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(54) Light-emitting device.

(57) A light-emitting device comprising a printed circuit board (2), one or a plurality of groups of LED lamps (1) mounted on the print base plate (2), each group comprising a plurality of the LED lamps (1), and an enclosure (3) encompassing each group of LED lamps (1), a characteristic feature being that those LED lamps (1) adjacently near the enclosure (3) in each group have narrower directivities than the other lamps in that group. As a modification, the LED lamps (1) near the enclosure (3) in each group may be tilted toward that enclosure. Alternatively, the lenses of the lamps (1a) near the enclosure (3) may be positioned higher than those of the other lamps (1b).

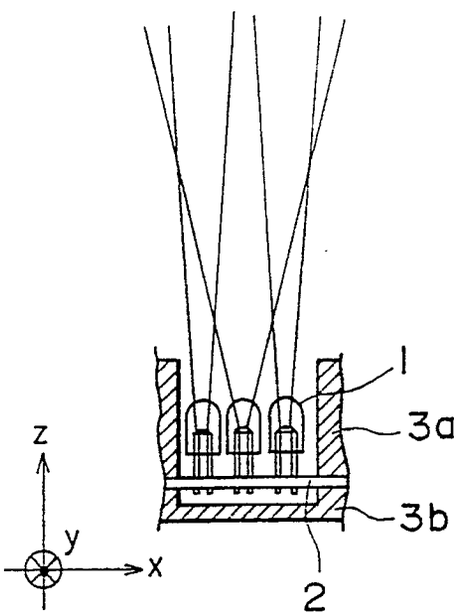

FIG. 1

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BACKGROUND OF THE INVENTION

The present invention relates to light-emitting devices in which light-emitting diodes (LED) are used, and which are used in LED display panels and the like.

In general, an LED display panel is constituted by a light-emitting device comprising a plurality of LED lamps arranged in one or more groups each group being in matrix formation. Such LED display panels are widely used for sign panels for roadways, outdoor sign boards, and the like.

In an light-emitting device, LED lamps emitting light of high brightness which can be readily discerned from a distance are used. Ordinarily these LED lamps emit light of a single or two kinds of wavelengths.

An example of a known light-emitting device in which LED lamps emitting light of two kinds of wavelengths is shown in FIGS. 9 and 10 of the accompanying drawings. In this device, 9 LED lamps 1 are mounted in a square formation on a printed circuit board 2 and accommodated within an enclosure 3. Four of these LED lamps 1 are red light emitting LED lamps R, while five lamps are green light emitting LED lamps G. These red lamps R and green lamps G are arranged in alternate positions for form a square matrix of three vertical columns and three horizontal rows or lines. This device is usually used for one dot of display panel.

This light-emitting device is capable of displaying light of three colors, namely, red light (when only red light emitting LED lamps R are lit), green light (when only green light emitting LED lamps G are lit), and orange light (when LED lamps R and LED lamps G are simultaneously lit).

In this device the enclosure 3 is provided for the purpose of shielding out incident light from adjacent LED light-emitting devices and incident light from the outside. However, when the display surface of the LED display panel is viewed from an oblique direction, the light from the lamps 1 in the vicinity of the enclosure is shielded and blocked by the enclosure 3. As a consequence, the light extracting or light displaying efficiency drops. This has been a problem in the prior art.

Another problem encountered heretofore has been insufficient brightness of the displayed light. More specifically, LED lamps of the same directivity are used in a conventional LED light-emitting device. Consequently, in the case where lamps of wide directivity were used, sufficient frontal brightness could not be obtained. Conversely, in the case where lamps of narrow directivity were used, the brightness of the emitted light as viewed from an oblique direction was insufficient.

SUMMARY OF THE INVENTION

The present invention has been made with the aim of solving the problems of the prior art described above. It is a general object of this invention to provide a light-emitting device capable of effectively utilizing light emitted from LED lamps.

According to this invention, briefly summarized, there is provided a light-emitting device comprising a print base plate, a plurality of LED lamps mounted on the print base plate, and an enclosure encompassing the LED lamps, which include LED lamps of mutually different directivities.

In the light-emitting device of the above described organization according to this invention, the LED lamps are mounted in a formation wherein lamps of different directivities and other characteristics are advantageously combined. As a result light from the LED lamps can be utilized effectively. Furthermore the directivities of the LED lamps can be readily selected.

The nature, utility, and further features of this invention will be more clearly apparent from the following detailed description with respect to preferred embodiments of the invention when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a sectional view showing one example of the light-emitting device according to this invention;

FIG. 2 is a planar layout view showing the state of mounting of LED lamps of different directivities according to the invention;

FIG. 3 is a graph indicating an example of directivities of LED lamps used in the invention;

FIGS. 4 and 5 are planar layout views respectively showing the other examples of matrix formations of LED lamps of different directivities according to the invention;

FIGS. 6(a), 6(b), and 6(c) are respectively a planar layout view, a rear planar view, and a side view, partly cut away, of still another example of the device of the invention;

FIGS. 7 and 8 are sectional views respectively showing further examples of the device of the invention; and

FIGS. 9 and 10 are respectively a plan view and a side sectional view of a known light-emitting device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In one example of the light-emitting device according to this invention as shown in FIG. 1, nine LED lamps 1 constituting one group are mounted in a square matrix formation on a printed circuit

board 2 similarly as in the known device illustrated in FIG. 10. These LED lamps 1 are accommodated within an enclosure comprising parts 3a and 3b. This group of LED lamps comprises 4 red-color emitting LED lamps and 5 green-color emitting LED lamps. The pattern of this group in the XY plane as shown in FIG. 2 has three rows of three lamps 1 each in the X direction and three columns of three lamps 1 each in the Y direction.

In this example of the device of this invention, the middle column in the Y direction comprises two red-light emitting LED lamps RA and one green-light emitting LED lamp GA interposed therebetween. Each of the columns of lamps adjacent to the enclosure part 3a comprises two green-light emitting lamps GB and one red-light emitting lamps RB interposed therebetween. These lamps GB and RB have narrow directivities.

In FIG. 3, the intermittent-line curve indicates the directivity of the red-light emitting lamp RA and green-light emitting lamp GA of broad directivity. The solid-line curve indicates the directivity of the red-light emitting lamp RB and green-light emitting lamp GB of narrow directivity.

Thus, according to this invention, LED lamps of narrow directivity are mounted adjacent to the enclosure 3 shown in FIG. 1, while the other LED lamps are of broad directivity. By this arrangement, the effect of shielding off of the light radiated from all LED lamps by the enclosure 3a and reflecting plates is reduced. Therefore the light emitted by the LED lamps can be effectively led out.

In the case where a light-emitting device of this invention is to be used to construct an LED display panel, the directivity in directions parallel to the ground particularly becomes problematical. For this reason, the directivity in only one direction (i.e., the X-axis direction) was considered in the above described example. Depending on the necessity, however, it is also possible to consider the directivities in the X and Y directions.

One example of this is shown in FIG. 4. A light-emitting device is constructed with nine monocolor red-light emitting LED lamps. In this case, a red-light emitting LED lamp RA of broad directivity is placed in the center of the group. For the other lamps adjacent to the enclosure, red-light emitting LED lamps of narrow directivity are used.

In another example as shown in FIG. 5, 16 LED lamps of two colors are used to constitute a group. For the four lamps in the central part of this group, red-light emitting LED lamps RA and green-light emitting LED lamps GA both of wide directivity are used. For the other 12 lamps around the periphery, red-light emitting LED lamps RB and green-light emitting LED lamps GB both of narrow directivity are used.

In still another example of this invention as shown in FIGS. 6(a), 6(b), and 6(c), a plurality of groups, for example 16 groups, of LED lamps 1 are mounted in a matrix formation on a single print base plate 2, each group comprising a plurality, for example 9, LED lamps 1. In this case also, in each group, LED lamps of wide directivity and those of narrow directivity are appropriately combined. In this manner, a functional effectiveness equivalent to that of the above described examples can be obtained. In FIG. 6(b), reference numeral 3a designates the enclosure on the display face side, while reference numeral 3b designates an enclosure including a mounting part used at the time of mounting of the light-emitting device.

In each of the above described example, the LED lamps 1 in the vicinity of the enclosure 3 may be mounted obliquely by changing their angles relative to the printed circuit board 2 as shown in FIG. 7 through the use of lead forming or the like. By this measure, light can be led out efficiently without causing a narrowing of the directivity even if LED lamps of narrow directivity are used.

Furthermore, as shown in FIG. 8, the heights of the lenses of the LED lamps 1a in the vicinity of the enclosure 3 may be made higher than those of the other LED lamps 1b. By this measure, the light shielding effect of the enclosure can be reduced. In this case, contrary to the light-emitting devices of the preceding examples, the directivities of the LED lamps 1a in the vicinity of the enclosure or reflection plate can be made broader than those of the other LED lamps 1b.

As described above, the present invention provides an light-emitting device in which LED lamps of different directivities are used in combination. As a result, the light shielding or shading effect of the enclosure can be reduced. Light can thereby be effectively directed out. Furthermore, LED light-emitting device in which directivities of the LED lamps can be readily selected can be produced.

Reference signs in the claims are intended for better understanding and shall not limit the scope.

Claims

1. A light-emitting device comprising a printed circuit board (2), a plurality of LED lamps (1) mounted on the print base plate, and an enclosure (3) encompassing the LED lamps (1), characterised in that LED lamps (RA, RB, GA, GB) of mutually different directivities are included among the plurality of LED lamps (1).

2. A light-emitting device according to claim 1, characterised in that the plurality of LED lamps (1) are divided into a plural number of groups of the LED lamps (1), each group comprising a specific number of LED lamps (1) and contain-

ing LED lamps of mutually different directivities.

3. A light-emitting device according to claim 1 or 2, characterised in that the plurality of LED lamps (1) emit light of the same wavelength.

4. A light-emitting device according to claim 1 or 2, characterised in that LED lamps (1) for emitting light of different wavelengths are included among the plurality of LED lamps.

5. A light-emitting device according to any one of claims 1 through 4, characterised in that the plurality of LED lamps (1) include LED lamps (1a) with light-emitting axes at angles of orientation relative to the printed circuit board (2) that are different from corresponding angles of orientation of other LED lamps (1b) of the plurality of LED lamps.

6. A light-emitting device according to any one of claims 1 through 5 in which the plurality of LED lamps (1) include LED lamps (1a) with lens heights relative to the printed circuit board (2) that are different from corresponding lens heights of other LED lamps (1b) of the plurality of LED lamps (1).

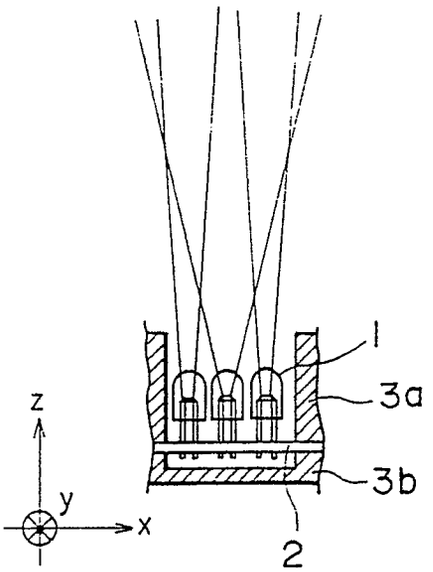

FIG. 1

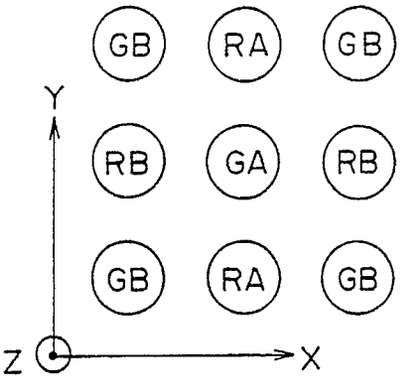

FIG. 2

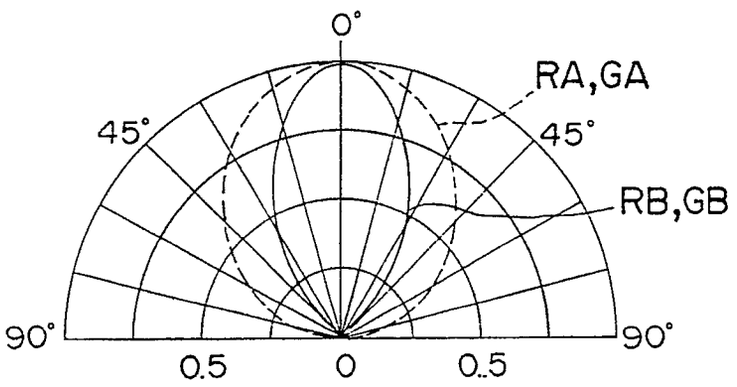

FIG. 3

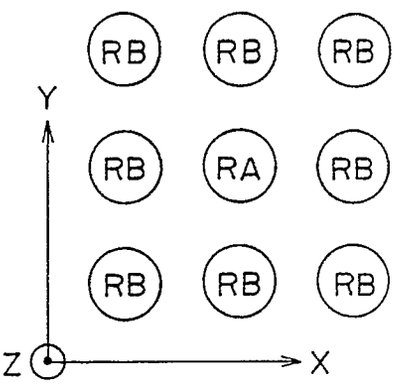

FIG. 4

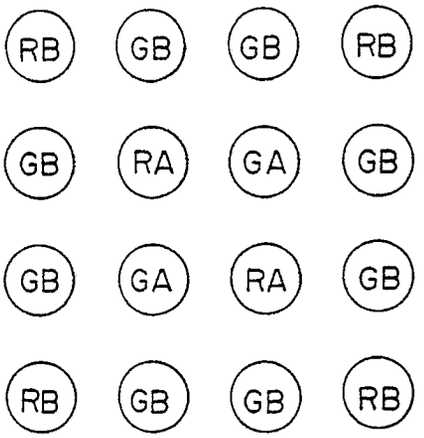

FIG. 5

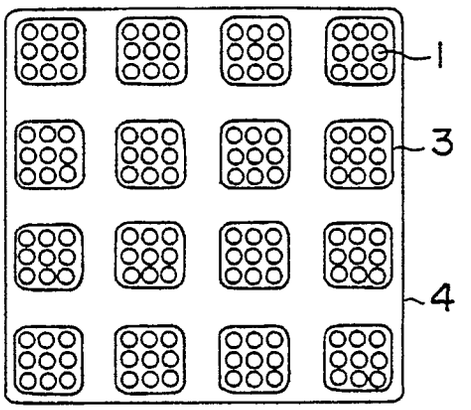

FIG. 6 (a)

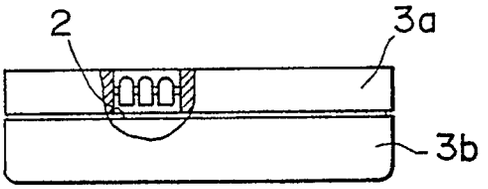

FIG. 6 (b)

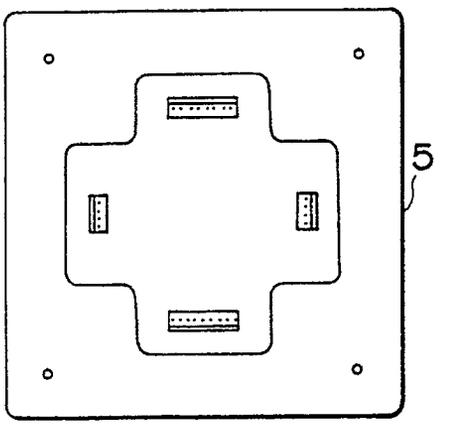

FIG. 6 (c)

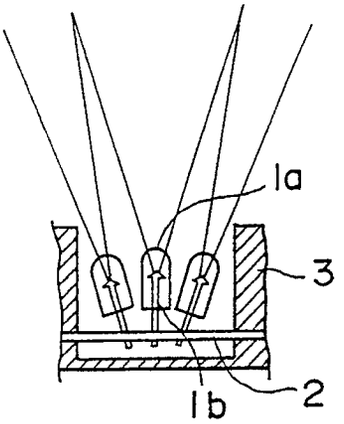

FIG. 7

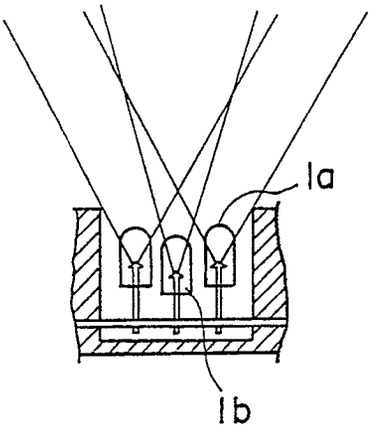

FIG. 8

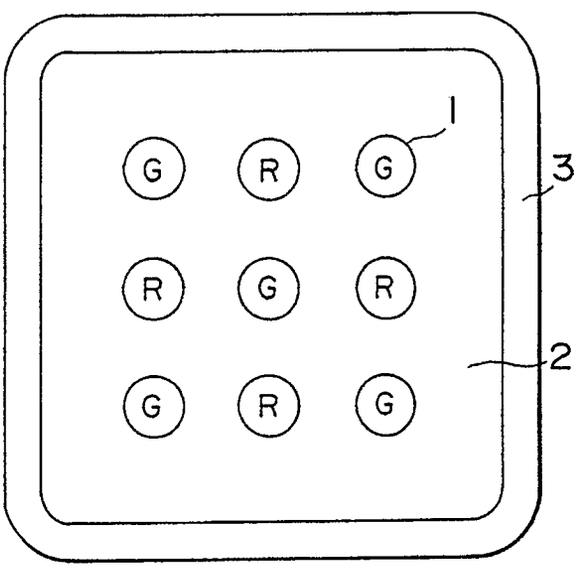

FIG. 9

PRIOR ART

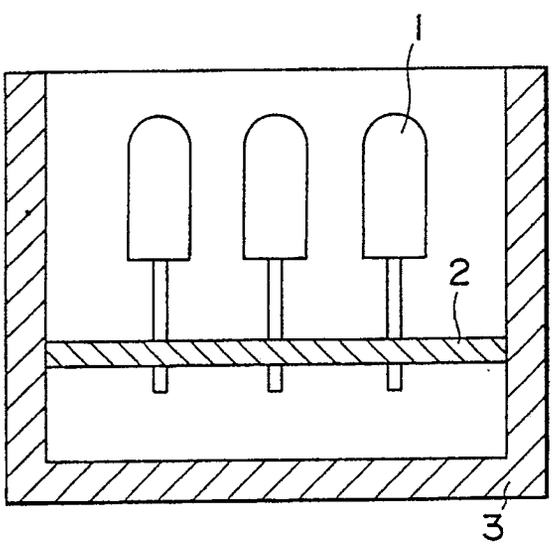

FIG. 10

PRIOR ART