longer be able to view the display details. Therefore, there has been a need for improved luminance to enable clear identification of the display on the display surface.

【0008】 Therefore, the present inventors conducted further studies on this light-emitting unit U. The results of these studies revealed that, with the conventional light-radiating hole 6 with a truncated conical shape that is formed in housing 5, while the diameter of the upper opening part 6a side is larger than that of the circuit board 1 side, the diameter of hole 6b on the side of circuit board 1 is also rather large, being a size to enclose the entirety of LED chip 3 that includes the fine metal wiring 4 part that is connected to wiring pattern 2B on circuit board 1, and the expanded opening of the inclined surface (6) connecting opening parts 6a and 6b vertically was formed to be small.

【0009】 Further, the fact that the expanded opening of this inclined surface (6) is small means that the majority of the light that is emitted from LED chip 3 will be

incident to the inclined reflective surface 7, due to the small angle of inclination $\theta/2$ of this reflective surface, as shown by arrow A in Figure 9, the light will reach opening part 6a while repeating multiple reflections within reflective surface 7 and will be emitted outside of housing 5. In this way, it was discovered that the repeated reflection in reflective surface 7 will attenuate the light through diffusion or scattering, etc., weakening the light in comparison to the instance in which the light is emitted from opening part 6a in a single reflection and reducing the luminance of the light-emitting surface.

【0010】 Therefore, while it should also be possible to increase the angle of inclination of reflective surface 7 formed in said housing 5, by increasing the size of opening part 6a while maintaining the same area on the light-emitting surface side, it will be necessary to reduce the number of LED chips 3 and 3 ..., and reducing the number of these LED chips 3 and 3 ... will clearly result in a reduction in the amount of light in comparison to the conventional amount. Further, conversely, by increasing the number of LED chips 3 and 3 ... formed on circuit board 1, the angle of inclination of reflective surface 7 will be further reduced while also causing problems such as the insulation spacing in wiring patterns 2A and 2B, preventing a relative increase in the light amount or luminance.

【0011】 [Problem to be Solved by the Invention] The problem to be resolved by the present invention is the fact that it is not possible to effectively emit the light incident to the reflective surface from the LED chips from the opening part of the housing.

【0012】 [Means for Solving the Problem] The light-emitting unit described in Claim 1 according to the present invention is characterized by the fact that it is equipped with a circuit board on which a plurality of LED chips have been arranged in a linear shape or matrix shape on a wiring pattern and a housing provided with light-radiating holes corresponding to each LED chip, wherein said light-radiating hole forms a truncated conical shape or a truncated pyramid shape, while the opening part of the side of that substrate has a size to enclose the LED chip part and consecutively connects the groove for use in the arrangement of the fine metal wiring that is connected to the other wiring pattern.

【0013】 The light-emitting unit described in Claim 2 according to the present invention is characterized by the fact that it is equipped with a circuit board on which a plurality of LED chips have been arranged in a linear shape or matrix shape on a wiring pattern and a housing provided with trough-shaped light-radiating units corresponding to each LED chip arranged in series on this circuit board, wherein the cross-section of the narrow side of said light-radiating unit forms a truncated conical shape or a truncated pyramid shape, while the width of the opening part of the side of that substrate on the consecutive long side has a size to enclose the LED chip part and consecutively connects the groove for use in the arrangement of the fine metal wiring that is connected to the other wiring pattern from each LED chip to the vicinity of each LED chip.

【0014】 The light-emitting unit described in Claim 3 according to the present invention is characterized by the fact that the expanded angle of the opening of the truncated conical or truncated pyramid-shaped light-radiating holes formed on the housing is 20 to 100 degrees.

【0015】 The display device described in Claim 4 according to the present invention is characterized by the fact that it is equipped with one set or a plurality of sets of the light-emitting unit described in any one of the

above-noted Claims 1 to 3 and a current limiting circuit that is connected in series to this light-emitting unit.

【0016】 The display device described in Claim 5 according to the present invention is characterized by the fact that it is equipped with one set or a plurality of sets of the light-emitting unit described in any one of the above-noted Claims 1 to 3 and a flicker drive circuit to selectively illuminate a plurality of LED chips that is connected to the output side of this light-emitting unit.

【0017】 The lighting system described in Claim 6 according to the present invention is characterized by the fact that it is equipped with one set or a plurality of sets of the light-emitting unit described in any one of the above-noted Claims 1 to 3 and a current limiting circuit that is connected in series to this light-emitting unit.

【0018】 The lighting system described in Claim 7 according to the present invention is characterized by the fact that it is equipped with one set or a plurality of sets of the light-emitting unit described in any one of the above-noted Claims 1 to 3 and a flicker drive circuit to selectively illuminate a plurality of LED chips that is connected to the output side of this light-emitting unit.

【0019】 [Operation] By constructing the opening part of the circuit board side of the housing to have a small diameter excluding the extended portion of the fine metal wiring and constructing a light-radiating hole having a reflective surface with a large angle of inclination, it will be possible to reduce the losses by reducing the repeated reflection of the light incident onto the reflective surface from the LED chips, thereby ensuring the efficient irradiation of the light from the opening part of the housing.

【0020】 [Examples of Embodiment] The first example of embodiment of the present invention is described below with reference to Figures 1 to 4. Figure 1 is a perspective view of the light emitting unit. Figure 2 is a top view of the main part from the D direction in Figure 1. Figure 3 is a cross-sectional view of the main part longitudinally along the X-X-ray in Figure 1, and Figure 4 is a cross-sectional view of the main part longitudinally along the Y-Y-ray in Figure 1.

【0021】 The outer packaging of this light-emitting unit U consists of circuit board 1 that is constructed of electrically insulating synthetic resin, and housing 5 that is constructed of synthetic resin mated to one side of this circuit board 1. For example, this circuit board 1 may have a vertical x horizontal dimension of approximately 5 cm x approximately 5 cm, and wiring patterns 2A and 2B that are constructed of copper foil or the like may be formed on this circuit board 1. A total of 81 LED chips 3 and 3 that are constructed of GaP or GaAlAs [Fig. 2 through Figure 4 show only one LED chip in the figures) may be anchored via an electrically conductive adhesive in a matrix shape of 9 rows and 9 columns lengthwise and breadth-wise at the specific spacing of, for instance, approximately 5 mm, on top of one extending common wiring pattern 2A, for example.

【0022】 Additionally, fine metal wiring 4 and 4 ... [Fig. 2 through Figure 4 show only a single wire in the figures) may form a wiring connection to connect each of the other independent wiring patterns 2B and 2B ... [Fig. 2 through Figure 4 show only a single pattern in the figures) and the top surface (anode) of the above-noted LED chips 3 and 3 ...

【0023】 Further, in housing 5 that is constructed of synthetic resin or the like that is mated with this circuit board 1, a total of 81 light-radiating holes 6 and 6 ... are formed as being segmented by partitions 6c and 6c ... in the portion that faces each LED chip 3 and 3 ... on circuit board 1, and the central axis of each LED chip 3

and 3 ... and each light-radiating hole is the same axis or is on approximately the same axis. The peripheral wall of this light-radiating hole 6 is an inclined surface that forms a truncated conical shape wherein the diameter of opening part 6a on the top side is larger than the diameter of opening part 6b on the circuit board 1 side, and while the diameter of the top side opening part 6a is approximately 4 mm, which is unchanged from the conventional diameter, the diameter of opening part 6b on the circuit board 1 side is approximately 1.5 mm from LED chip 3 and up to the center site of fine metal wiring 4 that extends in the other independent wiring pattern 2B, which is smaller than the conventional diameter. Further, the degree of the extended opening is approximately 40 degrees, resulting in a gradual incline. Additionally, slit-shaped groove 8 is formed as a notch in part of the peripheral wall of this light-radiating hole 6, enabling the above-noted fine metal wiring 4 to pass through groove 8 that is connected to light-radiating hole 6. Further, reflective coating 7 that has light-reflecting properties such as white light is formed in the inclined surface of this light-radiating hole 6.

【0024】 In the assembly of this light-emitting unit U, first, wiring pattern 2A and the segmented wiring pattern 2B and 2B ... that are consecutively connected of copper foil or the like are formed in the specified positions on circuit board 1, and then, LED chips 3 and 3 ... are bonded via a conductive adhesive at the specified spacing on top of the above-noted consecutively connected wiring pattern 2A. Next, fine metal wiring 4 and 4 ... are bonded and connected one after the other across the distance between the top surface of these LED chips 3 and 3 ... (whether this is the anode side or the cathode side will be determined based on if the LED is an n-p junction or a p-n junction) and wiring patterns 2B and 2B that are formed to be segmented. When this bonding has been completed, housing 5 is brought onto the top surface of circuit board 1, the positions of LED chips 3 and 3 ... are aligned with the positions of each light-radiating hole 6 and 6, and the assembly is completed by anchoring these using a fastening means such as an adhesive, locking through the use of surface irregularities, or a screw, none of which are shown in the figure.

【0025】 The illumination of this light-emitting unit U may be performed by feeding electricity from the power source following the connection of LED chips 3 and 3 ... in series with circuit board 1 or a current limiting circuit (not shown in the figure) that is provided separately from circuit board 1. Additionally, when changing the display, a flicker drive circuit (not shown in the figure) may be used to control the illumination of the specified LED chips 3 and 3 ... either individually or in groups (in the case of the present example of embodiment, control is performed by turning the side of each individual wiring pattern 2B ON or OFF), enabling the display of the specified text, numerical characters, or images, etc., through combinations of the light emitted from each LED chip 3 and 3 ... that has been illuminated, and enabling the functionality of light-emitting unit U as an electrical display system.

【0026】 When the specified LED chips 3 and 3 ... of light-emitting unit U with this type of structure are electrified and illuminated, the light emitted from LED chip 3 will consist of direct light B that proceeds straight upwards in the figure and reflected light A facing outside of light-radiating hole 6 following input against reflective surface 7 that is formed in the inclined surface of the peripheral wall of LED chip 3.

【0027】 In the case of the present invention, the angle of inclination $\theta/2$ of the inclined surface formed by the peripheral wall of this light-radiating hole 6 is larger than in the prior art, and therefore, there will be less

repetition of repeated reflection of the light emitted from LED chip 3 against reflective surface 7, ensuring that the majority of the light will reach opening part 6a in a single reflection to be radiated outside of housing 5.

【0028】 Therefore, the portion of the inclined surface of the peripheral wall of light-radiating hole 6 that suffers light losses will be only the portion of slit-shaped groove 8 through which the narrow fine metal wiring 4 passes, which represents only a small part of entirety, and as a result, it will be possible to obtain light-emitting unit U with increased brightness in which it has been possible to increase the luminance or amount of light to be irradiated from light-radiating hole 6.

【0029】 Further, it goes without saying that it is also acceptable to use a single light-emitting unit U, but for instance, as shown in Figure 5, by using a plurality of sets of light-emitting unit U as a road message sign and attaching these sets, for instance, to chassis 9 that has columns 9a and 9a in a matrix shape of 10 units x 20 units lengthwise and breadth-wise, and electrifying the specified LED chips via a flicker drive circuit (not shown in the figure) to illuminate the LED chips, it will be possible to display and provide the information required in the traffic.

【0030】 Additionally, Figure 6 and Figure 7 show the second example of embodiment of the present invention, and the parts that are the same as in Figure 1 through Figure 4 will be denoted using the same symbols, and the explanation of these parts will be omitted here. In this example of embodiment, light-radiating holes 6 and 6 ... that are formed in housing 5 form an inclined surface with a truncated pyramid shape, such as a quadrangular pyramid, in which the length of the side of opening part 6a on the top side is greater than that of opening part 6b on the circuit board 1 side, and the angle of inclination $\theta/2$ of the inclined slope that connects the top and bottom opening parts 6a and 6b is formed of an angle that is greater than in the prior art.

【0031】 Even in the case of this truncated quadrangular pyramid-shaped light-radiating hole 6, the central axis of each light-radiating hole 6 and 6 ... and each LED chip 3 and 3 ... is the same axis or is on approximately the same axis, and groove 8 is formed as a notch in one part of the peripheral wall of light-radiating hole 6. The above-noted fine metal wiring 4 passes through groove 8 that is connected with light-radiating hole 6, and from the middle of fine metal wiring 4 and the other wiring pattern 2B are inside the tunnel-shaped groove, and are not visible from above light-radiating hole 6.

【0032】 As is the case with the above-noted example of embodiment, in the case of the present example of embodiment as well, there is little repetition of repeated reflection of the light emitted from LED chip 3 against reflective surface (6), and the majority of light will reach opening part 6a in a single reflection to be irradiated outside of housing 5. Therefore, the portion suffering light losses in inclined surface (6) of the peripheral wall of light-radiating hole 6 will only be the part of slight, slit-shaped groove 8 through which the narrow fine metal wiring 4 passes, making it possible to increase the luminance or amount of light that is emitted.

【0033】 Additionally, Figure 8 shows the third example of embodiment of the present invention, and the parts that are the same as in Figure 1 through Figure 7 will be denoted using the same symbols, and the explanation of these parts will be omitted here. In the above-noted example of embodiment, LED chips 3 and 3 ... were provided in a matrix shape lengthwise and breadth-wise on top of the circuit board, but in this example of embodiment, a plurality of LED chips 3 and 3 ... are in series in a single row or in multiple rows on top of circuit board 1, though a single row arrangement is

used here. Regarding housing 5, light-radiating unit 61 (corresponding to light-radiating hole 6 of the above-noted examples of embodiment) has a trough shape that forms a long V-shape with an open bottom, in which the cross-section of the narrow side facing the plurality of LED chips 3 and 3 has a truncated conical shape or truncated pyramid shape (and LED chips 3 and 3 ... are notched at the bottom side). Grooves 8 and 8 ... are formed as notches in part of the peripheral wall of light-radiating unit 61 in the vicinity of each LED chip 3 and 3 ..., enabling the above-noted fine metal wiring 4 and 4 ... to pass within each groove 8 and 8 that is connected to light-radiating unit 61. In this figure, 2C is the shared feed part of wiring pattern 2A.

【0034】 Even in light-emitting unit U with this type of structure, light-radiating unit 61 of which the cross-section in part has the same reflective characteristics as in the above-noted example of embodiment has been formed, so the light emission properties boast higher values than observed in the conventional product.

【0035】 The present invention is not limited to the above-noted examples of embodiment, and for instance, the inclined surface of light-radiating hole 6 or light-radiating unit 61 with a truncated conical shape or truncated pyramid shape that may be formed in housing 5 may not have a completely linear shape. As shown in Figure 8, the surface may have curvature such as a parabolic curved surface or an elliptic curved surface. In other words, any surface is acceptable as long as the structure permits the beam of light moving towards the inclined surface (6) (reflective surface 7) from LED chip 3 to be irradiated from light-radiating hole 6 or light-radiating unit 61 in a smaller number of reflections without repeated reflection on the inclined surface (6) (reflective surface 7). Additionally, according to the testing conducted by the present inventors, if the degree of the expanded angle of light-radiating hole 6 or light-radiating unit 61 is too large, there will be diffusion of light, decreasing the luminance. In practical applications, there will be good improvement in the light emission characteristics with an expanded opening of 20 to 100 degrees, and in particular, an angle of 40 to 60 degrees resulted in dramatic improvement in the properties with good light harvesting as well.

【0036】 Additionally, in the above-noted example of embodiments, reflective coating 7 was formed in the peripheral wall of light-radiating hole 6, but it is not particularly necessary to form reflective coating 7 as long as housing 5 itself is white.

【0037】 Additionally, by making groove 8 through which fine metal wiring 4 passes and that is formed on the side of circuit board 1 of light-radiating hole 6 or light-radiating unit 61 as narrow as possible, there will be fewer light losses and it will be possible to improve the properties. This groove 8 does not extend to the surface of inclined surface (6), and other than the entrance for wiring 4, the part is formed in a tunnel shape, so the entirety of wiring 4 does not need to be visible from above.

【0038】 Additionally, the examples of embodiment discussed the display device and light-emitting unit for use in road message signs, but something compact such as that shown in the third example of embodiment may be used in the illumination of office equipment such as copy machines or fax machines, within motor vehicles such as in the stop lamp, in decorative illumination, or the illumination of exhibits, etc. Further, light-emitting unit U shown in the second and third examples of embodiment may be used as a single unit or as the amalgamation of multiple units and broadly applied, both

indoors and outdoors, to a wide variety of electronic signage, guide signs, labeling, or advertising displays.

【0039】 Furthermore, when using this light-emitting unit U, it is also acceptable to apply a protective clear cover, colored material, lens, or filter to the light-radiating surface facing light-radiating holes 6 and 6 ... of housing 5.

【0040】 Even further, the assembly procedures for this light-emitting unit U are not limited to the examples of embodiment, and it is acceptable to simply form a groove for use with the fine metal wiring in the housing side, and with no particular processes being required, there need be no changes whatsoever from the conventional operations.

【0041】 [Effect of the Invention] As described above, the present invention has a configuration in which there are fewer instances of the repeated reflection of the light that is emitted from the LED chips (light-emitting diode chips) against the peripheral wall surface of the light-emitting holes or light-emitting units, ensuring that the majority of the light will reach the opening part of the light-emitting holes in a single reflection to be irradiated outside of housing 5. Therefore, as a result, it will be possible to achieve a light-emitting unit, display device, and lighting system that boast an increase in the luminance or amount of light that will be irradiated from the light-emitting holes, improving the brightness.

【0042】 Additionally, the present invention has a variety of advantages in that, when the housing surface is treated as the same light-emitting area, there will be no increase in the quantity of LED chips, and it will be possible to reduce costs because the product can be manufactured using the same operations as are conventionally used.

[Brief Description of the Drawings]

[Fig. 1] This is a perspective view showing the first example of the light-emitting unit according to the present invention.

[Fig. 2] This is a top view showing an enlarged portion of a single light-radiating hole as seen from the Z direction in Figure 1.

[Fig. 3] This is a front view showing the cut surface along X-X line in Figure 1, enlarging the portion for a single light-radiating hole.

[Fig. 4] This is a side view showing the cut surface along Y-Y line in Figure 1, enlarging the portion for a single light-radiating hole.

[Fig. 5] This is a perspective view showing an example of a display device according to the present invention.

[Fig. 6] This is a perspective view showing the second example of the light-emitting unit according to the present invention.

[Fig. 7] This is a top view showing an enlarged portion of a single light-radiating hole as seen from the Z direction in Figure 6.

[Fig. 8] This is a perspective view showing the third example of the light-emitting unit according to the present invention.

[Fig. 9] This is a top view showing an enlargement of the main part of a conventional light-emitting unit.

[Explanation of References]

U: Light-emitting unit

1: Circuit board

2A, 2B: Wiring pattern

3: LED chip (light-emitting diode chip)

4: Fine metal wiring

5: Housing

6: Light-radiating hole (inclined surface)

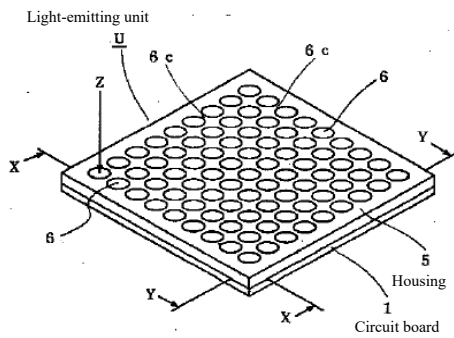
61: Light-radiating unit (inclined surface)

6a, 6b: Opening part

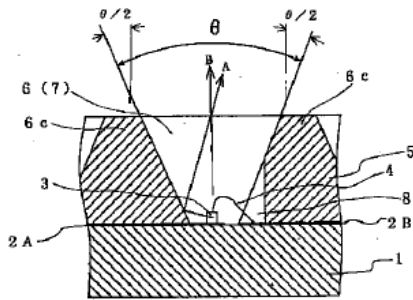
7: Reflective surface
8: Groove (slit)

Theta: Expanded opening angle
Theta/2: Angle of inclination of the inclined surface

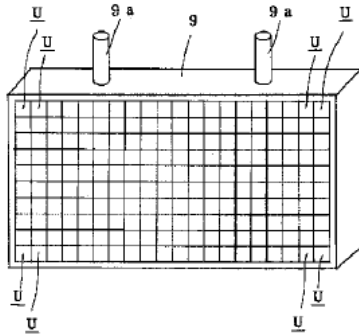
[Fig. 1]



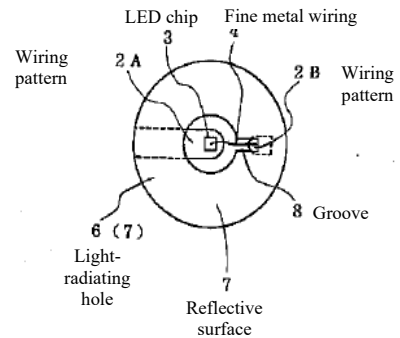
[Fig. 3]



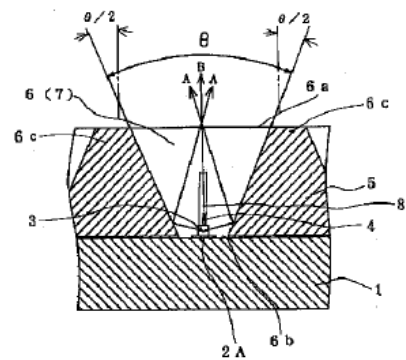
[Fig. 5]



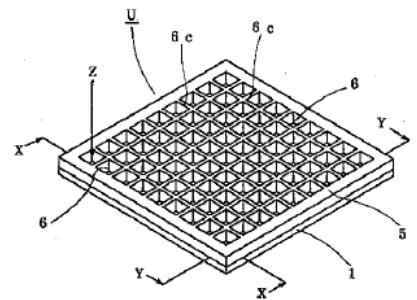
[Fig. 2]



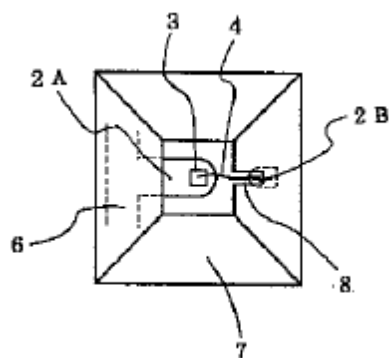
[Fig. 4]



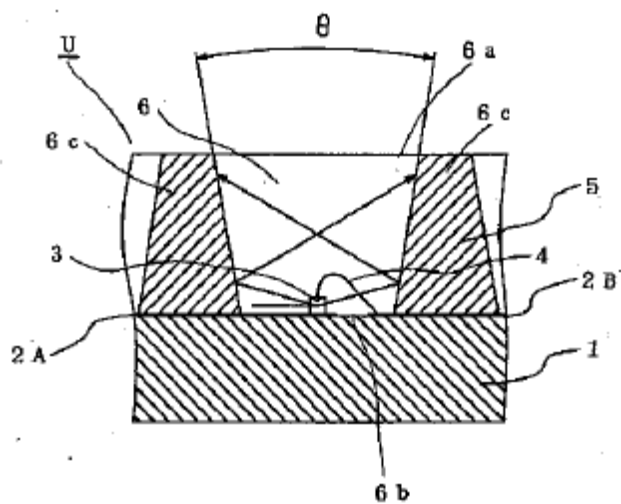
[Fig. 6]



[Fig. 7]



[Fig. 9]



[Fig. 8]

