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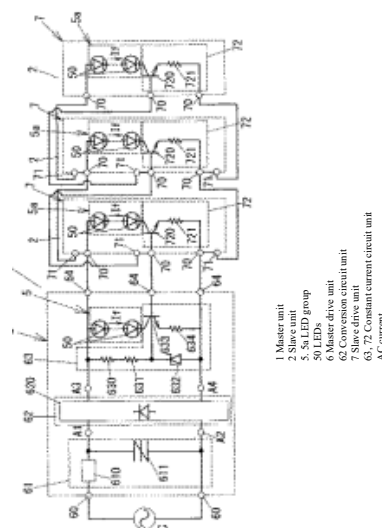
(54) [Title of the Invention] Illumination Apparatus

(57) [Abstract]

[Problem] To achieve smaller size, thinner and lower cost.

[Means for Solving] In the master driving unit 6 of the master unit 1, the pulsating DC power converted from the AC power of the power supply AC by the conversion circuit unit 62 and the constant current signal generated by the constant current circuit unit 63 are used to output the pulsating DC power in which the current is maintained at a constant level to the LED group 5, and in which a plurality of LEDs 50 are connected in series, to light the LED group 5. The DC power from the conversion circuit unit 62 and the constant current signal from the constant current circuit unit 63 are output to a slave drive unit 7 of the slave unit 2. In the slave drive unit 7 of the slave unit 2, the constant current circuit unit 72 maintains the current at a constant level and outputs a pulsating DC power to the LED group 5a, in which the plurality of LEDs 50 are connected in series, to light the LED group 5a.

[Representative Drawing] FIG. 1



[Scope of Patent Claims]

[Claim 1]

An illumination apparatus comprising of a first LED group in which the plurality of LEDs are connected in series;

a first housing unit that houses the first LED group;

a conversion circuit unit that is housed in the first housing unit and converts the AC power supplied from an AC power supply into DC power;

a first lighting circuit unit housed in the first housing unit that generates a constant current signal that maintains the current of the DC power at a constant magnitude, and that lights the first LED group based on the DC power that maintains the current at a constant magnitude by the constant current signal;

a first lighting unit provided with

and electrically connected to the first lighting unit;

a second LED group in which the plurality of LEDs are connected in series;

a second housing unit that houses the second LED group;

and a second lighting circuit unit housed in the second housing unit that receives the DC power and the constant current signal from the first lighting unit, and lights the second LED group based on the DC power in which the current is maintained at a constant level by the constant current signal,

and in which one or more second lighting units may be provided.

[Claim 2]

An illumination apparatus according to Claim 1, wherein the first lighting unit comprises a step-down circuit unit that steps down the DC power output from the conversion circuit unit and outputs the step-down power as new DC power to the first lighting circuit unit and the second lighting circuit unit.

[Claim 3]

An illumination apparatus according to Claim 1 or 2, wherein at least one of the first LED group and the second LED group is provided in multiple parallel connections.

[Detailed Description of the Invention]

[Technical field]

[0001]

The present invention relates to an illumination apparatus comprising a plurality of lighting units connecting a plurality of LEDs in series.

[Background Art]

[0002]

In recent years, the commercialization of blue LEDs (Light Emitting Diodes) has resulted in the development of high brightness LEDs that emit white light. As a result, the development and commercialization of illumination apparatus using LEDs, which have been mainly used for display and the like, as a lighting load have become active.

[0003]

LEDs basically do not turn off, and luminous flux attenuation can be suppressed by paying attention to temperature design, so the above illumination apparatus has the characteristic of being able to extend the life (time until the lighting load turns off) to tens of thousands of hours or more. For example, an illumination apparatus that can be lit for about 100,000 hours has been developed. It should be noted that the life of an illumination apparatus that uses a lamp as a lighting load is short, for example, several thousand hours for an incandescent lamp and about 10,000 hours for a fluorescent lamp.

[0004]

On the other hand, the aforementioned illumination apparatus has a small shape per LED, so it can be made smaller than when the lamp is used as a lighting load. It is also possible to freely propose the shape of the illumination apparatus by combining lighting units (modules) with multiple LEDs (for example, 10 or more).

[0005]

As a lighting unit provided in the aforementioned illumination apparatus, for example, the Patent Literature 1 discloses a lighting unit (LED assembly module) in which a plurality of LEDs are connected in series and the ratio of the relative positions where the emitted light from each LED is affected by the bonding wire is substantially equal. Based on the above, the lighting unit of Patent Literature 1 significantly reduces the local emphasis of the influence of the bonding wires on the illumination surface, which is substantially evenly affected by the light emitted from all the sections

and functions as a sufficiently homogeneous planar light emitter. Further, Patent Literature 2 discloses a lighting unit (light source device) in which a plurality of LEDs are connected in series in a line, and is provided with a semicylindrical transparent resin, and has excellent heat dissipation.

[0006]

Among the aforementioned illumination apparatus, commercialized ones include, for example, a lighting unit such as an LED line module that emits light by mounting a plurality of LEDs connected in series on a rectangular LED board (for example, on a printed circuit board). Further, as another example, an illumination apparatus having a lighting unit such as a flat light source in which a plurality of LEDs are arranged has been provided, and is used for road signal lights, warning signal lights for barriers, and the like. In addition, there are some illumination apparatuses that are used to illuminate, for example, showcases, display shelves, and the like. There are standards for the shapes of showcases, display shelves, and the like, so that the illumination apparatuses are also standardized to predetermined standards. Specifically, the length of a single illumination apparatus is typically of 3 types: 30 cm, 60 cm and 90 cm. In the above case, a lighting unit with a length of 30 cm is manufactured, and a plurality of lighting units are connected to obtain a length of 60 cm or 90 cm. When a straight tube type discharge lamp is used as the lighting load, the length of 60 cm or 90 cm is set by usually manufacturing 30 cm illumination apparatuses and connecting them.

[0007]

As shown in FIG. 8, an illumination apparatus having a plurality of connected lighting units supplies the alternating current power from an AC power source to each lighting unit 8 using cable 810. Each lighting unit 8 includes a drive unit 8a connected with a cable 810. The drive unit 8a includes the terminal units 80 and 81, a protection circuit unit 82, a conversion circuit unit 83, and a constant current circuit unit 84 in order from the AC power source side, and is connected to the LED group 85 in which a plurality of LEDs 850 are connected in series. Since the aforementioned illumination apparatus is required to be as thin and as compact as possible, the cross-sectional area of the lighting unit 8 must consequently also be made thin. Accordingly, there is a demand for a smaller and thinner drive unit 8a.

[Patent Literature 1] Japanese Unexamined Patent Application Publication H7-307491 (pages 4 and 5 and FIG. 1)

[Patent Literature 2] Japanese Unexamined Patent Application Publication 2002-299697 (pages 3 and 4 and FIG. 1)

[Disclosure of the Invention]

[Problems to be Solved by the Invention]

[0008]

As shown in FIG. 8, the aforementioned conventional illumination apparatus has the problem that the drive units 8a, 8a of all the lighting units 8, 8 are provided with the conversion circuit units 83, 83, respectively, so that the illumination apparatus cannot be made thin, which results in a large size and high costs.

[0009]

The present invention is made in view of the above points, and the purpose is to provide illumination apparatuses that can realize miniaturization, thinness, and low cost.

[Means for solving the problems]

[0010]

An illumination apparatus comprising of a first LED group in which a plurality of LEDs are connected in series; a first housing unit that houses the first LED group; a conversion circuit unit that is housed in the first housing and converts the AC power supplied from an AC power supply into DC power; a first lighting circuit unit that is housed in the first housing unit, which generates a constant current signal that maintains the current of the DC power at a constant magnitude, and that lights the first LED group based on the DC power in which the current is maintained at a constant magnitude by the constant current signal, and is electrically connected to the first lighting unit; a second LED group in which a plurality of LEDs are connected in series; a second housing that houses the second LED group; and a second lighting circuit unit housed in the second housing that receives the DC power and the constant current signal from the first lighting unit, and that lights the second LED group based on the DC power in which the current is maintained at a constant level by the constant current signal, and in which one or more second lighting units may be provided.

[0011]

In this configuration, the conversion circuits of the first lighting unit can be shared by one or more second lighting units, so that miniaturization, thinness, and low cost can be realized.

[0012]

The invention according to Claim 2 is characterized in that, in the invention according to Claim 1, the first lighting unit includes a step-down circuit unit that steps down the DC power output from the conversion circuit unit and outputs the step-down power as new DC power to the first lighting circuit unit and the second lighting circuit unit. With this configuration, efficiency can be increased even when the number of LEDs connected as the first LED groups and the second LED group is small.

[0013]

The invention according to Claim 3 is characterized in that, in the invention according to Claim 1 or Claim 2, at least one of the first LED group and the second LED group is provided in parallel in a plurality of parallel connections. In this configuration, the brightness can be increased.

[Effects of the Invention]

[0014]

According to the present invention, miniaturization, thinness and low costs can be realized.

[Best Embodiments of the Invention]

[0015]

(Embodiment 1)

First, the basic configuration of Embodiment 1 will be described with reference to FIGS. 1 and 2. The illumination apparatus of Embodiment 1, for example, is arranged linearly on a wall surface, such as a building, to perform line lighting, and as shown in FIG. 2, the apparatus comprises of a master unit (first lighting unit) 1 and a plurality of (3 in FIG. 2) slave units (second lighting units) 2, 2, and 2 that are connected in sequence. The master unit 1 includes a housing 3, a panel 4, an LED group 5, and a master drive unit 6 (see FIG. 1). On the other hand, each slave unit 2 includes a housing 3a, a panel 4, an LED group 5a, and a slave drive unit 7 (see FIG. 1), and is electrically connected to the master unit 1.

[0016]

The housing 3 is integrally provided with a rectangular bottom part (the back part in FIG. 2) formed by resin molding, a left side part (the left side in FIG. 2) extending forward (front direction in FIG. 2) from the periphery of the bottom part, a right side part 30 (see FIG. 3), an upper side part 31 and a lower side part (lower part in FIG. 2), and houses the LED group 5 and the master driving unit 6 (see FIG. 1). On the left side, the AC outlet 33 is installed via cable 32. The AC outlet 33 is electrically connected to the power supply AC (see FIG. 1). The AC power supply is an AC power source, for example, a commercial power source, which supplies AC power.

[0017]

On the other hand, the housing 3a, like the housing 3, includes a bottom part (the back part of FIG. 2), a left side part (the left side part of FIG. 2), a right side part 30, an upper side part 31, and a lower side part (the bottom part of FIG. 2). However, the housing 3a, unlike the housing 3, houses the LED group 5a and the slave drive unit 7 (see FIG. 1).

[0018]

The interior of the housing 3, and 3a are filled with a transparent resin 34, such as, for example, silicon resin. When filling the transparent resin 34, a defoaming means for venting the bubbles of the transparent resin 34 prior to filling is used, and a filling means is used for venting the bubbles of the transparent resin 34 under vacuum conditions, etc., to prevent bubbles from occurring in the transparent resin 34. As a result, the plurality of electronic components constituting the LED groups 5, and 5a, the master driving unit 6, the slave drive unit 7 (see FIG. 1), etc. are protected from water intrusion and condensation without obstructing the light emitted from the LED groups 5, and 5a, so that the lighting equipment can be used outdoors.

[0019]

The panel 4 is made of, for example, a transparent resin in the form of a rectangular plate, and is fitted into the housings 3 and 3a.

[0020]

The LED groups 5, and 5a each comprises of a plurality of LEDs 50 connected in series (see 18 in FIG. 2) on an LED substrate (not shown). Each LED 50 is, for example, a white LED or the like, and has a forward voltage of 3 to 4V. As described above, since a plurality of LEDs 50 are connected in series, there is no need to step down the AC voltage (for example 100V) of the AC power supply (see FIG. 1) to the above forward voltage, and lighting can be achieved with a simple circuit structure.

[0021]

An LED substrate (not shown) is formed, for example, in a rectangular plate shape. It is a lint board or the like, and includes a plurality of pairs of lands arranged in a longitudinal direction and a plurality of conducting wires electrically connecting the lands. Each land unit and conducting wire are made of metal such as copper foil, and have electrical conductivity. On each pair of land units, for example, a solder leveler is provided to facilitate soldering, and a plurality of LEDs 50 are mounted thereon in series in the longitudinal direction so as to radiate light toward the panel 4 side (front side in FIG. 2).

[0022]

As shown in FIG. 1, the master drive unit 6 includes the terminal units 60, 60, a protective circuit unit 61, a conversion circuit unit 62, a constant current circuit unit (lighting circuit unit) 63, and terminal units 64, 64, 64 in order from the AC power supply side on a circuit board (not shown) different from the LED board (not shown). The terminals 60, 60 are electrically connected to the AC power supply via a cable 32 and an AC outlet 33 (see FIG. 2). The terminal units 64, 64, 64 are electrically connected to the slave unit 2.

[0023]

The circuit board (not shown) is housed inside the housing 3 shown in FIG. 2, for example, on the side opposite to the side where the LED board (not shown) is provided with the LED group 5 (the back side in FIG. 2). As a result, the circuit board does not block the light emitted from the LED group 5, and the feed wiring with the slave unit 7 can be easily configured.

[0024]

The protection circuit unit 61 includes a fuse 610 and a surge absorber (varistor, ZNR) 611 in order from the AC power side, as shown in FIG. 1, to protect the master drive unit 6 from lightning surges, etc. The conversion circuit unit 62 includes a diode bridge 620 composed of four diodes (not shown), and converts AC power supplied from the AC power source into pulsating DC power. The conversion circuit unit 62 outputs the pulsating DC power to the constant current circuit unit 63, and also outputs it to the constant current circuit unit 72 of the slave drive unit 7 to be described later via the terminal units 64, 64. Although the magnitude of the pulsating DC power in Embodiment 1 fluctuates over time, the output direction is not reversed and the same direction is maintained.

[0025]

The constant current circuit section unit 63 includes resistors 630 and 631 and a Zener diode 632 connected in parallel with the LED group 5, and a transistor 633 and a resistor 634 connected in series with the LED group 5. The resistor 631 and the Zener diode 632 are connected to the base of the transistor 633. It should be noted that even if the resistors 630 and 631 are replaced by one resistor, they have the same function. The constant current circuit unit 63 receives the pulsating DC power from the conversion circuit unit 62, and the base voltage of the transistor 633 is made constant by the Zener diode 632, and the constant current signal, which is the base current of the transistor 633, is generated. The constant current circuit unit 63 outputs the constant current signal through the terminal unit 64 to the constant current circuit unit 72 of the slave drive unit 7, which will be described later.

[0026]

The aforementioned constant current circuit unit 63 supplies DC power to the LED group 5 for the pulsation current maintained at a certain size by the aforementioned constant current signal, and illuminates the LED group 5. If the forward current (LED current) flowing through the LED group 5 is I_f , the Zener voltage, that is the voltage across the Zener diode 632 is V_{zd} , the base-emitter voltage of the transistor 633 is V_{be} , and the resistance value of the resistor 634 is R , then $I_f = (V_{zd} - V_{be}) / R$, and the forward current I_f becomes constant. As described above, the constant current circuit unit 63 can perform constant current control to keep the forward current I_f constant without being affected by variations in the forward voltage of each LED 50 and fluctuations in the AC power supply. However, in Embodiment 1, a pulse current method is employed, and forward current I_f flows when the voltage of the pulsating DC power becomes equal to or higher than the forward voltage V_f of the LED group 5.

[0027]

Specifically, when the forward voltage V_f of the LED group 5 is obtained, for example, if the forward voltage of each LED 50 is 3.6 V, the forward voltage V_f when 18 LEDs 50 are connected in series is $3.6 \text{ (V/unit)} \times 18 \text{ (unit)} = 64.8 \text{ (V)}$. Based on the above, the LED group 5 can be directly driven by supplying the LED group 5 with pulsating DC power obtained by rectifying the AC power (voltage 100 V) from the AC power supply.

[0028]

The slave drive unit 7 includes terminal units 70, 70, 70, and terminal units 71, 71, 71, and a constant current circuit unit 72 on a circuit board (not shown) different from the LED board (not shown). The terminal units 70, 70, 70 are electrically connected to the terminal units 64, 64, 64 of the master drive unit 6 or to the terminal units 71, 71, 71 of the other slave drive unit 7. The terminal units 71, 71, 71 are electrically connected to the terminal units 70, 70, 70 of the other slave drive unit 7. It should be noted that the slave drive unit 7 (right side of FIG. 1) in the terminal slave unit 2 may not comprise the terminal units 71, 71, 71.

[0029]

The circuit board (not shown) is housed inside the housing 3a shown in FIG. 2, for example, on the side opposite to the side where the LED board (not shown) is provided with the LED group 5a (the back side in FIG. 2). As a result, the circuit board does not block the light emitted from the LED group 5a, and the feed wiring between the master unit 6 and the other slave unit 7 can be easily configured.

[0030]

The constant current circuit unit 72, as shown in FIG. 1, includes a transistor 720 and a resistor 721 connected in series with the LED group 5a. The constant current circuit unit 72 inputs the pulsating DC power from the master drive unit 6 through the terminal units 70, 70, 70 and also inputs the constant current signal to the base of the transistor 720. As a result, the constant current circuit unit 72 supplies the LED group 5a with a pulsating DC power whose current is maintained at a constant level according to the constant current signal, thereby lighting the LED group 5a. If the forward current flowing through the LED group 5a is I_f , and the Zener voltage that is the voltage across the Zener diode 633 of the constant current circuit unit 63 is V_{zd} , and the base-emitter voltage of the transistor 720 is V_{be} , and the resistance value of the resistor 721 is R , then $I_f = (V_{zd} - V_{be}) / R$, and the forward current I_f becomes constant. As described above, the constant current circuit unit 72 only needs to include the transistor 720 and the resistor 721, and can perform constant current control to keep the forward current I_f constant without being affected by variations in the forward voltage of each LED 50 and variations in the AC power supply. However, in Embodiment 1, a pulse current method is employed, and forward current I_f flows when the voltage of the pulsating DC power becomes equal to or higher than the forward voltage V_f of the LED group 5a.

[0031]

As described above, according to Embodiment 1, only the master unit 1 is provided with the conversion circuit unit 62, and the plurality of slave units 2, 2, 2 can share the conversion circuit unit 62, so that the plurality of slave units 2, 2, 2 and the illumination apparatus as a whole can be reduced in size and thickness, and be less expensive.

[0032]

It should be noted that the variant of Embodiment 1 is not limited to those with multiple slave units, but may include only one slave unit. Even with such a configuration, the same effects as those of the Embodiment 1 can be obtained.

[0033]

As another variant of Embodiment 1, the master unit 1 and the plurality of slave units 2, 2, 2 may also be connected by cables 32, 32, 32 as shown in FIG. 3. Specifically, the terminal units 64, 64, 64 (see FIG. 1) of the master drive unit 6 of the master unit 1 are electrically connected to the terminal units 70, 70, 70 (see FIG. 1) of the slave drive unit 7 of the slave unit 2 via a cable 32. As described above, the master drive unit 6 (see FIG. 1) supplies the pulsating DC power converted by the conversion circuit unit 62 (see FIG. 1) and the constant current signal generated by the constant current circuit unit 63 (see FIG. 1) to the constant current circuit unit 72 of the slave drive unit 7 via the terminal units 64, 64, 64. Also, the terminal units 71, 71, 71 of the slave drive unit 7 (see FIG. 1) are electrically connected to the terminal units 70, 70, 70 of the other slave drive unit 7 via a cable 32. Such a configuration can have the same effect as Embodiment 1 and can be installed separately from the master unit 1 and the plurality of slave units 2, 2, 2, respectively.

[0034]

Furthermore, as another modified example of Embodiment 1, the constant current circuit section of the master unit is not limited in circuit configuration, and may be provided with a circuit capable of performing constant current control. For example, instead of the Zener diode, a current mirror circuit having a series connection of a transistor and a resistor may be provided. In such a configuration, even if there is a variation in the forward voltage of each LED, the same effect as in Embodiment 1 can be obtained, and since the Zener diode is not included, the variation in operation in the constant current circuit unit of the master unit with respect to the ambient temperature can be reduced.

[0035]

Another modification of Embodiment 1 is not limited to the configuration in which the master unit is provided on one end side, and may be in a configuration in which the master unit is provided between a plurality of slave units. Even with such a configuration, the same effects as those of the Embodiment 1 can be obtained.

[0036]

(Embodiment 2)

The master drive unit 6a of Embodiment 2 has A1, A2, A3 and A4 in FIG. 4 connected to A1, A2, A3 and A4 in FIG. 1, respectively, and, like the master drive unit 6 of Embodiment 1 (see FIG. 1), it also includes terminal units 60 and 60, a protection circuit unit 61, a constant current circuit unit 63, and terminal units 64, 64 and 64, but it has the following features that are not found in the master drive unit 6 of Embodiment 1.

[0037]

In the master drive unit 6a of Embodiment 2, the conversion circuit unit 62a comprises a diode bridge 620 and a capacitor 621 on the output side of the diode bridge 620, as shown in FIG. 4. Capacitor 621 is a large-capacity electrolytic capacitor that further smooths the DC power of the pulsation transformed by the diode bridge 620 and outputs the smoothed DC power to the constant current circuit units 63 and 72. It should be noted that the master drive unit 6a of the Embodiment 2 is similar to the master drive unit 6 of the Embodiment 1 (see FIG. 1) in other respects except for the points described above.

[0038]

As described above, according to Embodiment 2, it is possible to obtain the same effects as those of Embodiment 1, and to supply the LED groups 5 and 5a with a smoothed DC power, so that the forward current I_f can be a complete DC current.

[0039]

(Embodiment 3)

The master drive unit 6b of Embodiment 3 has A1, A2, A3 and A4 of FIG. 5 connected to A1, A2, A3 and A4 of FIG. 1, respectively, and similar to the master drive unit 6 of Embodiment 1 (see FIG. 1), it is provided with terminal units 60 and 60, a protection circuit unit 61, a constant current circuit unit 63, and terminal units 64, 64 and 64, but it has the following features that are not found in the master drive unit 6 of Embodiment 1.

[0040]

The master drive 6b of Embodiment 3 includes a conversion circuit unit 62a and a step-down circuit 65 connected between the conversion circuit unit 62a and the constant current circuit unit 63 (see FIG. 1), as shown in FIG. 5. The step-down circuit unit 65 step-downs the DC power output from the conversion circuit unit 62a and outputs the step-down power to the constant current circuit unit 63 and 72 (see FIG. 1) as new DC power. It should be noted that the conversion circuit unit 62a of Embodiment 3 is the same as the conversion circuit unit 62a of Embodiment 2 (see FIG. 4). Also, the master drive unit 6b of Embodiment 3 is similar to the master drive unit 6 of Embodiment 1 (see FIG. 1) in other respects except for the points described above.

[0041]

As described above, according to Embodiment 3, the same effect as Embodiment 1 can be obtained, and even if the LEDs 50 connected as LED groups 5 and 5a are small, the efficiency can be increased because the power other than the power consumption of each LED50 can be reduced.

[0042]

(Embodiment 4)

The master unit 1a of Embodiment 4, includes a housing 3 and a panel 4 provided in the same manner as the master unit 1 of Embodiment 1 (see FIG. 2), as shown in FIG. 6(a), and the slave unit 2a of Embodiment 4 includes a housing 3a and a panel 4 provided in the same manner as the slave unit 2 of the first embodiment (see FIG. 2), as shown in FIG. 6(b). However, the master unit 1a and the slave unit 2a of Embodiment 4 have the features described below that are not included in the master unit 1 and the slave unit 2 of Embodiment 1.

[0043]

The master unit 1a of Embodiment 4 provides multiple LED groups 5, 5 (two rows in FIG. 6(a)) connected in parallel to the same LED substrate (not shown), as shown in FIG. 6(a). LED groups 5 and 5 are connected to the master drive unit 6c as shown in FIG. 7. The master drive unit 6c is obtained by connecting A3 and A4 in FIG. 7 to A3 and A4 in FIG. 1, respectively. In the master drive unit 6c, the constant current circuit unit 63a comprises a transistor 633 and a resistance 634 corresponding to each LED group 5. Further, the right side part 30 of the housing 3 is attached with a connector 35 via a cable 32, as shown in FIG. 6(a). The connector 35 connects to the connector 35 of the slave unit 2a described below. It should be noted that the master unit 1a of Embodiment 4 is similar to the master unit 1 of Embodiment 1 (see FIGS. 1 and 2) in other respects except for the points described above.

[0044]

On the other hand, the slave unit 2a of Embodiment 4 is provided with multiple LED groups 5a, 5a (two rows in FIG. 6(b)) connected in parallel to the same LED substrate (not shown), as shown in FIG. 6(b). The LED groups 5a and 5a are connected to the slave drive unit 7a as shown in FIG. 7. In the slave drive unit 7a, the constant current circuit unit 72a includes a transistor 720 and a resistor 721 corresponding to each LED group 5a. Further, the left side and right side 30 of the housing 3a are attached with connectors 35 via cables 32, respectively, as shown in FIG. 6(b). The connector 35 connects with the connector 35 of the master unit 1a or the connector 35 of another slave unit 2a. From the above, the terminal units 70, 70, 70 (see FIG. 7) of the slave drive unit 7a are electrically connected to the terminal units 64, 64, 64 (see FIG. 7) of the master drive unit 6c via the cable 32 and the connector 35. It should be noted that the slave unit 2a of Embodiment 4 is similar to the slave unit 2 of Embodiment 1 (see Figs. 1 and 2) in other respects except for the above points.

[0045]

Thus, according to Embodiment 4, the same effect as Embodiment 1 can be obtained, and since the LED groups 5 and 5a of the master unit 1a and the LED groups 5a, 5a of the slave unit 2a are connected in parallel (two rows in FIG. 6(a) and (b)), the brightness can be increased.

[0046]

It should be noted that as a variant of Embodiment 4, only one of the master or slave units may be configured to provide a plurality of LED groups in parallel. Even in such a configuration, the brightness can be increased.

[Brief Description of the Drawings]

[0047]

[FIG. 1] A circuit diagram of the illumination apparatus of Embodiment 1 according to the present invention.

[FIG. 2]A perspective view of the illumination apparatus above.

[FIG. 3] A perspective view of the illumination apparatus, which is a variant of the above.

[FIG. 4] A key circuit diagram of the illumination apparatus of Embodiment 2 according to the present invention.

[FIG. 5] A key circuit diagram of the illumination apparatus of Embodiment 3 according to the present invention.

[FIG. 6] An illumination apparatus of Embodiment 4 according to the present invention, wherein (a) is a perspective view of the master unit and (b) is a perspective view of the slave unit.

[FIG. 7] A schematic diagram of the main parts of the illumination apparatus above.

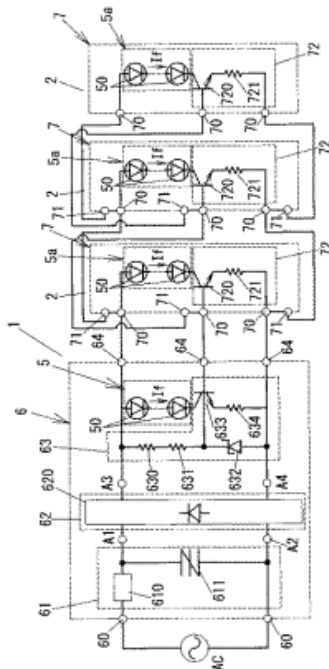
[FIG. 8] A circuit diagram of a conventional illumination apparatus.

[Explanation of references]

[0048]

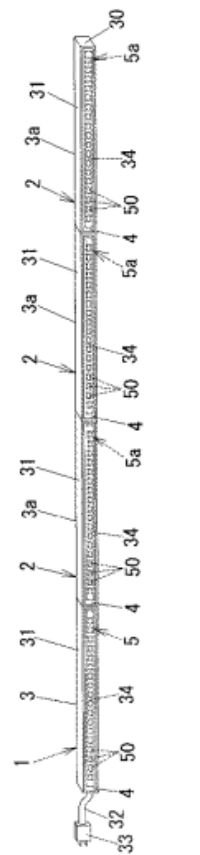
- 1 Master unit
- 2 Slave unit
- 5, 5a LED group
- 50 LEDs
- 6 Master drive unit
- 62 Conversion circuit unit
- 7 Slave drive unit
- 63, 72 Constant current circuit units
- AC power supply

[FIG. 1]

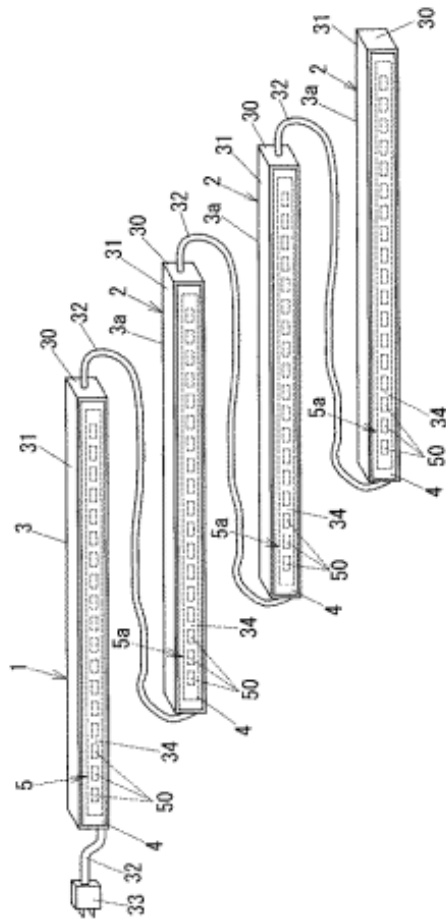


- 1 Master unit
- 2 Slave unit
- 5, 5a LED group
- 50 LEDs
- 6 Master drive unit
- 62 Conversion circuit unit
- 7 Slave drive unit
- 63, 72 Constant current circuit units
- AC power supply

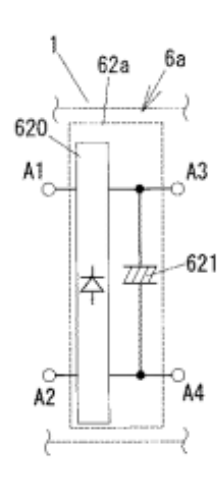
[FIG. 2]



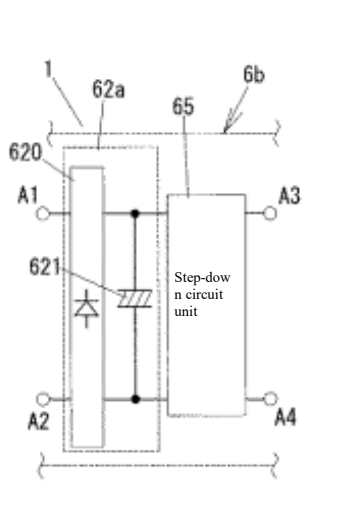
[FIG. 3]



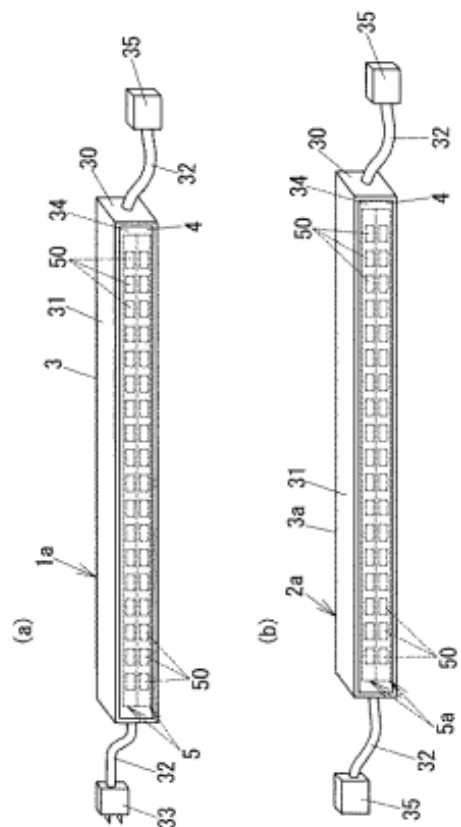
[FIG. 4]



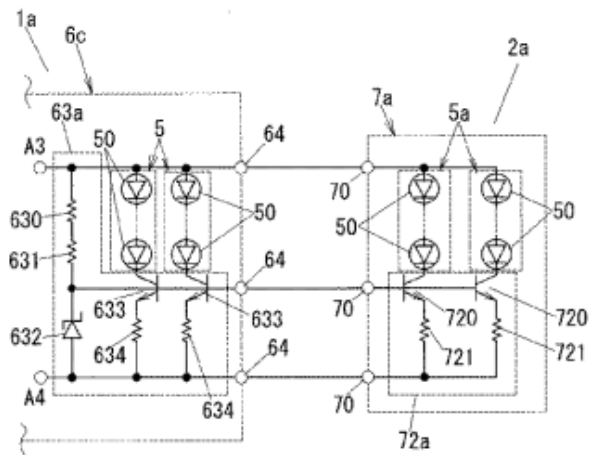
[FIG. 5]



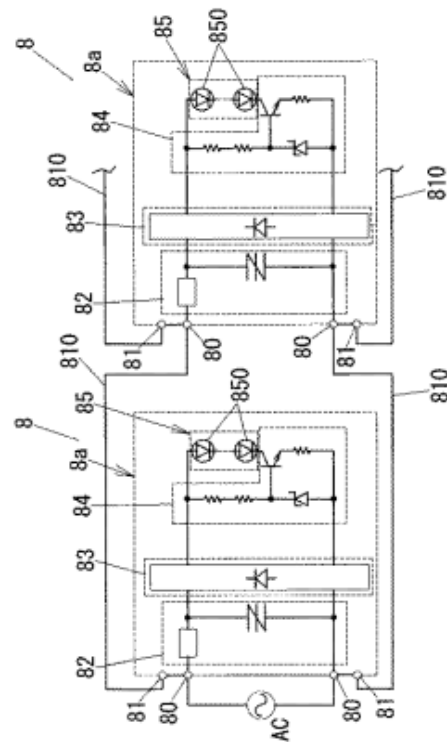
[FIG. 6]



[FIG. 7]



[FIG. 8]



(51) Int.C1.

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Theme codes (reference)

DECLARATION OF John Andrews

I, John Andrews, pursuant to 28 U.S.C. § 1746, hereby declare as follows:

1. I am a Translator at TransPerfect, Inc.
2. I submit this declaration to certify the accuracy of the English translation of JP2006228529A.
3. My statements are based on personal knowledge and my review of JP2006228529A and its Japanese to English translation. If called as a witness about the facts contained in these statements, I could testify competently based on such personal knowledge and the investigation I have conducted.
4. Attached as Exhibit A is a true and accurate copy of JP2006228529A.
5. Attached as Exhibit B is a true and accurate copy of an English translation of JP2006228529A (“the JP2006228529A Translation”).
6. The JP2006228529A Translation is a true and accurate translation of JP2006228529A from Japanese to English.
7. All statements made herein of my own knowledge are true, and all statements made on information and belief are believed to be true. Further, I am aware that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001. I declare under penalty of perjury that the foregoing is true and correct.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct. Executed on July 21, 2023, at New York, New York.



John Andrews