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

(11) EP 2 219 418 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
18.08.2010 Bulletin 2010/33

(51) Int Cl.:
H05B 33/08 *(2006.01)*

(21) Application number: **10000707.9**

(22) Date of filing: **25.01.2010**

(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
Designated Extension States:
AL BA RS

(30) Priority: **28.01.2009 JP 2009017108**

(71) Applicant: **Panasonic Electric Works Co., Ltd.**
Kadoma-shi
Osaka 571-8686 (JP)

(72) Inventors:
- **Maehara, Minoru**
  Osaka (JP)
- **Kadotani, Kazuyoshi**
  Osaka (JP)
- **Tanaka, Kenichiro**
  Osaka (JP)
- **Tanimura, Itirou**
  Osaka (JP)
- **Takuya, Nobuta**
  Nara (JP)

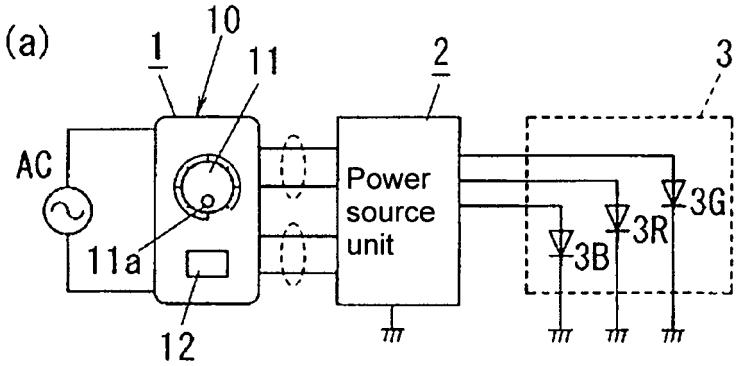
(74) Representative: **Rüger, Barthelt & Abel**
Patentanwälte
Postfach 10 04 61
73704 Esslingen a.N. (DE)

(54) LED illumination device

(57) [Object] To enable an adjustment of a light color and an illumination intensity of illumination light with a characteristic proximate to an incandescent lamp even in the case of using a light emitting diode as a light source.

[Means for Settlement] Determination means (a control signal generating part of a controller 1, and a control signal input part 20 and a drive signal converting part 23 of a power source unit 2) determines light amounts of the light emitting diodes 3R, 3G and 3B of the illumination light source 3, corresponding to an operation input received at operation input receiving means (an operating part 11 of the controller 1, a variable resistor, and a A/C converter), so that a color temperature and a light amount of the illumination light increases and decreases in conjunction with each other within a range lower than a color temperature at the time of rated lighting of the illumination light source 3 (about 2,800K), and chromaticity of illumination light varies approximately along a blackbody locus, as well as a change in a color temperature when the light amount is relatively small is larger than a change in a color temperature when the light amount is relatively large. Therefore, the light color and the illumination intensity of the illumination light can be adjusted with the characteristic proximate to the incandescent lamp.

Figure 1



EP 2 219 418 A2

Description

[Field of the Invention]

[0001] The present invention relates to an illumination device in which a light color of illumination light is made variable.

[Background Art]

[0002] As a conventional illumination device, the patent document 1 disclose, for example, the illumination device provided with an illumination unit having a red light emitting diode, a green light emitting diode, and a blue light emitting diode, and a control unit for driving each color light emitting diode of the illumination unit and adjusting a light amount (illumination intensity) thereof, wherein an operation part provided in the control unit for each color is operated individually to adjust the light amount of each color (red, green and blue) to make the light color (color temperature) of the illumination light (mixed color light) variable.

[Conventional Technique Document]

[Patent Document]

[0003] [Patent document 1] Japanese Unexamined Patent Publication No. 2008-293946

[Disclosure of the Invention]

[Problems to be solved by the Invention]

[0004] Then, the illumination device (illumination fixture) using the light emitting diode as a light source is often utilized as an alternative to an illumination device (illumination fixture) using an incandescent lamp as a light source. Here, the incandescent lamp has a characteristic, as shown in Figs. 2(a) and 2(b), in which the color temperature decreases in the same way as chromaticity of illumination light changing along a blackbody locus together with decrease in the light amount when a dimming ratio (light amount) is decreased with the time of rated lighting being set as 100%. In contrast, when the light emitting diode is dimmed, a characteristic is found in which only light amount is varied without varying a light wavelength.

[0005] In a conventional example described in the patent document 1, however, a user has to operate the three control parts of the control unit by himself/herself to adjust the light amounts of the red, green and blue light emitting diodes separately, thereby setting the color temperature of the mixed color light. It is thus significantly difficult to change the light amount and the color temperature of the illumination light with the characteristics proximate to the light amount/color temperature characteristics of the incandescent lamp.

[0006] In view of the foregoing, an object of the present invention is to provide an illumination device capable of adjusting a light color and an illumination intensity of the illumination light with the characteristic proximate to the incandescent lamp even in the case where the light emitting diode is used as the light source.

[Means adapted to solve the Problems]

[0007] In order to achieve the object described above, the present invention includes an illumination light source having a plurality of light emitting diodes with different light colors; driving means adapted to make a plurality of light emitting diodes emit light individually and with an arbitrary light amount; operation input receiving means adapted to receive an operation input by a human; and determination means adapted to determine the light amount of each light emitting diode of the illumination light source so that a color temperature and a light amount of illumination light irradiated from the illumination light source are a color temperature and a light amount corresponding to an operation input received at the operation input receiving means, wherein the driving means makes each light emitting diode emit light with the light amount determined by the determination means; and the determination means determines a light amount of each light emitting diode of the illumination light source so that the color temperature and the light amount of the illumination light increases and decreases in conjunction with each other corresponding to a change in the operation input within a range lower than a color temperature at the time of rated lighting of the illumination light source, and chromaticity of the illumination light varies approximately along a blackbody locus, as well as a change in a color temperature when the light amount is relatively small is larger than a change in a color temperature when the light amount is relatively large.

[0008] According to the present invention, the color temperature of the illumination light source at the time of rated lighting is set almost equal to a color temperature of an incandescent lamp at the time of rated lighting, so that the light color and the illumination intensity of the illumination light can be adjusted with a characteristic proximate to the incandescent lamp even in the case where the light emitting diode is used as a light source.

[Effect of the Invention]

[0009] According to the present invention, the light color and the illumination intensity of the illumination light can be adjusted with the characteristics proximate to the incandescent lamp even in the case where the light emitting diode is used as the light source.

[Brief Description of the Drawings]

[0010]

[Fig. 1(a)] Fig. 1(a) is an overall structural view of a first embodiment of the present invention.
[Fig. 1(b)] Fig. 1(b) is a block diagram of a power source unit of the first embodiment of the present invention.
[Fig. 1(c)] Fig. 1(c) is a circuit configuration diagram of an LED driving part of the first embodiment of the present invention.
[Fig. 2(a)] Fig. 2(a) is an explanatory view explaining the color temperature/light amount characteristics of an illumination light source in the same described above.
[Fig. 2(b)] Fig. 2(b) is an explanatory view explaining the color temperature/light amount characteristics of the illumination light source in the same described above.
[Fig. 3] Fig. 3 is a block diagram showing the other structure of the power source unit same described above.
[Fig. 4(a)] Fig. 4(a) is an overall structural view of the second embodiment of the present invention.
[Fig. 4(b)] Fig. 4(b) is a block diagram of a power source unit of the second embodiment of the present invention.
[Fig. 5] Fig. 5 is a block diagram showing the other structure of the power source unit same described above.

[Best Mode for Carrying Out the Invention]

(First Embodiment)

[0011] An illumination device according to the present embodiment is composed of an illumination light source 3, a controller 1, and a power source unit 2, as shown in Fig. 1(a). The illumination light source 3 has three-color light emitting diodes 3R, 3G, and 3B, i.e., red (R), green (G) and blue (B). Here, chromaticity coordinates of the light colors of the light emitting diodes 3R, 3G and 3B having their own colors are (x_R, y_R), (x_G, y_G) and (x_B, y_B), respectively. If the light amounts of the light emitting diodes 3R, 3G and 3B are respectively Y_R, Y_G and Y_B, chromaticity coordinates (xo, y_0) of the light color and the light amount Yo of illumination light as being mixed color light are expressed in a following formula 1.

[0012]

[Formula 1]

$$x_0 = \frac{x_R\frac{Y_R}{y_R} + x_G\frac{Y_G}{y_G} + x_B\frac{Y_B}{y_B}}{\frac{Y_R}{y_R} + \frac{Y_G}{y_G} + \frac{Y_B}{y_B}}$$

$$y_0 = \frac{Y_R + Y_G + Y_B}{\frac{Y_R}{y_R} + \frac{Y_G}{y_G} + \frac{Y_B}{y_B}}$$

$$Y_0 = Y_R + Y_G + Y_B$$

[0013] Here, since a changes in the light amounts Y_R, Y_G and Y_B with regard to the light emitting diodes 3R, 3G and 3B do not change the light color (light wavelength), the variation in a ratio among the light amounts Y_R, Y_G and Y_B of the light emitting diodes 3R, 3G and 3B can change the light color of the illumination light obtained as a mixed color. Furthermore, a change in the light amounts Y_R, Y_G and Y_B while keeping the ratio among the light amounts Y_R, Y_G and Y_B of the light emitting diodes 3R, 3G and 3B can change a light amount of the illumination light in one same light color. Since the light amounts Y_R, Y_G and Y_B of the light emitting diodes 3R, 3G and 3B are determined depending on an amount of supplied power, an increase and a decrease in the amount of power supplied from the power source unit 2 to the light emitting diodes 3R, 3G and 3B enables the light color and light amount of the illumination light to be adjusted, as discussed later.

[0014] As shown in Fig. 1(b), the power supply unit 2 is provided with a control signal input part 20 to which a control signal is inputted from the controller 1, an AC/DC converting part 21 for converting an AC voltage supplied through the controller 1 into a desired DC voltage, a green LED driving part 22G for driving a green light emitting diode 3G, a red LED driving part 22R for driving a red light emitting diode 3R, a blue LED driving part 22B for driving a blue light emitting diode 3B, and a drive signal converting part 23 for converting a control signal inputted to the control signal input part 20 into a drive signal to be fed to the green LED driving part 22G, the red LED driving part 22R, and the blue LED driving part 22B.

[0015] Each of three driving parts 22G, 22R and 22B have a same configuration in common which is structured by a current-limiting resistor R that is inserted between an output terminal at a higher potential side of the AC/DC converting part 21 and an anode of the light emitting diode 3, a switching element Q1 including a field-effect transistor having a source connected to a cathode of the light emitting diode 3 and a drain connected to an output terminal at a lower potential side (a ground) of the AC/DC

converting part 21, and a waveform shaping circuit for shaping a waveform of the drive signal outputted from the drive signal converting part 23, as shown in Fig. 1(c). The waveform shaping circuit, which is conventionally known, includes a PNP-type bipolar transistor Tr1 in which a collector is connected to the output terminal at the higher potential side of the AC/DC converting part 21 and an emitter is connected to a gate of the switching element Q1, and an NPN-type bipolar transistor Tr2 in which a collector is connected to the gate of the switching element Q1 and an emitter is connected to the ground. The waveform shaping circuit shapes the waveform of the drive signal to be inputted to two transistors Tr1 and Tr2 connected in parallel with each other to output it to a gate of the switching element Q1. Here, the drive signal converting part 23 outputs a drive signal including a rectangular wave signal with a constant period whose on-duty ratio is variable to PWM control the switching element Q1 of the driving parts 22G, 22R and 22B, thereby adjusting the amount of the power supplied to the light emitting diodes 3G, 3R and 3B.

[0016] The controller 1 has a housing 10 including a box-shaped molded synthetic resin, and a cylindrical-shaped operating part 11 and an operation button 12 of a power source switch are arranged on a front surface of the housing 10 (refer to Fig. 1(a)). A power source switch (not shown), which includes a tumbler switch or a push button switch, is for opening and closing a power supply path from the AC power source AC to the power source unit 2. The housing 10 accommodates therein a variable resistor (not shown) whose resistance value changes through an operation of the operating part 11, an A/D converting part (not shown) for A/D converting the resistance value of the variable resistor, and a control signal generating part (not shown) for generating a control signal based on the resistance value converted into a digital value by the A/D converting part.

[0017] The operation part 11 is provided rotatably to the housing 10 in a range of about 315° (7/4Π). The resistance value of the variable resistor becomes minimum when a mark 11a formed on the front surface is positioned at six o'clock, and the resistance value of the variable resistor becomes maximum when the mark 11a is positioned at a midpoint between a position of four o'clock and a position of five o'clock (the position of four thirty). Then, the resistance value of the variable resistor varies linearly when the operating part 11 rotates clockwise or counterclockwise between the position of six o'clock and a position of four thirty, so that an operation amount of the operating part 11 (the position of the mark 11a) can be notified based on the resistance value. The control signal generating part generates a control signal (a PWM signal) having an on-duty ratio corresponding one-to-one to the values from the minimum to the maximum of the resistance value of the variable resistor, and then outputs it to the power source unit 2. Here, the operation amount of the operating part 11, i.e., the on-duty ratio of the control signal corresponds to the light color of the illumination light (the color temperature) of the illumination light source 3.

[0018] In the power source unit 2, the control signal outputted from the control signal generating part of the controller 1 is converted into a DC voltage signal with a voltage level corresponding to the on-duty ratio (the color temperature) by the control signal input part 20, and also the DC voltage signal is converted into a drive signal to the each color LED driving parts 22G, 22R and 22B at the drive signal converting part 23. The drive signal converting part 23 has a microcomputer and a memory. The memory stores the conversion table representing a signal level of the DC voltage signal (the color temperature), chromaticity coordinates (xo, yo) of the light color of the illumination light corresponding to the color temperature, a ratio among the light amounts Y_R, Y_G and Y_B of the light emitting diodes 3R, 3G and 3B corresponding to the chromaticity coordinates, and a correspondence relation among the light amounts Y_R, Y_G and Y_B of the light emitting diodes 3R, 3G and 3B. The microcomputer converts the DC voltage signal into the drive signal based on the conversion table.

[0019] Then, although it is possible to adjust the light color and the light amount of the illumination light independent with respect to each other, it is preferable to simulate the characteristics of the illumination intensity (the light mount) and the light color (the color temperature) obtained at the time of dimming the incandescent lamp, considering replacement of the existing illumination device using the incandescent lamp as the light source, as described in the conventional technique.

[0020] Therefore, in the present embodiment, the light amounts Y_R, Y_G and Y_B of the light emitting diodes 3R, 3G and 3B are determined so that the color temperature and the light amount of the illumination light increases and decreases in conjunction with each other corresponding to the operation amount of the operating part 11 within a range lower than the color temperature of the incandescent lamp at the time of rated lighting (for example, about 2,800K in the case of a typical mini halogen bulb), and the chromaticity of the illumination light varies approximately along a blackbody locus (refer to a curve line B in Fig. 2(b)), as well as the change in the color temperature when the light amount is relatively small is larger than the change in the color temperature when the light amount is relatively large, similar to the light amount/color temperature characteristics shown by a curve line A in Fig. 2(a)

[0021] In this manner, the control signal is converted into the drive signal at the drive signal converting part 23 so that the color temperature of the illumination light increases and decreases within the range lower than the color temperature at the time of rated lighting (about 2,800K) corresponding to the operation amount of the operating part 11 of the controller 1 (the position of the mark 11a), and the chromaticity of the illumination light varies approximately along a blackbody locus, as well as the change in a color temperature when the light amount

Yo is relatively small is larger than a change in a color temperature when the light amount Yo is relatively large.

[0022] As described above, according to the present embodiment, the determination means (the control signal generating part of the controller 1, and the control signal input part 20 and the drive signal converting part 23 of the power source unit 2) determines the light amounts of the light emitting diodes 3R, 3G and 3B of the illumination light source 3, corresponding to the operation input received at the operation input receiving means (the operating part 11 of the controller 1, the variable resistor, and the A/C converting part), so that the color temperature and the light amount of the illumination light increases and decreases in conjunction with each other corresponding to a change in the operation input within a range lower than the color temperature at the time of rated lighting of the illumination light source 3 (about 2,800K in the present embodiment), and the chromaticity of the illumination light varies approximately along a blackbody locus, as well as the change in the color temperature when the light amount is relatively small is larger than the change in color temperature when the light amount is relatively large. Therefore, the light color and the illumination intensity of the illumination light can be adjusted with the characteristics proximate to the incandescent lamp even in the case where the illumination light source 3 is structured by the light emitting diode.

[0023] In addition, Fig. 3 is a block diagram showing other structure of the power source unit 2. In this structure, a function of the drive signal converting part 23, which converts the DC voltage signal outputted from the control signal input part 20 into a drive signal to each color of the LED driving part 22G, 22R and 22B, is included in the each LED driving part 22G, 22R and 22B, and the drive signal converting part 23 is omitted.

(Second Embodiment)

[0024] The feature of the illumination device of the present embodiment is that the power source unit 2 is integrated into the housing 10 of the controller 1 in the first embodiment, as shown in Fig. 4, and a basic structure is same as that in the first embodiment. Therefore, a like component is denoted by a like reference numeral and the description thereof will be omitted.

[0025] In the present embodiment, the housing 10 accommodates therein a variable resistor (not shown) whose resistance value varies through an operation of the operation part 11, an A/D converting part (not shown) for A/D converting a resistance value of the variable resistor, and, instead of the control signal input part 20, a controller input part 24 for generating a DC voltage signal corresponding to a color temperature based on the resistance value converted into a digital value at the A/D converter. The DC voltage signal outputted from the controller input part 24, however, is identical to the DC voltage signal outputted from the control signal input part 20 in the first embodiment. Moreover, Fig. 4(b) illustrates a power source switch SW that does not illustrated in the first embodiment.

[0026] In this manner, although the first embodiment requires arranging the controller 1 and the power source unit 2 separately to connect them by wires, one for supplying the power and the other for transmitting the control signal, the present embodiment advantageously requires only the arrangement of the controller 1 and can omit the wiring of the wires.

[0027] Further, Fig. 5 shows a block diagram showing the other structure of the controller 1. In this structure, a function of the drive signal converting part 23, which converts the DC voltage signal outputted from the controller input part 24 into a drive signal to each color LED driving part 22G, 22R and 22B, is included in each LED driving part 22G, 22R and 22B, and the drive signal converting part 23 is omitted.

[0028] In addition, although the first and second embodiments use three light emitting diodes 3R, 3G and 3B having respective colors (three types), i.e., red, green and blue, it is possible to use the light emitting diodes with, for example, two colors (two types) such as white and red to constitute the illumination light source 3 so that an adjustment of a ratio and absolute values of a light amount of the white light emitting diode and a light amount of the red light emitting diode varies the light amount and the color temperature with the characteristics proximate to the light amount/color temperature characteristics of the incandescent lamp. In this case, there is a benefit that decrease in the number of the light emitting diodes to be controlled can simplify signal processing at the drive signal converting part 23.

[Description of Reference Numerals]

[0029]

1 Controller
2 Power source unit
3 Illumination light source
3R Red light emitting diode
3G Green light emitting diode
3B Blue light emitting diode
11 Operation part (Operation input receiving means)
20 Control signal input part (Determination means)
22G Green LED driving part (Driving means)
22R Red LED driving part (Driving means)
22B Blue LED driving part (Driving means)
23 Drive signal converting part (Determination means)

Claims

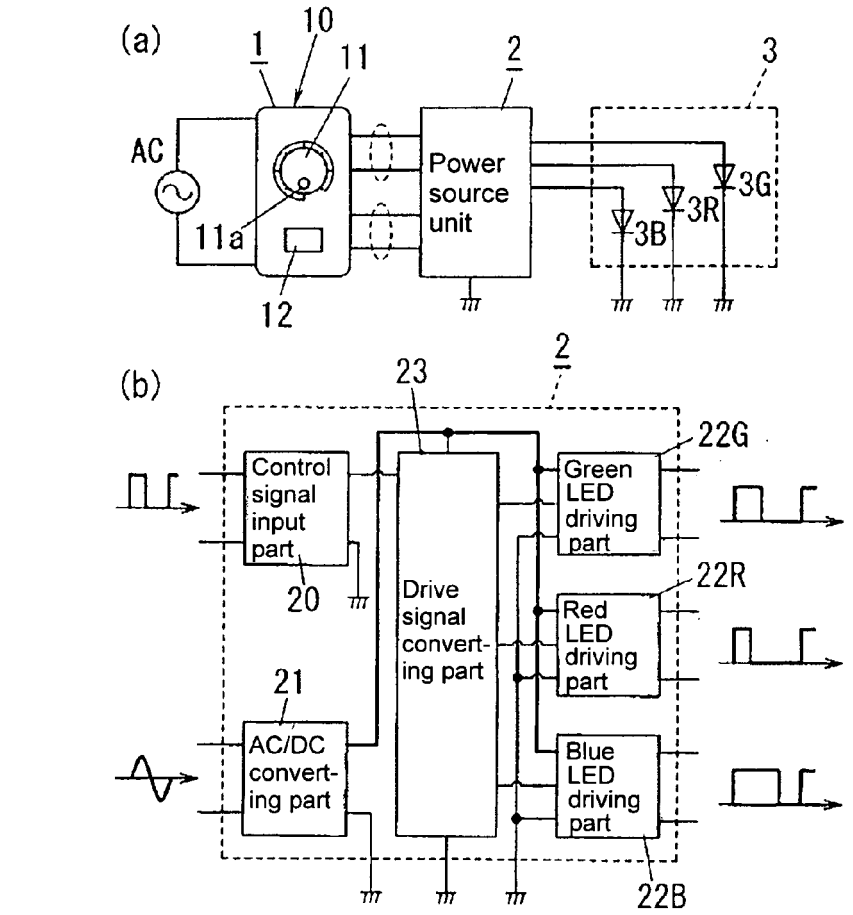
1. An illumination device, comprising:

an illumination light source having a plurality of light emitting diodes with different light colors;

driving means adapted to make a plurality of light emitting diodes emit light individually and with an arbitrary light amount;
operation input receiving means adapted to receive an operation input by a human; and
determination means adapted to determine the light amount of each light emitting diode of the illumination light source so that a color temperature and a light amount of illumination light irradiated from the illumination light source are a color temperature and a light amount corresponding to an operation input received at the operation input receiving means, wherein:

the driving means makes each light emitting diode emit light with the light amount determined by the determination means; and
the determination means determines a light amount of each light emitting diode of the illumination light source so that the color temperature and the light amount of the illumination light increases and decreases in conjunction with each other corresponding to a change in the operation input within a range lower than a color temperature at the time of rated lighting of the illumination light source, and chromaticity of the illumination light varies approximately along a blackbody locus, as well as a change in a color temperature at the time of the light amount being relatively small is larger than a change in a color temperature at the time of the light amount being relatively large.

Figure 1



1 Controller
2 Power source unit
3 Illumination light source
3R Red light emitting diode
3G Green light emitting diode
3B Blue light emitting diode
11 Operation part (Operation input receiving means)
20 Control signal input part (Determination means)
22G Green LED driving part (Driving means)
22R Red LED driving part (Driving means)
22B Blue LED driving part (Driving means)
23 Drive signal converting part (Determination means)

Figure 2

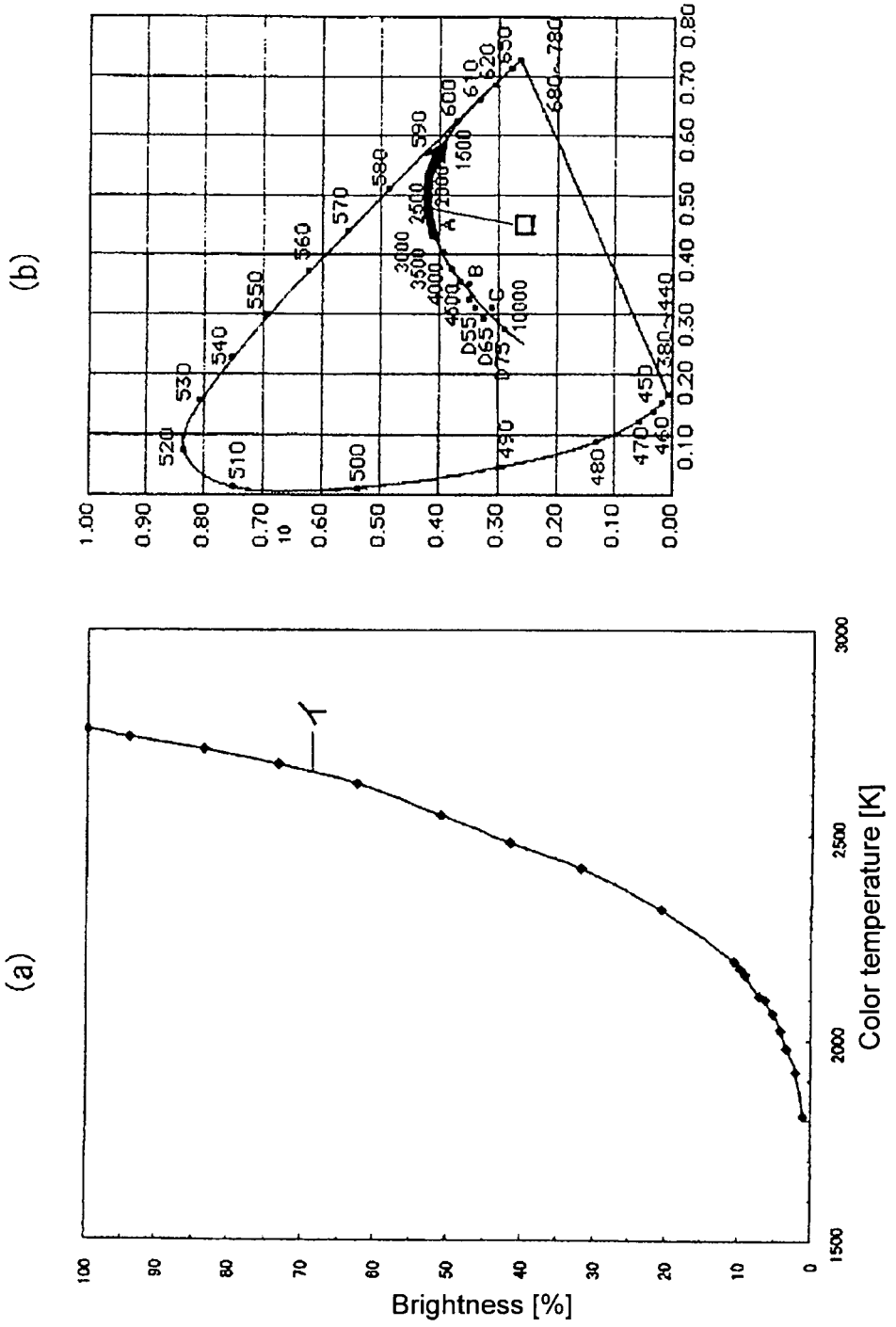


Figure 3

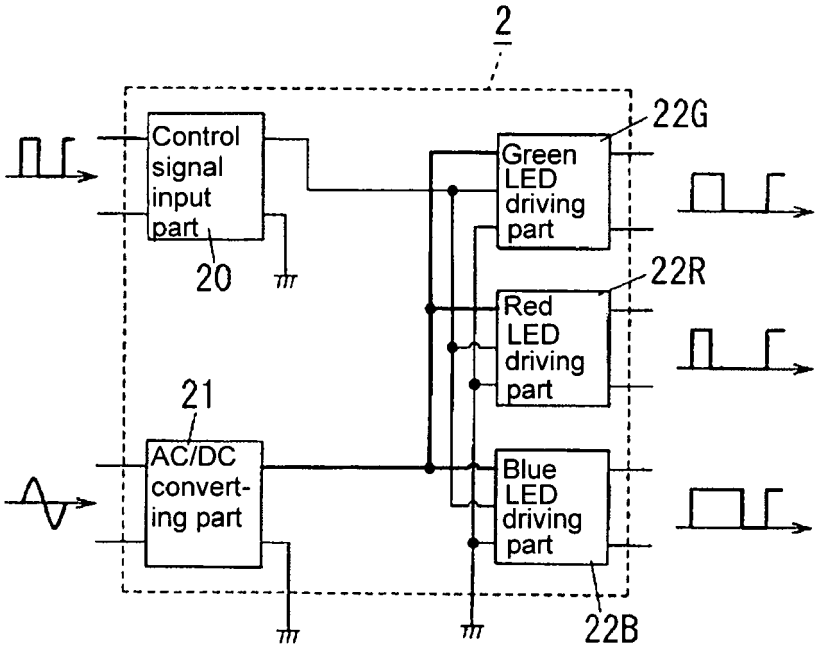

2
Control signal input part
20
21
AC/DC convert-ing part
Green LED driving part
22G
Red LED driving part
22R
Blue LED driving part
22B

Figure 4

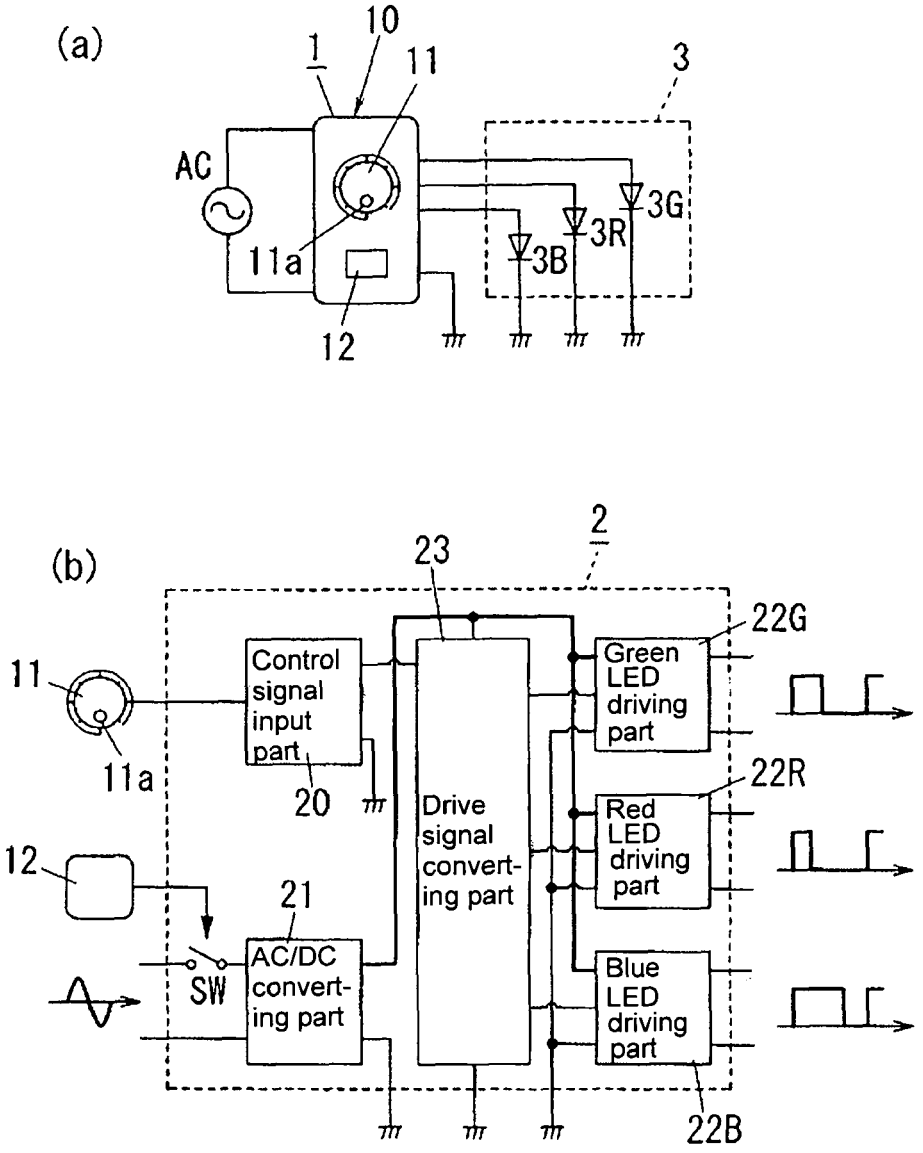
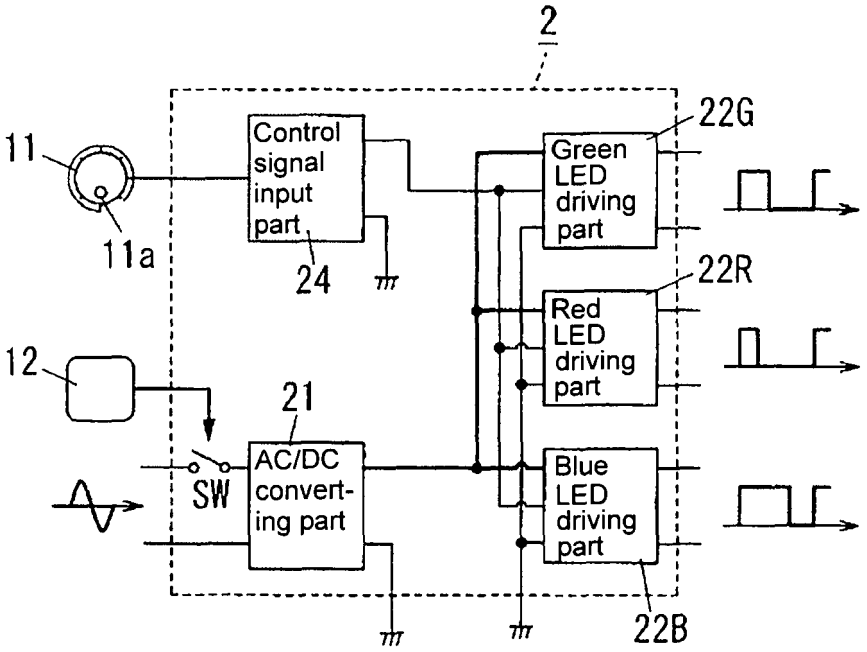

(a)
1
10
11
3
AC
11a
12
3B
3R
3G
(b)
2
23
22G
11
Control signal input part
Green LED driving part
11a
20
22R
Drive signal convert-ing part
Red LED driving part
12
21
SW
AC/DC convert-ing part
Blue LED driving part
22B

Figure 5


2
11
11a
Control signal input part
24
22G
Green LED driving part
22R
Red LED driving part
12
21
SW
AC/DC convert-ing part
Blue LED driving part
22B

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2008293946 A **[0003]**