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

(11) EP 2 551 229 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
30.01.2013 Bulletin 2013/05

(21) Application number: **10848389.2**

(22) Date of filing: **25.03.2010**

(51) Int Cl.:
B66B 11/02 *(2006.01)*

(86) International application number:
PCT/JP2010/055217

(87) International publication number:
WO 2011/117996 (29.09.2011 Gazette 2011/39)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

(71) Applicant: **Mitsubishi Electric Corporation**
Tokyo 100-8310 (JP)

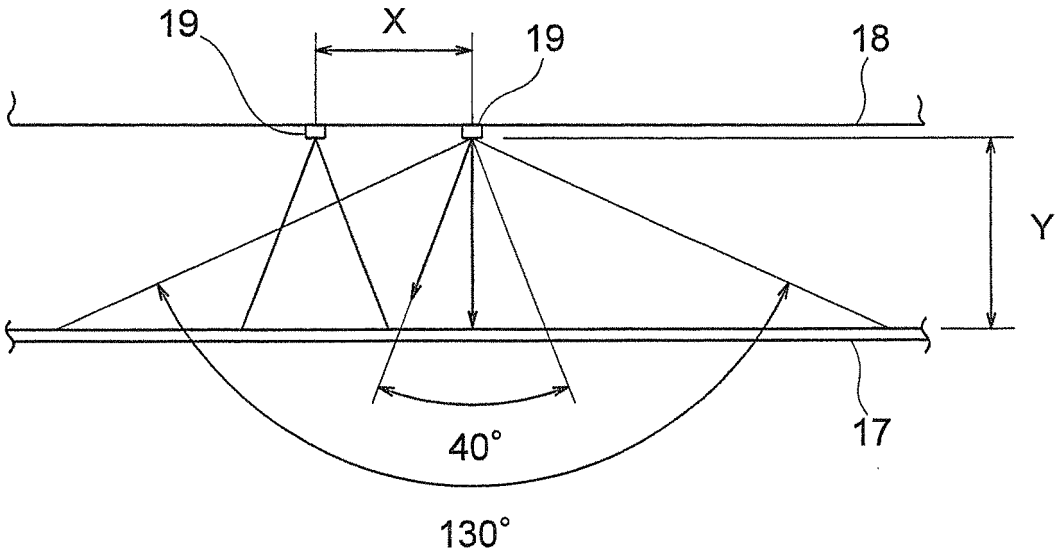
(72) Inventor: **YAMADA, Masaaki**
Tokyo 100-8310 (JP)

(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) **ELEVATOR CAR INTERIOR ILLUMINATION APPARATUS**

(57) A light-source device includes a plurality of LEDs provided at intervals. A light beam from each of the plurality of LEDs is radiated to interior of a car. An illumination cover is provided on an inner side of the car as compared with the each of the plurality of LEDs. The illumination cover scatters the light beam from the each of the plurality of LEDs to the interior of the car. The each of the plurality of LEDs has directivity characteristics allowing a relative luminosity to a luminosity on an optical axis to be 80% or higher in a region in which an angle with respect to the optical axis is 20 degrees or smaller. A relationship between a pitch X (mm) between the plurality of LEDs and a distance Y (mm) between the each of the plurality of LEDs and the illumination cover satisfies: $Y \geq 0.9X+9$.

FIG. 6



EP 2 551 229 A1

Description

Technical Field

[0001] The present invention relates to an elevator car interior illumination apparatus for illuminating the interior of a car through light emission of LEDs.

Background Art

[0002] Conventionally, for a longer lifetime and energy saving, an elevator car interior illumination apparatus for controlling a plurality of LEDs to emit light to illuminate the interior of a car is known. The LEDs are collectively covered with a protective plate for diffusing the light (see Patent Literature 1).

Citation List

Patent Literature

[0003] Patent Literature 1: JP 2004-338825 A

Summary of Invention

Technical Problem

[0004] However, the LEDs have directivity which is extremely stronger than that of a normal fluorescent lamp. Therefore, even if the light from each of the LEDs is diffused by the protective plate, a bright portion and a dark portion are generated distinctively on the protective plate in accordance with the arrangement of the LEDs, depending on the position of the protective plate. Therefore, a design for giving the impression of soft light as if the entire protective plate uniformly shined cannot be realized. As a result, designability of the illumination apparatus is lowered.

[0005] The present invention has been made to solve the problem described above and therefore, has an object to provide an elevator car interior illumination apparatus capable of improving designability.

Solution to Problem

[0006] According to the present invention, there is provided an elevator car interior illumination apparatus, including: a light-source device including a plurality of LEDs provided at intervals, for radiating a light beam from each of the plurality of LEDs to interior of a car; and an illumination cover provided on an inner side of the car as compared with the each of the plurality of LEDs, for scattering the light beam from the each of the plurality of LEDs to the interior of the car, in which: the each of the plurality of LEDs has directivity characteristics allowing a relative luminosity to a luminosity on an optical axis to be 80% or higher in a region in which an angle with respect to the optical axis is 20 degrees or smaller, and a relation between a pitch X (mm) between the plurality of LEDs and a distance Y (mm) between the each of the plurality of LEDs and the illumination cover satisfies: $Y \geq 0.9X+9$.

Advantageous Effects of Invention

[0007] According to the elevator car interior illumination apparatus of the present invention, each of the LEDs has directivity characteristics which allow the relative luminosity to be 80% or higher in the region in which the angle with respect to the optical axis is 20 degrees or smaller, and the relation between the pitch X (mm) between the LEDs and the distance Y (mm) between each of the LEDs and the illumination cover satisfies: $Y \geq 0.9X+9$. Therefore, for the neighboring LEDs, the ranges in which the luminosity is low can be overlapped while the ranges in which the luminosity is high are prevented from overlapping. Thus, the luminosity at the position of the illumination cover can be made close to be uniform. Therefore, the generation of a bright portion and a dark portion on the illumination cover can be suppressed, and the design can be made closer to the one which gives the impression of soft light as if the entire illumination cover uniformly shined. As a result, the designability of the illumination apparatus can be improved. Moreover, because the directivity characteristics of each of the LEDs are set within the range of the directivity characteristics of a common LED, the cost of each of the LEDs can be reduced.

Brief Description of Drawings

[0008]

[FIG. 1] A longitudinal sectional view illustrating a car of an elevator according to a first embodiment of the present invention.
[FIG. 2] A longitudinal sectional view illustrating a car ceiling illustrated in FIG. 1.
[FIG. 3] A front view of the car ceiling as viewed from the interior of the car illustrated in FIG. 1.
[FIG. 4] A front view illustrating a state in which an illumination cover is removed from the car ceiling illustrated in FIG. 3.
[FIG. 5] A front view illustrating an LED unit illustrated in FIG. 4.
[FIG. 6] An enlarged view illustrating an illumination apparatus illustrated in FIG. 2.
[FIG. 7] A graph showing the relation between an evaluation of designability at the illumination cover, a pitch X (mm) between LEDs, and a distance Y (mm) between each of the LEDs and the illumination cover illustrated in FIG. 6.

Description of Embodiment

[0009] Hereinafter, a preferred embodiment of the present invention is described referring to the drawings.

First Embodiment

[0010] FIG. 1 is a longitudinal sectional view illustrating a car of an elevator according to a first embodiment of the present invention. In the drawing, a car 1 includes a car floor 2, car walls 3 provided vertically on edge portions of the car floor 2, and a car ceiling 4 provided above the car floor 2 so as to be supported by the car walls 3. A car doorway (not shown) is provided to a part of the car walls 3.

[0011] FIG. 2 is a longitudinal sectional view illustrating the car ceiling 4 illustrated in FIG. 1. FIG. 3 is a front view of the car ceiling 4 as viewed from the interior of the car 1 illustrated in FIG. 1. Further, FIG. 4 is a front view illustrating a state in which an illumination cover is removed from the car ceiling 4 illustrated in FIG. 3. In the drawings, the car ceiling 4 includes a ceiling panel 6 provided with an opening portion 5, and a hood (illumination box) 7 (FIG. 2) provided above the opening portion 5 (specifically, at a position on the outer side of the car 1 as compared with the opening portion 5) and mounted onto the ceiling panel 6. A car interior illumination apparatus (hereinafter, referred to simply as "illumination apparatus") 8 for illuminating the interior of the car 1 is provided to the car ceiling 4.

[0012] In a central portion of the ceiling panel 6, a concave portion 9, which is recessed toward the inner side of the car 1, is provided as illustrated in FIG. 2. The ceiling panel 6 includes a ceiling upper plate portion 10 horizontally provided around the concave portion 9, a ceiling lower plate portion 11 provided at a position lower than the ceiling upper plate portion 10 to form a bottom surface of the concave portion 9, and a ceiling vertical plate portion 12 which connects the ceiling upper plate portion 10 and the ceiling lower plate portion 11 to form an inner surface of the concave portion 9. The opening portion 5 is provided to the ceiling lower plate portion 11. In this example, a shape of the opening portion 5 is square with a longitudinal size of 600 (mm) and a lateral size of 600 (mm) as illustrated in FIGS. 3 and 4.

[0013] The hood 7 is provided inside the concave portion 9. Moreover, the hood 7 includes an edge portion 13 mounted to the ceiling lower plate portion 11, and a plate-like hood main body 14 provided on an upper end portion of the edge portion 13 so as to be horizontally provided above the opening portion 5. In this example, a depth size of the concave portion 9 is set to 50 (mm).

[0014] The illumination apparatus 8 includes a plurality of (in this example, nine) LED units (light-source devices) 16 respectively mounted to the hood main body 14 through an intermediation of a mounting plate 15 for heat radiation, and an illumination cover 17 provided below the LED units 16 (specifically, at a position on the inner side of the car 1 as compared with the position of each of the LED units 16) to close the opening portion 5.

[0015] The LED units 16 are horizontally arranged along the hood main body 14. Moreover, the LED units 16 are arranged within the range of the opening portion 5 as viewed from the interior of the car 1, as illustrated in FIG. 4. In this example, the nine LED units 16 in total are evenly arranged in three rows in the vertical direction of the opening portion 5 and in three rows in the horizontal direction of the opening portion 5.

[0016] The LED units 16 are mounted to the hood main body 14 through an intermediation of the common mounting plate 15, as illustrated in FIG. 2. As a material of the mounting plate 15, for example, a metal such as aluminum, a resin having a high thermal conductivity, or the like is used. Heat generated in each of the LED units 16 is transmitted to the hood 7 through the mounting plate 15 to diffuse to the outside air.

[0017] FIG. 5 is a front view illustrating the LED unit 16 illustrated in FIG. 4. Each of the LED units 16 includes a substrate 18 and a plurality of LEDs 19 mounted on the substrate 18.

[0018] The substrate 18 is provided with a plurality of mount holes 20 for mounting the LED unit 16 to the mounting plate 15 with screws, and resistors 21 electrically connected to the respective LEDs 19. A plurality of connectors 22 for electrically connecting a power source and the LED unit 16 and for individually electrically connecting the LED units 16 are also provided to the substrate 18.

[0019] Each of the LEDs 19 emits a light beam by being supplied with electric power. The light beam from each of the LEDs 19 passes through the illumination cover 17 to be radiated to the interior of the car 1. The LEDs 19 are arranged at intervals along a surface of the substrate 18 (specifically, a common plane along the hood main body 14 (predetermined plane)). The LEDs 19 are arranged at even intervals.

[0020] In this example, a shape of the substrate 18 is square with a longitudinal size of 198 (mm) and a lateral size of 198 (mm). Moreover, in this example, thirty-six LEDs 19 in total are mounted on the common substrate 18 in six rows in the longitudinal direction of the substrate 18 and in six rows in the horizontal direction of the substrate 18. An interval (pitch) X (mm) between the LEDs 19 mounted on the common substrate 18 is 33.5 (mm). Among the LEDs 19 mounted on the common substrate 18, a distance A (mm) between the LED 19 mounted on the outermost side of the substrate 18 and the longitudinal or horizontal side of the substrate 18 is an approximately half distance of the pitch between the LEDs 19, that is, 15.7 (mm). As a result, the pitch between the LEDs 19 respectively arranged on the outermost sides of the neighboring substrates 18 is the same as the pitch between the LEDs 19 mounted on the common substrate 18, that is, 33.5 (mm).

[0021] The illumination cover 17 is a flat plate having translucency. The illumination cover 17 is arranged in parallel to each substrate 18, as illustrated in FIG. 2. Therefore, from each of the LEDs 19, the distance to the illumination cover 17 is set the same. Further, the illumination cover 17 scatters the light beam from each of the LEDs 19 to the interior of the car 1. In this manner, the

boundary between a bright portion and a dark portion generated on the illumination cover 17 due to the light beam from each of the LEDs 19 becomes ambiguous.

[0022] The illumination cover 17 is made of a transparent or translucent material (for example, a resin, glass or the like). Moreover, in this example, a color of the illumination cover 17 is opaque white.

[0023] FIG. 6 is an enlarged view illustrating the illumination apparatus 8 illustrated in FIG. 2. Optical axes of the LEDs 19 are parallel to each other. The optical axes of the LEDs 19 are vertical to the illumination cover 17.

[0024] The light beam from the LEDs 19 is radiated within the region of 75 degrees or smaller with respect to the optical axis. Specifically, a divergence angle of the light beam from each of the LEDs 19 is 130 degrees. A luminosity is the highest on the optical axis of each of the LEDs 19 and continuously decreases toward the periphery from the optical axis. In this example, it is supposed that the luminosity on the optical axis is 100%. Then, the luminosity becomes 80% and higher in the region in which the angle with respect to the optical axis is 20 degrees or smaller (specifically, within an angular region of 40 degrees about the optical axis as the center) . Specifically, each of the LEDs 19 has directivity characteristics which allow a rate of the luminosity (relative luminosity) to the luminosity on the optical axis to be 80% or higher in the region in which the angle with respect to the optical axis is 20 degrees or smaller.

[0025] If a distance Y (mm) between each of the LEDs 19 and the illumination cover 17 is constant, when the pitch X (mm) between the LEDs 19 is set too small, the light beams from the neighboring LEDs 19 overlap each other to increase the size of light patches (the degree of contrast between the bright portion and the dark portion) on the illumination cover 17. On the contrary, when the pitch X (mm) between the LEDs 19 is set too large, the ranges of the light beams from the neighboring LEDs 19 become independent of each other to also increase the size of light patches (the degree of contrast between the bright portion and the dark portion) on the illumination cover 17. Therefore, if the pitch X (mm) between the LEDs 19 is too small or too large, the designability is lowered.

[0026] Accordingly, the designability at the illumination cover 17 was evaluated (the degree of contrast between brightness and darkness of light was evaluated) while the pitch X (mm) between the LEDs 19 and the distance Y between each of the LEDs 19 and the illumination cover 17 were varied.

[0027] FIG. 7 is a graph showing the relation between the evaluation of the designability at the illumination cover 17 illustrated in FIG. 6, the pitch X (mm) between the LEDs 19, and the distance Y (mm) between each of the LEDs 19 and the illumination cover 17. In FIG. 7, the evaluations of the designability are shown for the case where the pitch X (mm) between the LEDs 19 is 33.5 (mm) and the case where the pitch is 60 (mm). In FIG. 7, as the evaluation of the designability, the circle indicates good designability, the triangle indicates slightly poor designability, and the cross indicates poor designability. Further, the evaluation of the designability shown in FIG. 7 was obtained when a light transmittance of the illumination cover 17 was 60%.

[0028] From the graph of FIG. 7, it is understood the designability evaluated at the illumination cover 17 is good when the relation between the pitch X (mm) between the LEDs 19 and the distance Y (mm) between each of the LEDs 19 and the illumination cover 17 satisfies the following Expression (1).

[0029]

$$Y \geq 0.9X + 9 \quad \ldots(1)$$

[0030] The designability was evaluated for each of three cases, that is, in the case where the light transmittance of the illumination cover 17 was 45%, the case where the light transmittance was 60%, and the case where the light transmittance was 80%. As a result, when the relation between the pitch X (mm) between the LEDs 19 and the distance Y (mm) between each of the LEDs 19 and the illumination cover 17 satisfied Expression (1), the designability was good in the case where the light transmittance of the illumination cover 17 was 45% and the case where the light transmittance was 60%. In the case where the light transmittance of the illumination cover 17 was 80%, however, the shape of each of the LEDs 19 was distinguished to lower the designability. Therefore, for improving the designability evaluated at the illumination cover 17, the illumination cover 17 is required to have the light transmittance at least in the range of 40% to 60%.

[0031] Further, the designability evaluated at the illumination cover 17 was maintained even when a luminous flux value for one LED 19 was varied within the range of 5 to 30 (lm (lumen)). Therefore, it is understood that the designability evaluated at the illumination cover 17 is determined regardless of the luminous flux value for one LED 19. Specifically, it is understood that, even if the luminosity of the LEDs 19 drops due to a change with time, the designability evaluated at the illumination cover 17 is maintained to suppress the degradation of the size of the light patches on the illumination cover 17. In general, the LEDs 19 are replaced before the luminous flux value for one LED becomes lower than 5 (lumen).

[0032] In this example, the pitch X (mm) between the LEDs 19 is set to 33.5 (mm), whereas the distance Y (mm) between each of the LEDs 19 and the illumination cover 17 is set to 40 (mm). Specifically, in this example, the relation between the pitch X (mm) between the LEDs 19 and the distance Y (mm) between each of the LEDs 19 and the illumination cover 17 satisfies Expression (1).

[0033] It is also conceivable to place a lens between each of the LEDs 19 and the illumination cover 17 to increase the divergence angle of the light beam from each of the LEDs so as to allow the illumination cover 17

to be placed closer to the LEDs 19. However, the light patches are generated or an illuminance is lowered by the effects of diffraction of the light beams by the lenses. Therefore, the improvement of designability is limited.

[0034] In the elevator car interior illumination apparatus as described above, each of the LEDs 19 has directivity characteristics which allow the relative luminosity to be 80% or higher in the region in which the angle with respect to the optical axis is 20 degrees or smaller. In addition, the relation between the pitch X (mm) between the LEDs 19 and the distance Y (mm) between each of the LEDs 19 and the illumination cover 17 satisfies: $Y \geq 0.9X+9$. Therefore, the ranges where the luminosity is high can be prevented from overlapping for the neighboring LEDs 19. Therefore, the luminosity at the position of the illumination cover 17 can be made close to be uniform. Therefore, the generation of the bright portion and the dark portion on the illumination cover 17 can be suppressed. Accordingly, the design can be made closer to the one which gives the impression of soft light as if the entire illumination cover 17 uniformly shined. As a result, the designability of the illumination apparatus 8 can be improved. Further, the directivity characteristics of each of the LEDs 19 are set within the range of the directivity characteristics of a common LED. Therefore, the cost of each of the LEDs 19 can be reduced.

[0035] Further, the LED units 16 are mounted to the hood 7 through an intermediation of the mounting plate 15 for heat radiation. Therefore, the mounting plate 15 have both the function of mounting the LED units 16 to the hood 7 and the function of diffusing heat from the LED units 16. In this manner, the number of components can be reduced. Moreover, the common mounting plate 15, on which the plurality of LED units 16 are previously mounted, is mounted to the hood 7. As a result, an operation of mounting the LED units 16 to the hood 7 can be facilitated.

[0036] Although the illumination apparatus 8 is provided only to the car ceiling 4 in the example described above, the illumination apparatus 8 may be provided at least any one of the car walls 3 and the car floor 2.

Reference Signs List

[0037] 1 car, 4 car ceiling, 8 illumination apparatus, 15 mounting plate, 16 LED unit (light-source device), 17 illumination cover, 19 LED

Claims

1. An elevator car interior illumination apparatus, comprising:

   a light-source device including a plurality of LEDs provided at intervals, for radiating a light beam from each of the plurality of LEDs to interior of a car; and

   an illumination cover provided on an inner side of the car as compared with the each of the plurality of LEDs, for scattering the light beam from the each of the plurality of LEDs to the interior of the car, wherein:

   the each of the plurality of LEDs has directivity characteristics allowing a relative luminosity to a luminosity on an optical axis to be 80% or higher in a region in which an angle with respect to the optical axis is 20 degrees or smaller, and
   a relation between a pitch X (mm) between the plurality of LEDs and a distance Y (mm) between the each of the plurality of LEDs and the illumination cover satisfies: $Y \geq 0.9X+9$.

2. An elevator car interior illumination apparatus according to claim 1, wherein the light-source device is mounted onto a car ceiling through an intermediation of a mounting plate for heat radiation.

FIG. 1

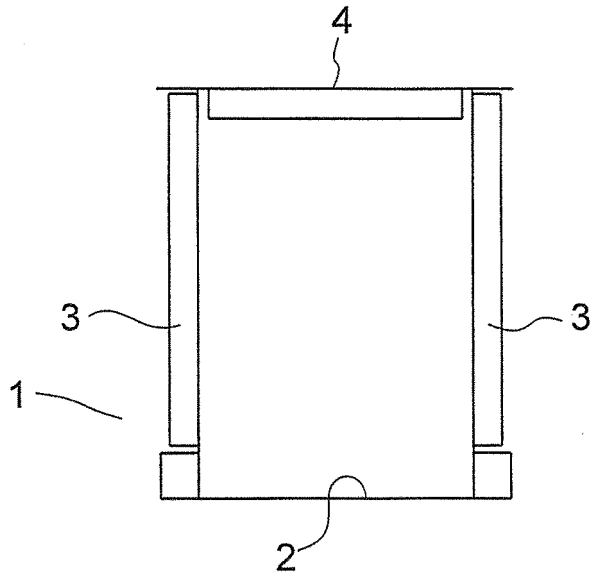


FIG. 2

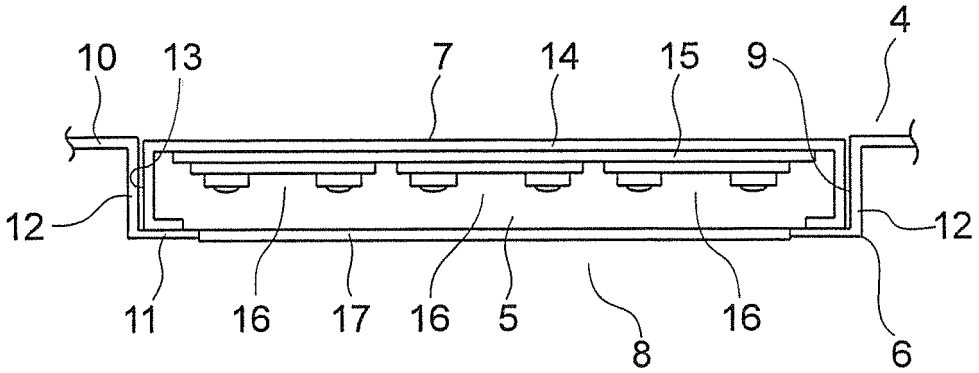


FIG. 3

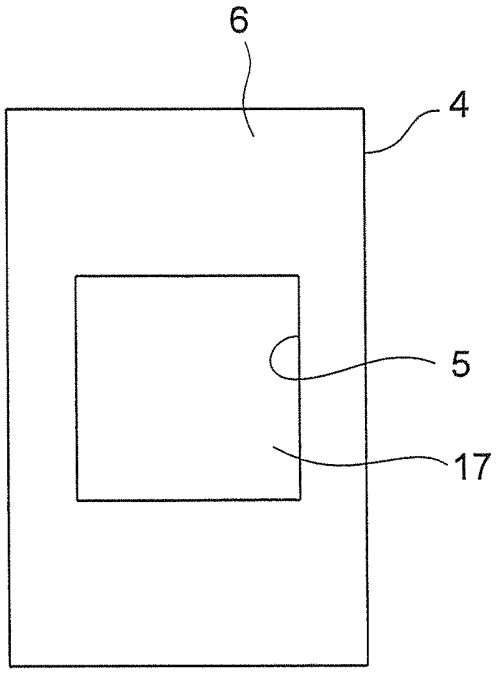


FIG. 4

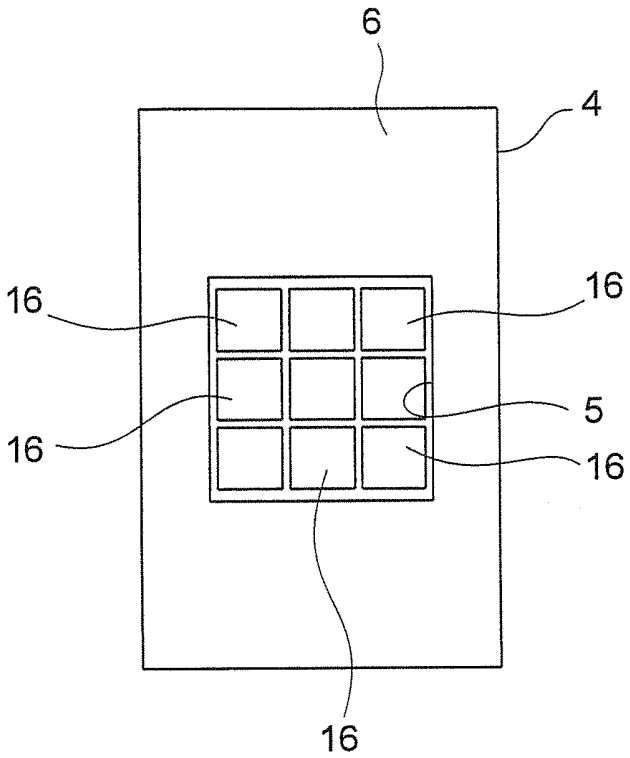


FIG. 5

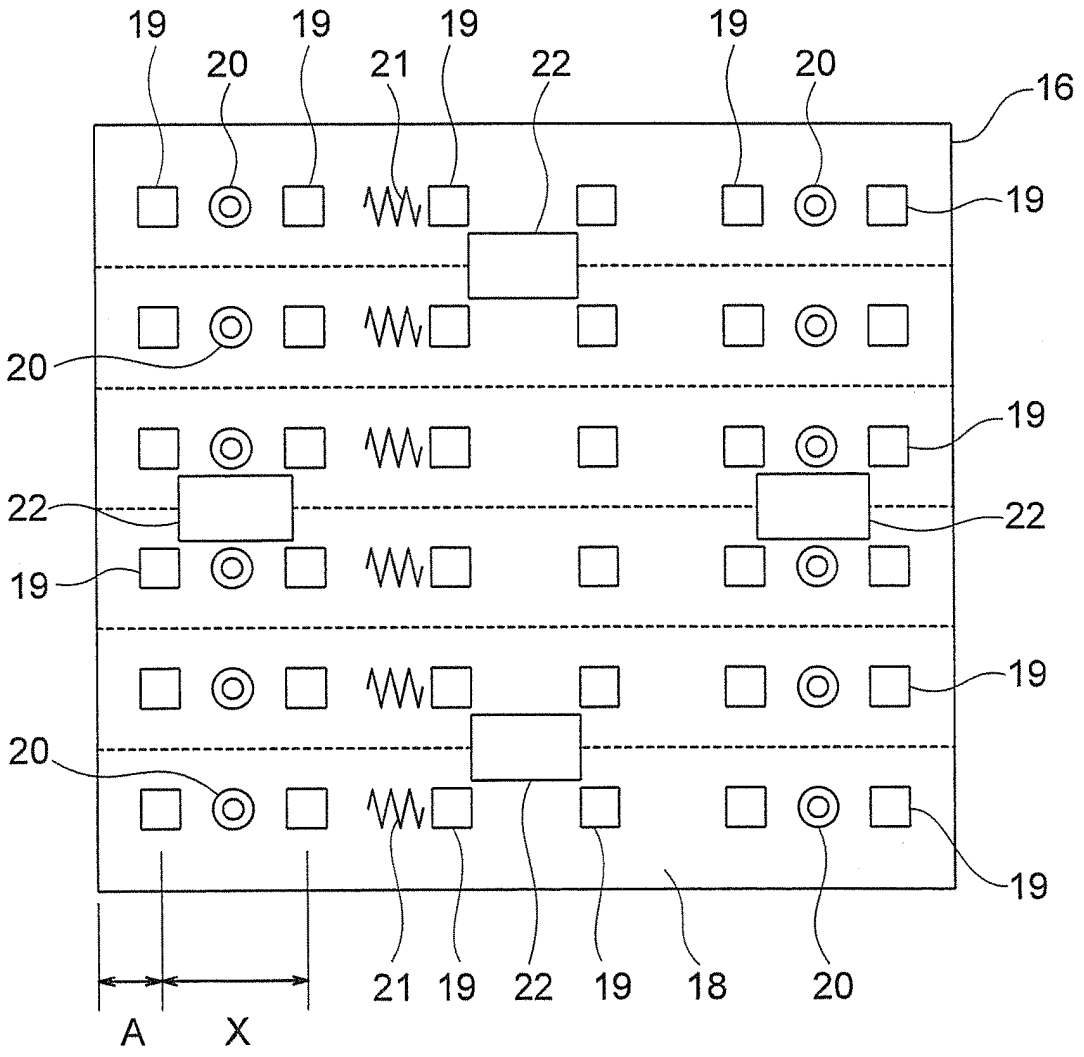

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FIG. 6

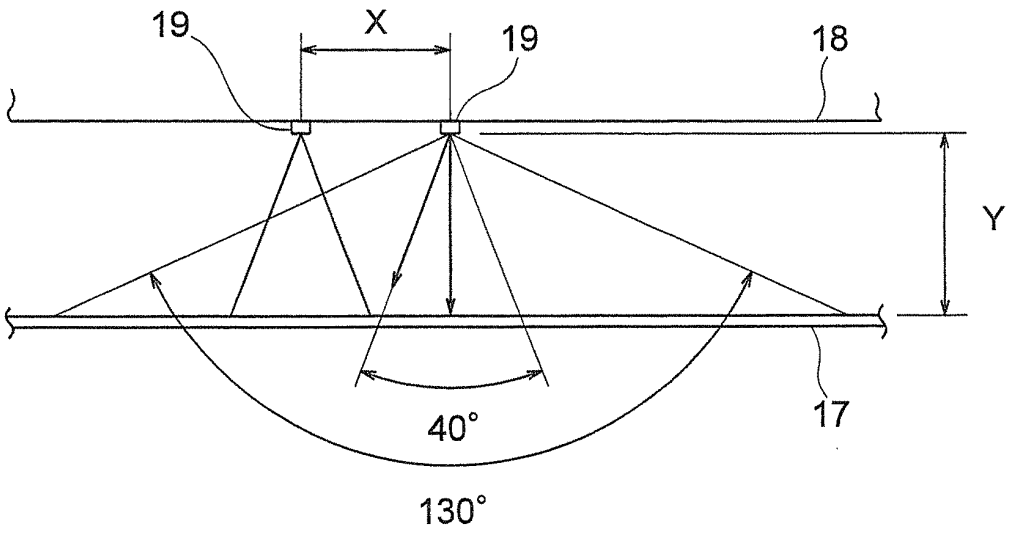
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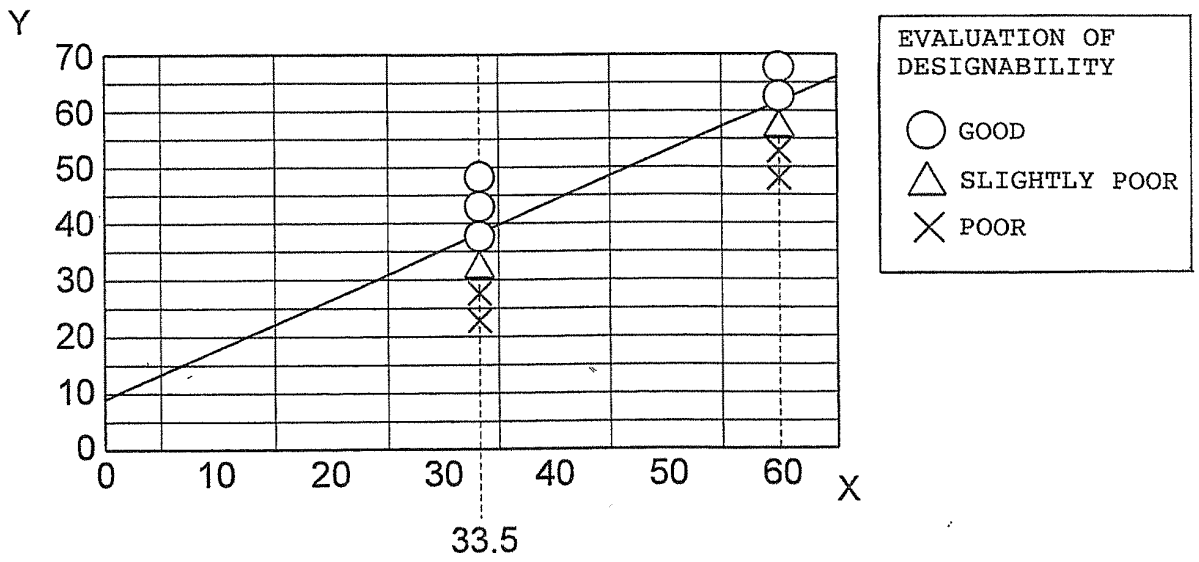
FIG. 7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EVALUATION OF DESIGNABILITY
GOOD
SLIGHTLY POOR
POOR

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/055217

A. CLASSIFICATION OF SUBJECT MATTER
B66B11/02(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)
B66B11/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2010
Kokai Jitsuyo Shinan Koho 1971-2010 Toroku Jitsuyo Shinan Koho 1994-2010

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2010-058941 A (Toshiba Elevator and Building Systems Corp.), 18 March 2010 (18.03.2010), paragraphs [0016] to [0017] (Family: none)	1-2
Y	JP 2004-115209 A (Toshiba Elevator and Building Systems Corp.), 15 April 2004 (15.04.2004), paragraphs [0006] to [0007] (Family: none)	1-2
Y	JP 06-314516 A (Tokyo Electric Co., Ltd.), 08 November 1994 (08.11.1994), paragraph [0016] (Family: none)	2

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

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
31 May, 2010 (31.05.10)	08 June, 2010 (08.06.10)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/055217

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2004-149303 A (Toshiba Elevator and Building Systems Corp.), 27 May 2004 (27.05.2004), paragraphs [0025] to [0026] (Family: none)	1
A	JP 2006-106075 A (Seiko Epson Corp.), 20 April 2006 (20.04.2006), paragraphs [0029] to [0032] (Family: none)	1

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2004338825 A **[0003]**