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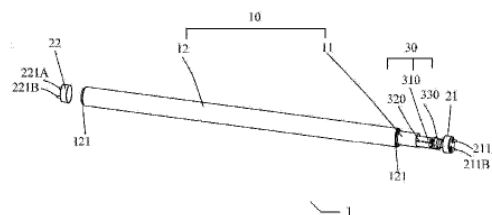
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(54) Title of Invention

LED FLUORESCENT LAMP AND INSTALLATION
METHOD THEREOF

(57) Abstract

The invention relates to semiconductor lighting technology, particularly to an LED fluorescent lamp and an installation method of the fluorescent lamp. An LED fluorescent lamp according to an embodiment of the invention comprises: a glass inner tube; a glass outer tube sleeved outside the glass inner tube; end covers enclosing two ends of the glass inner tube and provided with plugs adaptable to fluorescent lamp holders; and an LED driver power supply, comprising a strip substrate fixed inside the glass inner tube, a plurality of LED units arranged on the strip substrate, and a drive circuit module, which is arranged at one or two ends of the strip substrate and electrically connected to the LED units and the plugs.



1. An LED fluorescent lamp, wherein the LED fluorescent lamp comprises:
 - a glass inner tube;
 - a glass outer tube sleeved outside the glass inner tube;
 - end covers enclosing two ends of the glass inner tube and provided with plugs adaptable to fluorescent lamp holders; and
 - an LED driver power supply, comprising:
 - a strip substrate fixed inside the glass inner tube;
 - a plurality of LED units arranged on the strip substrate; and
 - a drive circuit module, which is arranged at one or two ends of the strip substrate and electrically connected to the LED units and the plugs.
2. The LED fluorescent lamp according to claim 1, wherein the outer surfaces of the ends of the glass outer tube shrink inwards.
3. The LED fluorescent lamp according to claim 1, wherein the inner surface and/or outer surface of the glass inner tube are frosted surfaces.
4. The LED fluorescent lamp according to claim 1, wherein the inner surface of the glass outer tube is covered with light diffusion powder.
5. The LED fluorescent lamp according to claim 1, wherein the LED units are coupled in series, parallel or hybrid manner.
6. The LED fluorescent lamp according to claim 1, wherein the drive circuit module comprises:
 - a bridge rectifier filter unit;
 - a DC-DC boost conversion unit, comprising an inductor, a switching diode, a PWM controller and an MOS tube, wherein the inductor and the switching diode are connected in series between the bridge rectifier filter unit and the LED load, the drain of the MOS tube being electrically connected between the inductor and the anode of the switching diode, and the grid being electrically connected to the output terminal of the PWM controller; and
 - a feedback unit, comprising a triode transistor, the base of which is electrically connected

- to the loop of the LED units and the collector of which is electrically connected to the control terminal of the PWM controller.
7. The LED fluorescent lamp according to claim 1, wherein the drive circuit module further comprises a pair of electrode pins arranged at a first end of the strip substrate, which are electrically connected to the live line and neutral line of an external AC power supply via the plugs, respectively.
 8. The LED fluorescent lamp according to claim 7, wherein the drive circuit module further comprises a pair of directly connected pins, which are arranged at a second end opposite the first end.
 9. An installation method of the LED fluorescent lamp as recited in claim 8, with lamp holders comprising a first pair of jacks and a second pair of jacks, wherein a connector is electrically connected between a jack in the first pair of jacks and a jack in the second pair of jacks, the other jack in the first pair of jacks being electrically connected to the live line of an external AC power supply, and the other jack in the second pair of jacks being electrically connected to the neutral line of the external AC power supply via an inductive ballast.
 10. The installation method according to claim 9, wherein the connector is removable and comprises an interface terminal, which is matched with the starter socket on the inductive ballast.

LED FLUORESCENT LAMP AND INSTALLATION METHOD THEREOF

TECHNICAL FIELD

[0001] The present invention relates to semiconductor lighting technology, particularly to an LED fluorescent lamp and an installation method of the fluorescent lamp.

BACKGROUND ART

[0002] Light emitting diodes (LEDs), currently used as a source of light in a lighting device, are solid-state semiconductor devices. Their basic structure generally consists of a support with leads, a semiconductor die mounted on the support, and a packaging material (e.g., silicone or epoxy resin) sealing around the die. The foregoing semiconductor die contains a P-N structure. When a current passes through it, electrons are pushed towards the P region, where the electrons are compounded with holes and emit energy in the form of photons, while the wavelength of light is determined by the material forming the P-N structure.

[0003] Compared with traditional fluorescent lamps, LED fluorescent lamps have many advantages such as high photoelectric conversion efficiency, constant brightness of the light source, no strobing and no harmful heavy metals. A typical LED fluorescent lamp tube comprises a tube body, end covers, a lamp panel and a driver power supply, wherein the driver power supply can be built in the tube body or mounted outside the tube body.

[0004] Chinese utility model patent 200920134372.8 discloses a fluorescent lamp with an external LED power supply, the fluorescent lamp comprises an LED fluorescent lamp body, the lamp body is connected to the external LED power supply, the LED power supply comprises a PCB, input and output terminals and a power box, the PCB is built in the power box, and the input terminal is connected to the LED fluorescent lamp body via the PCB and the output terminal. The use of an external power supply requires a large change in the wiring of the fluorescent lamp and is not convenient in installation.

[0005] Chinese invention patent application 201110037855.9 discloses an LED fluorescent lamp, comprising a lamp tube and end covers mounted on two ends of the lamp tube, wherein

the lamp tube comprises a lamp panel, a plurality of LEDs arrayed on the lamp panel, and a light emitting housing located above the LEDs, step-down constant current source modules that provide a constant current to the LEDs are mounted inside the end covers, and the conductive terminals of the anode and cathode of the lamp panel are connected to the output terminals of the step-down constant current source modules. For the foregoing fluorescent lamp, the edge of the lamp panel is liable to experience friction with the inner wall of the lamp tube during installation of the lamp panel, thereby scraping off the light diffusion powder coated on the inner wall. Further, the foregoing LED fluorescent lamp is designed to completely abandon the constraints of the original fluorescent lamp holders and although it is conducive to optimizing the structure and circuit design of the fluorescent lamp, it is poorly compatible with existing fluorescent lamp holders.

SUMMARY OF THE INVENTION

[0006] An objective of the present invention is to provide an LED fluorescent lamp which has the advantages of a compact structure and a simple manufacturing process.

[0007] An LED fluorescent lamp according to an embodiment of the present invention comprises:

[0008] a glass inner tube;

[0009] a glass outer tube sleeved outside the glass inner tube;

[0010] end covers enclosing two ends of the glass inner tube and provided with plugs adaptable to fluorescent lamp holders; and

[0011] an LED driver power supply, comprising:

[0012] a strip substrate fixed inside the glass inner tube;

[0013] a plurality of LED units arranged on the strip substrate; and

[0014] a drive circuit module, which is arranged at one or two ends of the strip substrate and electrically connected to the LED units and the plugs.

[0015] In the foregoing embodiment, by arranging the substrate to the inside of the glass inner tube, the light diffusion powder on the inner surface of the glass outer tube can be protected from being scraped off. Further, the LED units and the drive circuit module are integrated on

the same substrate, thereby reducing the volume of optoelectronic units and enabling optimization of the overall structure of the LED fluorescent lamp.

[0016] Preferably, in the foregoing LED fluorescent lamp, the ends of the glass outer tube shrink inwards. More preferably, in the foregoing LED fluorescent lamp, the outer surfaces of the ends of the glass outer tube shrink inwards to form steps, and the end covers cover the steps. After the shrinking treatment, the stress of the glass tube is effectively released, thereby improving the strength of the tube body.

[0017] Preferably, in the foregoing LED fluorescent lamp, the inner surface and/or outer surface of the glass inner tube are frosted surfaces.

[0018] Preferably, in the foregoing LED fluorescent lamp, the inner surface of the glass outer tube is covered with light diffusion powder.

[0019] Preferably, in the foregoing LED fluorescent lamp, the inner surface and/or outer surface of the glass outer tube are frosted surfaces.

[0020] Preferably, in the foregoing LED fluorescent lamp, the strip substrate is bonded to two ends of the glass inner tube.

[0021] Preferably, in the foregoing LED fluorescent lamp, the strip substrate is an aluminum substrate or double-sided printed circuit board.

[0022] Preferably, in the foregoing LED fluorescent lamp, the LED units are coupled in series, parallel or hybrid manner.

[0023] Preferably, in the foregoing LED fluorescent lamp, the drive circuit module comprises:

[0024] a bridge rectifier filter unit;

[0025] a DC-DC boost conversion unit, comprising an inductor, a switching diode, a PWM controller and an MOS tube, wherein the inductor and the switching diode are connected in series between the bridge rectifier filter unit and LED units coupled in series, the drain of the MOS tube is electrically connected between the inductor and the anode of the switching diode, and the grid is electrically connected to the output terminal of the PWM controller; and

[0026] a feedback unit, comprising a triode transistor, the base of which is electrically connected to the loop of the LED units coupled in series and the collector of which is electrically

connected to the control terminal of the PWM controller.

[0027] In the foregoing embodiment, a feedback signal is provided to the PWM controller through the triode transistor, and at the same time, the functions of constant current and constant voltage are realized. Further, in the drive circuit module of the foregoing structure, the number of components is small and miniaturization can be achieved, thereby making it possible to integrate the LED units and the drive circuit module on the same substrate.

[0028] Preferably, in the foregoing embodiment, the drive circuit module further comprises a capacitor electrically connected between the control terminal of the PWM controller and the ground. By choosing a high-capacity capacitor, the feedback loop response can be slowed down, thereby achieving the purpose of power factor correction.

[0029] Preferably, in the foregoing embodiment, the PWM controller and the MOS tube are integrated in the same IC chip. Or, preferably, the PWM controller, the MOS tube and the triode transistor are integrated in the same IC chip. The integration of the foregoing multiple semiconductor devices improves reliability and contributes to the miniaturization of the drive circuit module.

[0030] Preferably, in the foregoing LED fluorescent lamp, the drive circuit module further comprises a pair of pins arranged at a first end of the strip substrate, which are electrically connected to the live line and neutral line of an external AC power supply via the plugs, respectively.

[0031] Preferably, in the foregoing LED fluorescent lamp, the drive circuit module further comprises a pair of directly connected pins, which are arranged at a second end opposite the first end.

[0032] Another objective of the present invention is to provide an installation method of the foregoing LED fluorescent lamp which has an advantage of simple installation.

[0033] In the installation method of the foregoing LED fluorescent lamp, lamp holders comprise a first pair of jacks and a second pair of jacks, wherein a connector is electrically connected between a jack in the first pair of jacks and a jack in the second pair of jacks, the other jack in the first pair of jacks is electrically connected to the live line of an external AC power supply, and the other jack in the second pair of jacks is electrically connected to the neutral line of the external AC power supply via an inductive ballast.

[0034] Preferably, the connector is removable and comprises an interface terminal, which is matched with the starter socket on the inductive ballast.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] The present invention will now be described by referring to the accompanying drawings, from which the foregoing and/or other aspects and advantages will be evident and understandable. Identical or similar units in the accompanying drawings are expressed with the same reference signs.

[0036] Fig. 1 is a schematic exploded view of an LED fluorescent lamp according to an embodiment of the present invention.

[0037] Fig. 2 is a schematic diagram of an LED driver power supply that can be used in the LED fluorescent lamp shown in Fig. 1.

[0038] Fig. 3 is a partial schematic view of the LED fluorescent lamp shown in Fig. 1.

[0039] Fig. 4A is a wiring diagram of an ordinary fluorescent lamp using an inductive ballast, and Fig. 4B is a wiring diagram of the LED fluorescent lamp in an embodiment shown in Fig. 1 instead of the ordinary fluorescent lamp shown in Fig. 4A.

[0040] Fig. 5A is a wiring diagram of an ordinary fluorescent lamp using an inductive ballast, and Fig. 5B is a wiring diagram of the LED fluorescent lamp in an embodiment shown in Fig. 1 instead of the ordinary fluorescent lamp shown in Fig. 5A.

[0041] Fig. 6 is a schematic circuit diagram of a drive circuit module contained in the LED driver power supply shown in Fig. 2.

[0042] Fig. 7 is a schematic circuit diagram of an alternative drive circuit module contained in the LED driver power supply shown in Fig. 2.

[0043] List of reference signs in the accompanying drawings:

[0044] 1 - LED fluorescent lamp

[0045] 10 - tube body

[0046] 11 - inner tube

[0047] 12 - outer tube

- [0048] 21, 22 - end covers
- [0049] 211A, 211B, 212A, 212B - plugs
- [0050] 30 - LED driver power supply
- [0051] 310 - substrate
- [0052] 320 - light emitting diode (LED) unit
- [0053] 330 - driver power supply module
- [0054] 331 - bridge rectifier filter unit
- [0055] 332 - DC-DC boost conversion unit
- [0056] 333 - feedback unit
- [0057] BR1 - full-bridge rectifier
- [0058] C1, C2, C3, C4, C5, C6 - capacitors
- [0059] D1 - switching diode
- [0060] L1, L2 - inductors
- [0061] LED1-LEDn - LED loads
- [0062] Q1 - triode transistor
- [0063] R1, R2, R3, R4, R5 - resistors
- [0064] T1 - MOS tube
- [0065] U1 - switch adjuster
- [0066] U2 - PWM controller
- [0067] 340A, 340B, 350A, 350B - pins
- [0068] 40 - adhesive
- [0069] 2 - ordinary fluorescent lamp
- [0070] 3 - starter
- [0071] 4 - inductive ballast
- [0072] 5 - connector

[0073] 6 - electronic ballast

DETAILED DESCRIPTION

[0074] The present invention is described in more detail below by referring to the accompanying drawings which illustrate the schematic embodiments of the present invention. However, the present invention can be implemented in different forms and should not be interpreted as being limited to the embodiments provided in this document. The foregoing embodiments are provided to make the disclosure herein comprehensive and complete and to convey a more complete picture of the scope of protection of the present invention to those skilled in the art.

[0075] In this Description, unless otherwise specified, the term “semiconductor wafer” refers to a plurality of stand-alone individual circuits formed on a semiconductor material (e.g., silicon and gallium arsenide), “semiconductor die” or “die” refers to such individual circuit, and “packaged chip” refers to a physical structure of a semiconductor die after packaging, in which the semiconductor die is typically mounted on a support and packaged with a sealing material.

[0076] The term “light emitting diode (LED) unit” refers to a unit containing an electroluminescent material. Examples of such units include, but are not limited to, P-N junction inorganic semiconductor light emitting diodes and organic light emitting diodes (OLEDs and polymer light emitting diodes (PLEDs)).

[0077] The P-N junction inorganic semiconductor light emitting diodes may have different structural forms, including but not limited to light emitting diode cores and light emitting diode cells. The “light-emitting diode core” refers to an electroluminescent semiconductor die containing a P-N structure, while the “light-emitting diode cell” refers to a physical structure formed after packaging of the core, in which the core is typically mounted on a support and packaged with a sealing material.

[0078] The terms “wiring,” “wiring pattern” and “wiring layer” refer to conductive patterns arranged on an insulating surface for electrical connection between components, including but not limited to traces and holes (e.g., pads, component holes, fastening holes and plated-through holes).

[0079] The term “thermal radiation” refers to the phenomenon of radiation of electromagnetic waves by an object due to its temperature.

[0080] The term “heat conduction” refers to the transfer of heat in a solid from a part with a higher temperature to a part with a lower temperature.

[0081] “Electrical connection” and “coupling” should be understood to include the circumstance of direct transmission of electrical energy or electrical signals between two units, or the circumstance of indirect transmission of electrical energy or electrical signals via one or more third units.

[0082] “Driver power supply” or “LED driver power supply” refers to an “electronic control device” connected between an alternating current (AC) or direct current (DC) power supply outside the lighting device and the light emitting diode as a light source, and is used to provide the required current or voltage (e.g., constant current, constant voltage or constant power) to the light emitting diode. In specific embodiments, the driver power supply can be achieved in a modular structure. For example, it comprises a printed circuit board and one or more components mounted on the printed circuit board and electrically connected together by means of wiring. Examples of these components include but are not limited to LED drive controller chips, rectifier chips, resistors, capacitors and coils.

[0083] Terms such as “contain” and “comprise” mean that in addition to having the units and steps that are directly and explicitly expressed in the Description and Claims, the technical solution of the present invention does not exclude the circumstance of having other units and steps that are not directly or explicitly expressed.

[0084] Terms such as “first,” “second,” “third” and “fourth” do not indicate the order of the units in terms of time, space, size, etc., but merely serve to distinguish the units.

[0085] Phrases such as “object A is arranged on the surface of object B” should be understood broadly as placing object A directly on the surface of object B, or placing object A on the surface of another object that is in contact with object B.

[0086] The embodiments of the present invention are described below in conjunction with accompanying drawings.

[0087] Fig. 1 is a schematic exploded view of an LED fluorescent lamp according to an embodiment of the present invention.

[0088] The LED fluorescent lamp 1 shown in Fig. 1 comprises a tube body 10, a pair of end covers 21 & 22 located at two ends of the tube body 10, and an LED driver power supply 30 located inside the tube body 10.

[0089] As shown in Fig. 1, the tube body 10 comprises an inner tube 11 and an outer tube 12 sleeved outside the inner tube 11, and they may be made of a glass material. It should be understood that the layout of the outer tube 12 sleeved outside the inner tube 11 should be broadly understood to include at least the following circumstances: the outer surface of the inner tube 11 is in full contact with the inner surface of the outer tube 12; and at least a gap partially exists between the inner tube 11 and the outer tube 12.

[0090] To avoid a glare effect, at least one of the inner and outer surfaces of the inner tube 11 can be frosted (e.g., an acid solution is used to roughen a surface of the inner tube). Optionally, it is also possible to consider coating the inner surface of the outer tube 12 with light diffusion powder or frosting at least one of the inner and outer surfaces of the outer tube. In this embodiment, because the printed circuit board of the LED driver power supply 30 is arranged inside the inner tube 11, the circuit board can be prevented from scraping off the light diffusion powder on the inner surface of the outer tube 12 during the assembly process.

[0091] As also shown in Fig. 1, the outer tube 12 shrinks inwards at its ends 121, so that the outer diameter of the outer tube at the ends is smaller than the outer diameter in the remaining part. In the process when the ends of the outer tube shrink inwards, the stress in the wall of the outer tube is effectively released, thereby improving the strength and helping reduce loss in the transport and assembly processes. It should be noted that the purpose of the shrinkage is to release stress, so it is not necessary to reduce the inner diameter of the outer tube 12. In this embodiment, the inner tube 11 is slightly shorter than the outer tube 12, so that in the LED fluorescent lamp after assembly, the inner tube 11 is completely located in the inside of the outer tube 12. However, in order to show the inner tube 11 in Fig. 1, the right end of the inner tube 11 extends to the outside of the outer tube 21. Optionally, the inner tube 11 can be longer than the outer tube 12, too, so the two ends of the inner tube 11 extend out of the outer tube 12 after assembly.

[0092] Plugs adaptable to ordinary fluorescent lamp holders are arranged on each of the end covers 21 and 22, i.e., a pair of plugs 211A and 211B located on the outer surface of the end cover 21 and the other pair of plugs 221A and 221B located on the outer surface of the end

cover 22 in Fig. 1. The plugs on the one hand provide electrical connection between the LED driver power supply 30 and an external power supply, and on the other hand enable the LED fluorescent lamp to be fixed to the lamp holders. It should be understood that Fig. 1 shows a schematic view in an exploded state, and when the LED fluorescent lamp 1 completes assembly, the end covers 21 and 22 will enclose the two ends of the inner tube 11, respectively. In this embodiment, the inner surfaces of the end covers 21 and 22 can be bonded to the outer surface of the outer tube 12 by means of an adhesive (e.g., lamp mud), thereby achieving fixation of the end covers.

[0093] In this embodiment, the LED driver power supply 30 may adopt the structure and form shown in Fig. 2 to Fig. 5, wherein the LED units as light sources and the driver power supply module are integrated on the same substrate.

[0094] Fig. 2 is a schematic diagram of an LED driver power supply that can be used in the LED fluorescent lamp shown in Fig. 1.

[0095] The LED driver power supply 30 shown in Fig. 2 comprises a substrate 310, a plurality of light emitting diode (LED) units 320 and a driver power supply module 330. Each component unit is further described below.

[0096] The substrate 310 is in the shape of a strip as shown in Fig. 2, and can be a ceramic substrate made by the mold pressing method. The plate made by this method is thicker (e.g., 1.5-3 mm) and harder. Optionally, the substrate 310 can also be made of a thermally conductive insulating polymer composite material. Further, in order to improve the heat dissipation capability, the substrate surface can be covered with an infrared radiation material, or the substrate can be made of a material with excellent thermal conductivity and infrared radiation performance, so that the heat from the LED units and the driver power supply module is dissipated by means of heat conduction and heat radiation at the same time. It should be noted that in addition to the foregoing ceramics, thermally conductive polymer composite material and infrared radiation material, the substrate 310 can also be an aluminum substrate or a glass fiber board. Further, the components of the LED power supply can be arranged on a surface or two surfaces of the substrate 310.

[0097] The substrate 310 of the LED power supply 30 is fixed to the inside of the inner tube 11. Therefore, the substrate 310 can be fixed to the inner surface of the inner tube 11 at ends by means of a silicone-like adhesive, for example.

[0098] As also shown in Fig. 2, a plurality of LED units 320 are arranged longitudinally along the substrate 310 to form a uniform luminous zone. Although the LED units shown in the figure are arranged in a straight row on the substrate, the arrangement is not limited to this; for example, the LED units can also be arranged in multiple rows or in an S-shape. The LED units 320 can adopt the form of packaged chips or cores, which are mounted on the substrate 310, for example using surface mounting technology. Alternatively, the components of the driver power supply module 330 to be described in detail below can also be mounted on the substrate 310 using surface mounting technology.

[0099] In the LED driver power supply shown in Fig. 2, the plurality of LED units 320 are coupled together in series, and the drive circuit module 330 is electrically connected to the LED units 320, for example through the wiring on the substrate 310, thereby providing a constant current and/or voltage to the LED units 320. It should be noted that although the plurality of LED units here are coupled together in series, they can also be coupled together in parallel, in a hybrid manner or in the form of a cross array.

[0100] As shown in Fig. 2, the components of the drive circuit module 330 are arranged at two ends of the substrate 310. Further, pins 340A and 340B are arranged at one end of the substrate 310 as a first electrode and a second electrode of the LED drive circuit module 330, respectively (therefore, the pins 340A and 340B are hereinafter also referred to as “electrode pins”). After assembly, the electrode pins 340A and 340B are electrically connected to the plugs 211A and 211B on the end cover 21. During operation, one of the pins 340A and 340B is electrically connected to the live line of an external AC power supply (e.g., mains supply) via a corresponding plug on the end cover 21, while the other pin is electrically connected to the neutral line of the external AC power supply via a plug on the end cover 21, thereby causing the external AC power supply to supply power to the drive circuit module 330. In the embodiment shown in Fig. 2, the electrode pins 340A and 340B are welded on the substrate 310. In order to reinforce the electrode pins, the electrode pins can pass through the substrate 310 and be welded on another surface of the substrate 310.

[0101] Optionally, as shown in Fig. 3, a pair of pins 350A and 350B electrically connected to the plugs 221A and 221B on the end cover 22, respectively, are arranged on the other end of the substrate 310. After passing through the substrate 310, the two pins are connected together, thereby being firmly fixed on the substrate 310. Preferably, the pins 350A and 350B can be

integrated components. Further, the ends of the substrate 310 are fixed to the inner surface of the inner tube 11 by means of an adhesive 40.

[0102] From the following description, it can be seen that arranging a pair of directly connected pins 350A and 350B on an end opposite the end on which the electrode pins 340A and 340B are arranged can greatly facilitate installation of the LED fluorescent lamp.

[0103] Fig. 4A is a wiring diagram of an ordinary fluorescent lamp using an inductive ballast, and Fig. 4B is a wiring diagram of the LED fluorescent lamp in an embodiment shown in Fig. 1 instead of the ordinary fluorescent lamp shown in Fig. 4A.

[0104] In an ordinary fluorescent lamp lighting circuit, lamp holders generally comprise two pairs of jacks, and two pairs of plugs of the fluorescent lamp are inserted into the two pairs of jacks, respectively. As shown in Fig. 4A, a starter 3 is connected between jacks B and D, which belong to different pairs of jacks, respectively, a jack A is electrically connected to the live line L of an external power supply, while a jack C is electrically connected to the neutral line N of the external power supply via an inductive ballast 4, and after installation, the two pairs of plugs of the ordinary fluorescent lamp 2 are electrically connected to the jacks A and B and the jacks C and D, respectively. Compared with Fig. 4A, under the wiring method shown in Fig. 4B, the starter 3 is replaced with a connector 5. Preferably, the connector 5 is removable and adopts a form similar to a starter, i.e., comprises an interface terminal, which is matched with the starter socket on the inductive ballast.

[0105] In the embodiments shown in the foregoing Fig. 1 to Fig. 3, the electrode pins 340A and 340B of the LED driver power supply are directly connected to two plugs of the same end cover, but there are no special requirements for the positions of the electrode pins when the LED fluorescent lamp 1 is installed on the lamp holders. That is to say, whether the plugs connecting the electrode pins are on the side of the live line (i.e., electrically connected to the jacks A and B) or the side of the neutral line (i.e., electrically connected to the jacks C and D) in the wiring diagram shown in Fig. 4B, the external power supply can supply power to the LED fluorescent lamp 1 normally. Specifically speaking, for example when the electrode pins 340A and 340B are electrically connected to the jacks A and B, respectively, and the pins 350A and 350B are electrically connected to the jacks C and D, respectively, the electrode pin 340A is electrically connected to the live line L and meanwhile, as the pins 350A and 350B located at the other end of the substrate 310 are shorted, the electrode pin 340B can be electrically connected to the

neutral line N via the connector 5, the pins 350A and 350B, and the inductive ballast 4, thereby achieving power supply from the external power supply to the LED driver power supply. Alternatively, when the electrode pins 340A and 340B are electrically connected to the jacks C and D, respectively, and the pins 350A and 350B are electrically connected to the jacks A and B, respectively, the electrode pin 340A can be electrically connected to the neutral line N via the inductive ballast 4 and meanwhile, as the pins 350A and 350B located at the other end of the substrate 310 are shorted, the electrode pin 340B can be electrically connected to the live line L via the connector 5 and the pins 350A and 350B, thereby achieving power supply from the external power supply to the LED driver power supply.

[0106] Fig. 5A is a wiring diagram of an ordinary fluorescent lamp using an inductive ballast, and Fig. 5B is a wiring diagram of the LED fluorescent lamp in an embodiment shown in Fig. 1 instead of the ordinary fluorescent lamp shown in Fig. 5A.

[0107] As shown in Fig. 5A, the live line L and neutral line N of an external AC power supply are electrically connected to an electronic ballast 6, while jacks A, B, C and D of the lamp holders are electrically connected to the output terminal of the electronic ballast 6. After installation, the two pairs of plugs of the ordinary fluorescent lamp 2 are electrically connected to the jacks A, B and the jacks C and D, respectively. Compared with Fig. 5A, under the wiring method shown in Fig. 5B, the electronic ballast 6 is removed, and the jack B is directly connected to the jack D, while the other pair of jacks C and D are electrically connected to the live line L and neutral line N of the external AC power supply, respectively. Likewise, in Fig. 5B, whether the plugs connecting the electrode pins are on the side of the live line (i.e., electrically connected to the jacks A and B) or the side of the neutral line (i.e., electrically connected to the jacks C and D), the external power supply can supply power to the LED fluorescent lamp 1 normally. For example, if the electrode pins 340A and 340B are electrically connected to the jacks A and B, respectively, and the pins 350A and 350B are electrically connected to the jacks C and D, respectively, the electrode pin 340A is electrically connected to the live line L and meanwhile, the electrode pin 340B is electrically connected to the neutral line N via the pins 350A and 350B, thereby achieving power supply from the external power supply to the LED driver power supply. Alternatively, if the electrode pins 340A and 340B are electrically connected to the jacks C and D, respectively, and the pins 350A and 350B are electrically connected to the jacks A and B, respectively, the electrode pin 340A is electrically connected to the neutral line N, and the electrode pin 340B can be electrically connected to the live line L

via the pins 350A and 350B, thereby achieving power supply from the external power supply to the LED driver power supply.

[0108] It should be noted that although the components of the drive circuit module 330 are arranged at the two ends of the substrate 310 as shown in Fig. 2, it is also feasible to arrange these components at one end only. It should be further noted that the pins 340A and 340B as electrodes of the LED driver power supply can also be arranged at the two ends of the substrate 310 and in this layout, the pins 340A and 330B are electrically connected to the live line and neutral line of the external AC power supply via the plugs on different end covers, respectively.

[0109] The driver power supply module 330 can adopt circuits with various topological structures, including but not limited to non-isolated step-down topological circuit structure, flyback topological circuit structure and half-bridge LLC topological circuit structure. A detailed description of the driver power supply module is available in the book “Design of LED Lighting Driver Power Supply and Luminaire” (First Edition) published Posts & Telecom Press in May 2011, which is included in this Description by full reference.

[0110] The driver power supply module 330 can be driven in various ways (e.g., constant-voltage power supply, constant-current power supply, and constant-voltage constant-current power supply) to supply an appropriate current or voltage to the LED units, and can consist of one or more separate components. In the LED driver power supply shown in Fig. 2, one or more components of the driver power supply module are achieved in the form of dies or package chips.

[0111] Fig. 6 is a schematic circuit diagram of a drive circuit module contained in the LED driver power supply shown in Fig. 2.

[0112] The drive circuit module 330 shown in Fig. 6 comprises a bridge rectifier filter unit 331, a DC-DC boost conversion unit 332 and a feedback unit 333. Each unit is further described below.

[0113] As shown in Fig. 4, the bridge rectifier filter unit 331 comprises a full-bridge rectifier BR1, capacitors C1, C2 & C3, a varistor R1 and an inductor L1. After being rectified by the full-bridge rectifier BR1, AC (e.g., mains supply) outputs a full-wave pulsating voltage at the anode terminal 1. The filter capacitors C1, C2 & C3, the varistor R1 and the inductor L1 constitute an EMI filter circuit, which on the one hand, suppresses the impact of high-frequency

interference in the AC grid on the drive circuit and on the other hand, suppresses the electromagnetic interference of the drive circuit to the AC grid.

[0114] It should be noted that although full-wave rectification is shown here, half-wave rectification is also usable.

[0115] As shown in Fig. 6, the filter capacitor C1 and the varistor R1 are connected in parallel between the AC input terminals B3 and B4 of the full-bridge rectifier BR1, wherein the varistor R1 holds the input voltage of the full-bridge rectifier BR1 at a predetermined level by suppressing abnormal overvoltage in the circuit. The filter capacitors C2 & C3 and the inductor L1 form a π -shaped filter loop and are electrically connected between the anode terminal B1 and the cathode terminal B2 of the full-bridge rectifier BR1 to low-pass filter the pulsating voltage output from the full-bridge rectifier BR1.

[0116] The boost conversion unit 332 is electrically connected to the bridge rectifier filter unit 331, the feedback unit 333 and the LED loads LED1-LEDn (i.e., the plurality of LED units 320 coupled in series in the LED driver power supply shown in Fig. 2), steps up the pulsating voltage output from the rectifier filter unit 331 to a desired voltage and current level and supplies it to the LED load. Further, the DC-DC boost conversion unit 332 works in conjunction with the feedback unit 333 to keep the current and voltage supplied to the LED load constant and to achieve the function of power factor correction. In typical applications, the total voltage of the multiple LED units connected in series is designed to exceed the maximum voltage of the grid input, so a voltage boost is necessary. Taking 220V AC with a fluctuation range of $\pm 10\%$ as an example, if its maximum voltage is about 342V, then the voltage of the LEDs connected in series will exceed 342V.

[0117] In the driver power supply module shown in Fig. 6, the DC-DC boost conversion 332 comprises an inductor L2, a switching diode D1, a capacitor C6 and a switch adjuster U1.

[0118] Preferably, an IC chip integrated with a pulse width modulation (PWM) controller and a metal oxide semiconductor field effect tube (hereinafter also referred to as “MOS tube”) can be used as a switch adjuster U1, wherein the output terminal of the PWM controller is electrically connected to the grid of the MOS tube to control the ON and OFF of the MOS tube. In a specific switch adjuster chip, in order to simplify the adjustment to duty cycle, the switching frequency of the MOS tube can be kept at a constant value (e.g., about 1 MHz), and the turn-off time of the MOS tube is adjustable; alternatively, the turn-off time of the MOS tube can be kept

at a constant value (e.g., about 320 ns), while the switching frequency of the MOS tube is adjustable. Typically, such switch adjuster chip is generally configured to have a drain pin electrically connected to the drain of the MOS tube, and a feedback pin electrically connected to the control terminal of the PWM controller. Examples of the foregoing switch adjuster include but are not limited to CW12L30 and CW12L40 chips produced by China-based Chipswinner Electronics Limited.

[0119] As shown in Fig. 6, the inductor L2 and the switching diode D1 are connected in series between the bridge rectifier filter unit 331 and the LED load, wherein the anode of the switching diode D1 is electrically connected to the inductor L2, and the cathode of the switching diode D1 is electrically connected to the LED load. Preferably, a Schottky diode with a high speed and a small voltage drop can be used as the switching diode D1. As also shown in Fig. 6, the drain pin D of the switch adjuster U1 is electrically connected between the inductor L2 and the anode of the switching diode D1, and the feedback pin FB is electrically connected to the feedback unit 333. Further, in the embodiment shown in Fig. 6, the capacitor C6 and the LED load are jointly connected to the cathode of the switching diode D1 to discharge electricity to the LED load when the switching diode D1 is cut off.

[0120] As shown in Fig. 6, the switch adjuster U1 comprises a power pin VCC and a ground pin GND, wherein the power pin VCC is grounded via the capacitor C4.

[0121] The feedback unit 333 comprises a triode transistor Q1, resistors R2 & R3 and a capacitor C5. As shown in Fig. 6, the triode transistor Q1 is connected in the form of a common emitter amplifier circuit, wherein the collector is electrically connected to the feedback pin of the switch adjuster U1 via the resistor R3 to provide the feedback signal to the switch adjuster U1, the emitter is electrically connected to the ground to serve as a common ground terminal of the input loop and the output loop, and the base is connected to the loop of the LED load to extract the detection signal. The resistor R2 is electrically connected between the base and the ground to form an input loop. In addition, the feedback pin FB of the switch adjuster U1 is also grounded via the capacitor C5.

[0122] The working principle of the drive circuit module 330 shown in Fig. 6 is described below.

[0123] When an AC power supply is connected, the bridge rectifier filter unit 331 converts the input AC power into a pulsating voltage and outputs it to the inductor L2 of the DC-DC

boost conversion unit 332. The MOS tube inside the switch adjuster U1 is switched on and off at a very high frequency under the control of the PWM controller signals.

[0124] When the MOS is switched on, the current flows through the inductor L2 and the MOS tube under the effect of the output voltage of the bridge rectifier filter unit 331, and the switching diode D1 is cut off due to the voltage on the capacitor C6. As the current flowing through the inductor L2 increases, the energy stored in the inductor increases. At that time, the LED load is powered by the capacitor C6, and works relying on the discharge current of the capacitor C6.

[0125] When the MOS tube is switched to an off state, the current flowing through the inductor L2 begins to decrease, thereby inducing an inductive electromotive force at the two ends of the inductor L2, of which polarity is positive at the upper end and negative at the right end. The inductive electromotive force is superimposed on the output voltage of the bridge rectifier filter unit 331 to boost the output voltage of the bridge rectifier filter unit 331. Now, the superimposed voltage is higher than the voltage on the capacitor C6, so the switching diode D1 enters an on state, the LED load is powered by the inductor L2 instead, and the capacitor C6 is also charged by the inductor L2 until the MOS tube is switched to an on state again. In this embodiment, the level of the inductive electromotive force depends on the duty cycle of the MOS tube, so a desired voltage boost can be obtained by adjusting the duty cycle of the output signal of the PWM controller.

[0126] When the MOS tube is switched back to an on state again, the superimposed voltage at the switching diode D1 begins to decrease and will again be lower than the voltage on the capacitor C6, so the switching diode D1 goes into a cutoff state, the LED load is powered by the capacitor C6 with a boosted voltage, and the inductor L2 begins to store electricity again.

[0127] From the above, it can be seen that under the control of the PWM controller, the MOS tube keeps being switched between the foregoing on and off states, so that the voltage on the anode of the LED load is maintained at a high level at all times.

[0128] As shown in Fig. 6, the LED load and the resistors R4 and R5 are connected in parallel between the cathode of the switching diode D1 and the resistor R2, and the cathode of the LED load is electrically connected to the base of the triode transistor Q1. When the current and/or voltage flowing through the LED load fluctuates, the current flowing through the base of the triode transistor Q1 will change, too. The feedback signal amplified by the triode transistor Q1

is output from the collector via the resistor R3 to the feedback pin of the switch adjuster U1, so that the PWM controller can adjust the duty cycle of the output signal according to the feedback signal to keep the current and voltage supplied to the LED load constant.

[0129] In the embodiment shown in Fig. 6, the feedback pin FB of the switch adjuster U1 is also grounded via the high-capacity capacitor C5, which allows the feedback loop to respond more slowly and the feedback level to be nearly constant in the half cycle of the AC line. An essentially constant feedback level indicates that the current in the MOS tube corresponds to the average energy transferred to the LED load in the half cycle of the AC line. As the switch adjuster U1 works at a fixed frequency, the increase in current will not exceed a certain range before the MOS tube conduction time is over. By reducing the switching current flowing through the MOS tube when the input AC voltage increases and by increasing the switching current flowing through the MOS tube when the input AC voltage decreases, the ripple at the input terminal of the LED load can be minimized and the AC input current can track the change of the AC input voltage at any moment, thereby realizing the function of power factor correction.

[0130] It should be noted that in the embodiment shown in Fig. 6, the PWM controller and the MOS tube are integrated in the same IC chip. In order to further improve the integration, it is also possible to consider integrating the triode transistor Q1, the PWM controller and the MOS tube in the same IC chip.

[0131] Optionally, the PWM controller and the MOS tube can also be provided as discrete circuit elements in the LED driver power supply according to the embodiment shown in Fig. 2. The drive circuit module shown in Fig. 7 illustrates an example of this form, wherein the units identical or similar to those in Fig. 6 are expressed with the same reference signs.

[0132] Similarly, the drive circuit module 330 shown in Fig. 7 also comprises a bridge rectifier filter unit 331, a DC-DC boost conversion unit 332 and a feedback unit 333. The bridge rectifier filter unit 331 and the feedback unit 333 adopt a form and structure identical to those shown in Fig. 3, which are not described again here.

[0133] As shown in Fig. 7, the DC-DC boost conversion unit 332 comprises an inductor L2, a switching diode D1, a capacitor C6, a PWM controller U2 and an MOS tube T1, wherein the inductor L2 and the switching diode D1 are connected in series between the bridge rectifier filter unit 331 and the LED load, the anode of the switching diode D1 is electrically connected to the inductor L2, and the cathode is electrically connected to the LED load. In this embodiment,

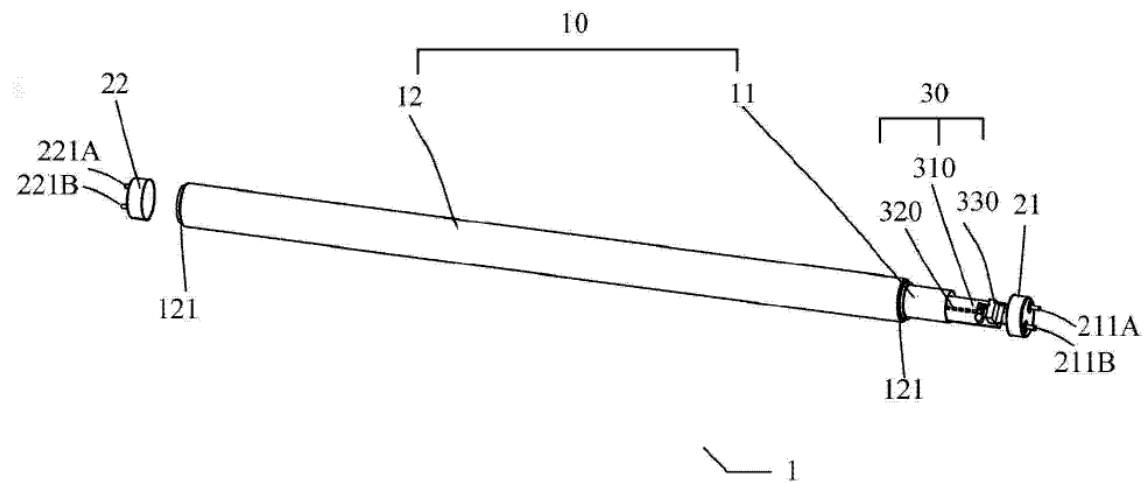
the drain D of the MOS tube T1 is electrically connected between the inductor L2 and the anode of the switching diode D1, the source S is electrically connected to the ground, and the grid G is connected to the output terminal P of the PWM controller U2. The PWM controller U2 is provided in the form of an IC chip in general, and its control terminal FB is electrically connected to the feedback unit 333. As shown in Fig. 4, the capacitor C6 is electrically connected between the cathode of the switching diode D1 and the LED load to discharge electricity to the LED load when the switching diode D1 is cut off.

[0134] Similarly, the feedback unit 133 also comprises a triode transistor Q1, resistors R2 & R3 and a capacitor C5. The triode transistor Q1 is connected in the form of a common emitter amplifier circuit, wherein the collector is electrically connected to the control terminal FB of the PWM controller U2 via the resistor R3 to provide the feedback signal to the PWM controller U2, the emitter is electrically connected to the ground to serve as a common ground terminal of the input loop and the output loop, and the base is connected to the loop of the LED load to extract the detection signal. The control terminal FB of the PWM controller is also grounded via the capacitor C5.

[0135] The working principle of the drive circuit module shown in Fig. 7 is similar to that shown in Fig. 6, so it is not described again here.

[0136] Optionally, the driver power supply module shown in the foregoing Fig. 6 and Fig. 7 can also integrate circuits for other functions, such as a dimming control circuit, a sensing circuit, an intelligent lighting control circuit, a communication circuit and a protection circuit. These circuits can be integrated with the driver controller in the same semiconductor die or packaged chip, or these circuits can be provided separately in the form of a semiconductor die or packaged chip, or some or all of these circuits can be combined together and provided in the form of a semiconductor die or packaged chip.

[0137] Although some aspects of the present invention have been shown and discussed, those skilled in the art should be aware that the foregoing aspects can be changed without departing from the principle and spirit of the present invention, and therefore the scope of the present invention is defined by the claims and equivalents.

**Fig. 1**

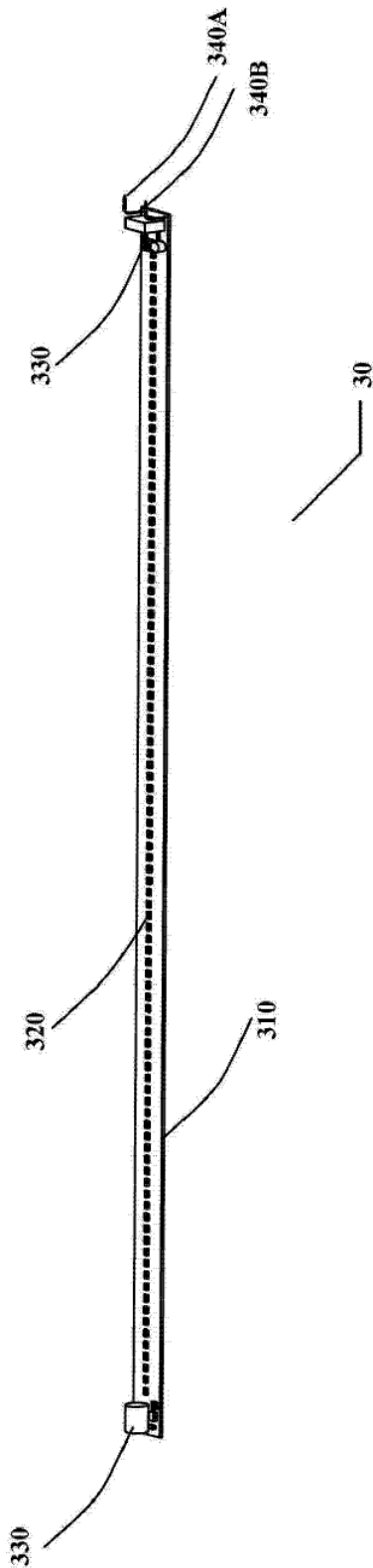
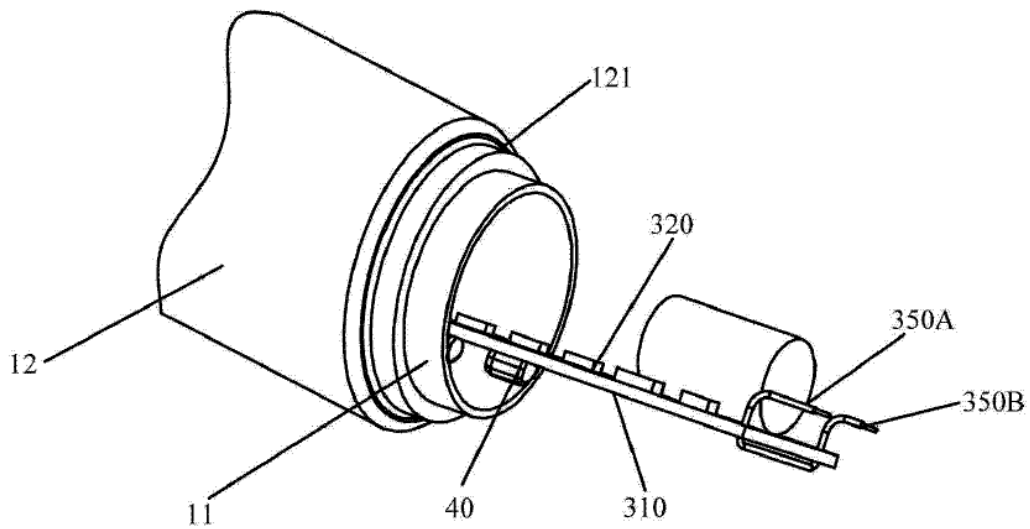
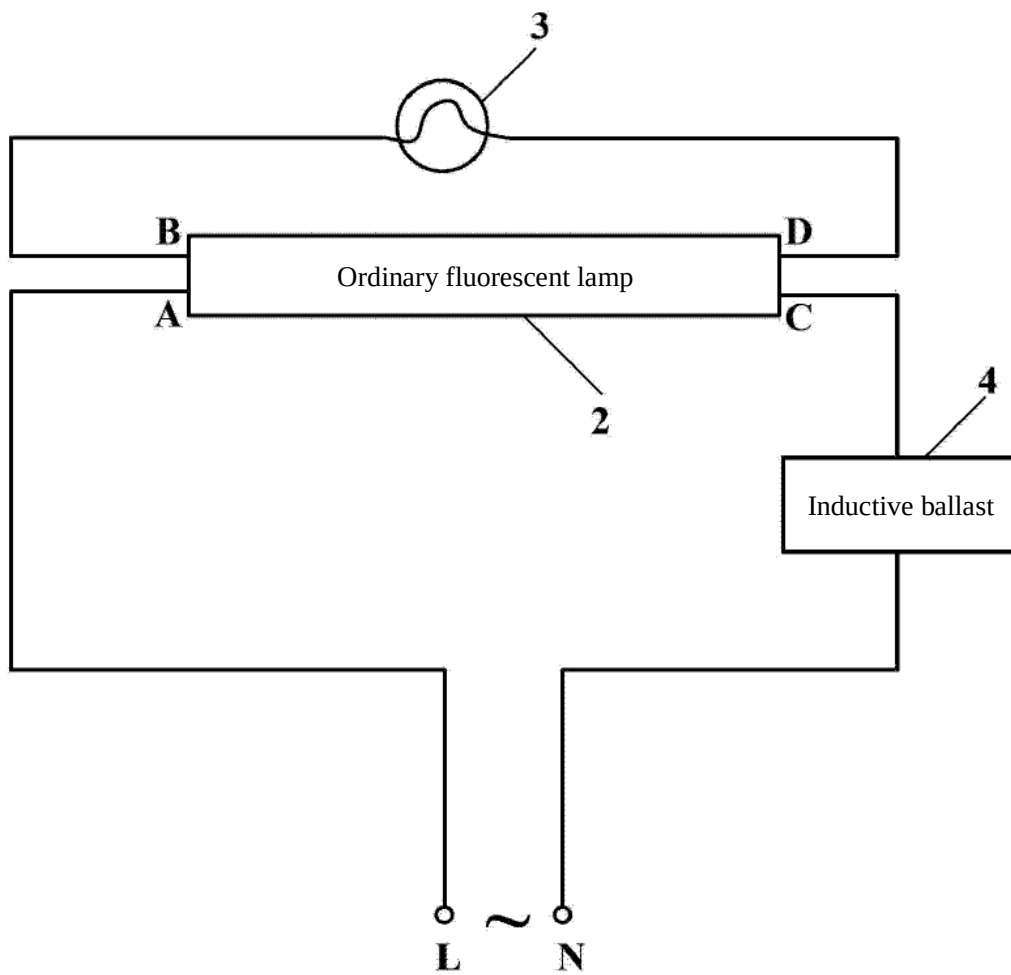


Fig. 2

**Fig. 3****Fig. 4A**

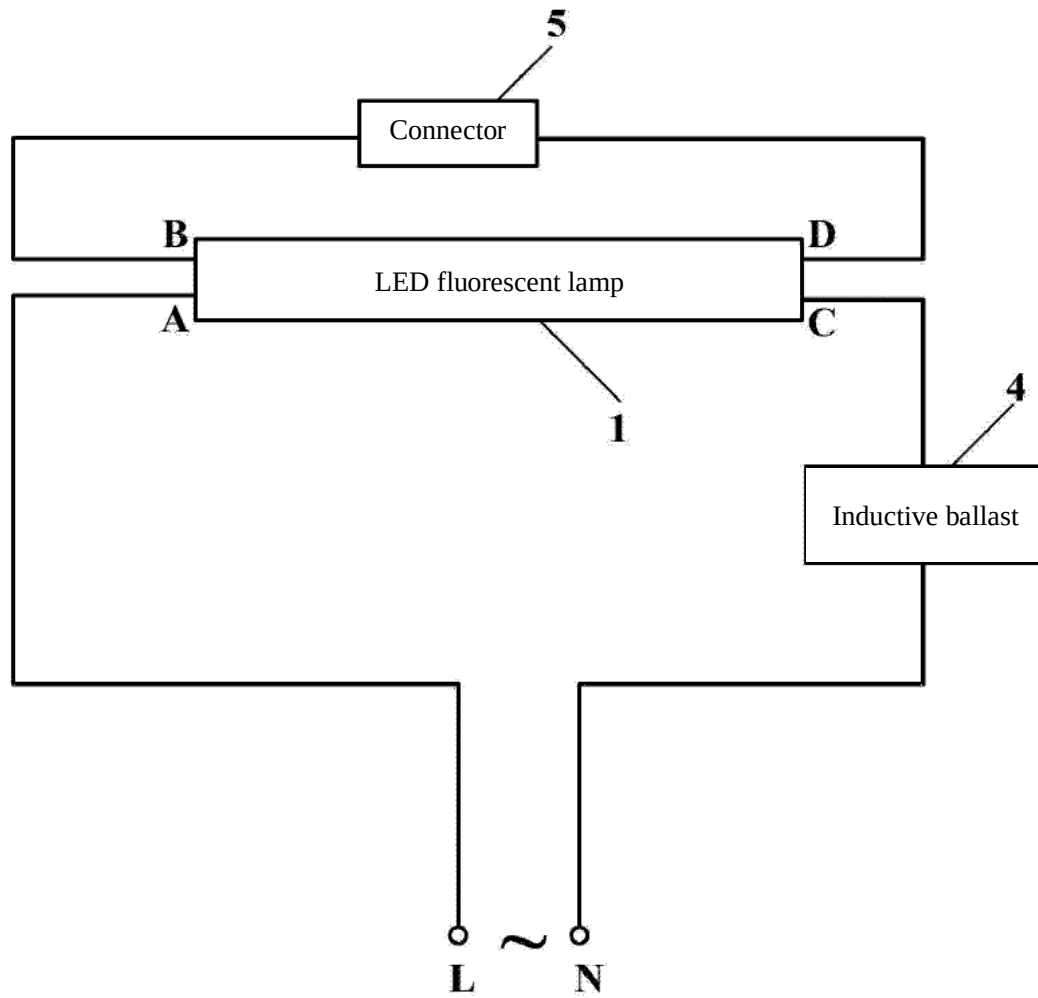


Fig. 4B

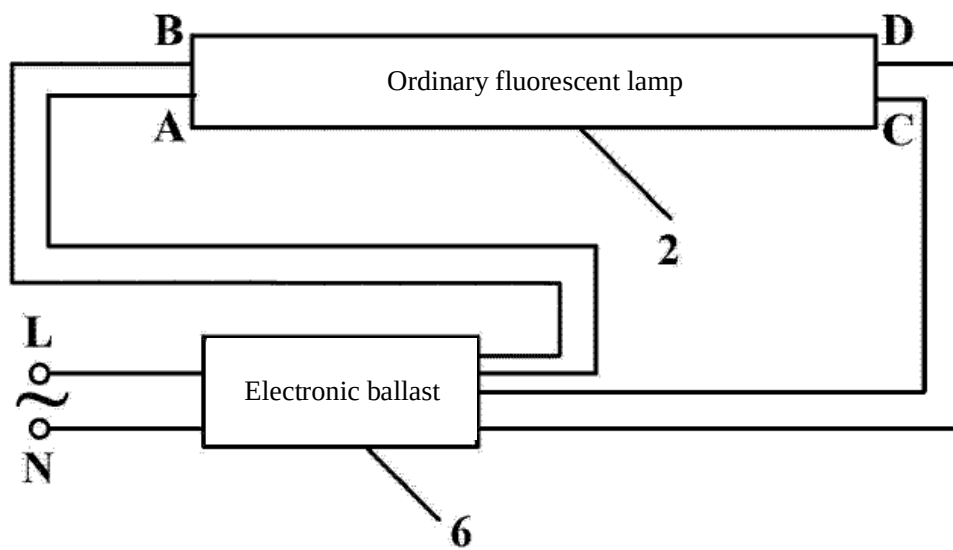


Fig. 5A

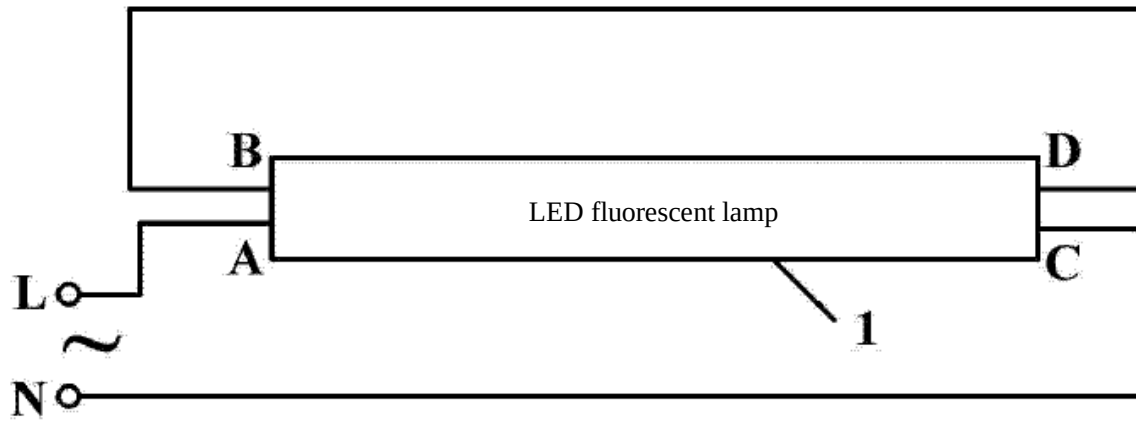


Fig. 5B

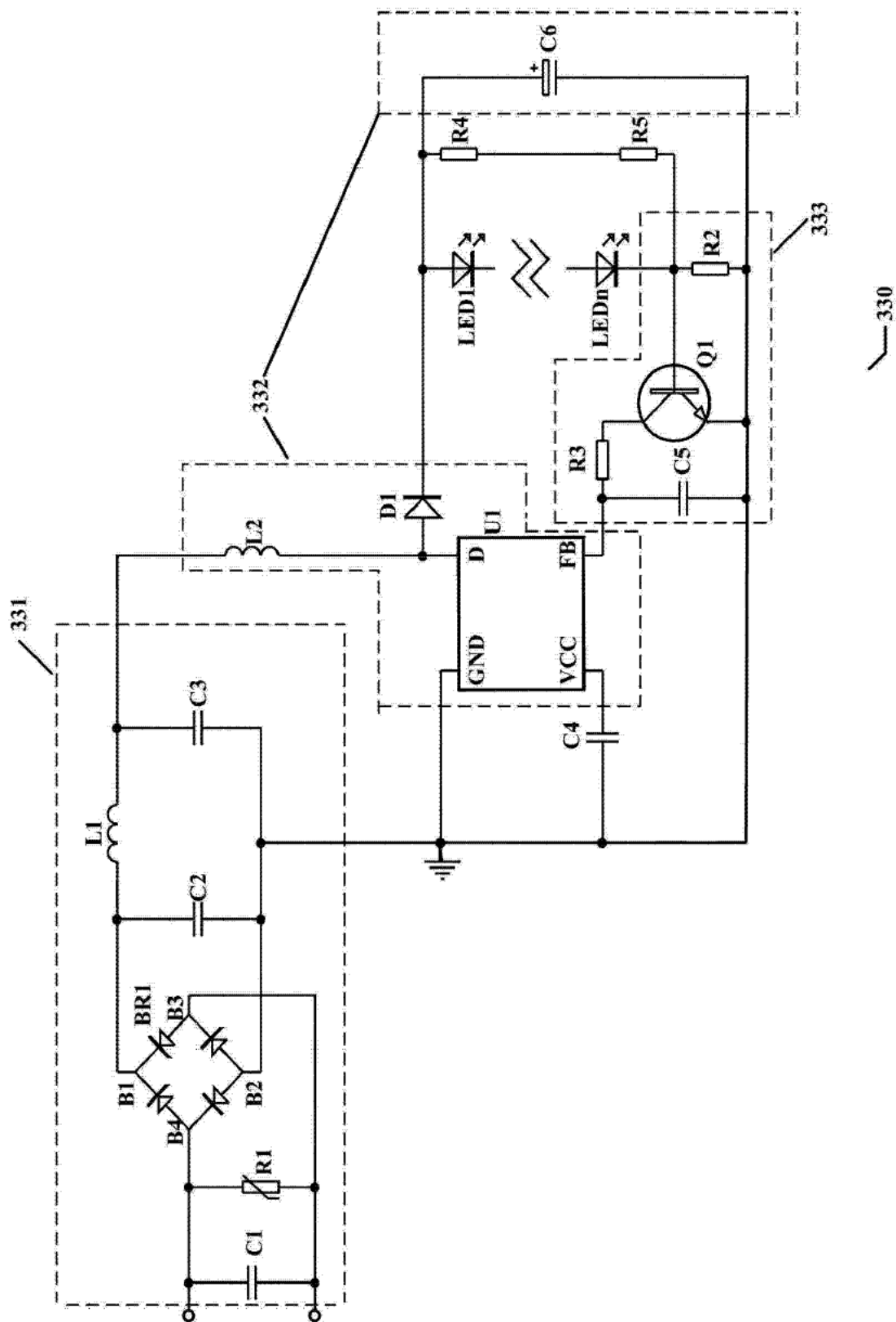


Fig. 6

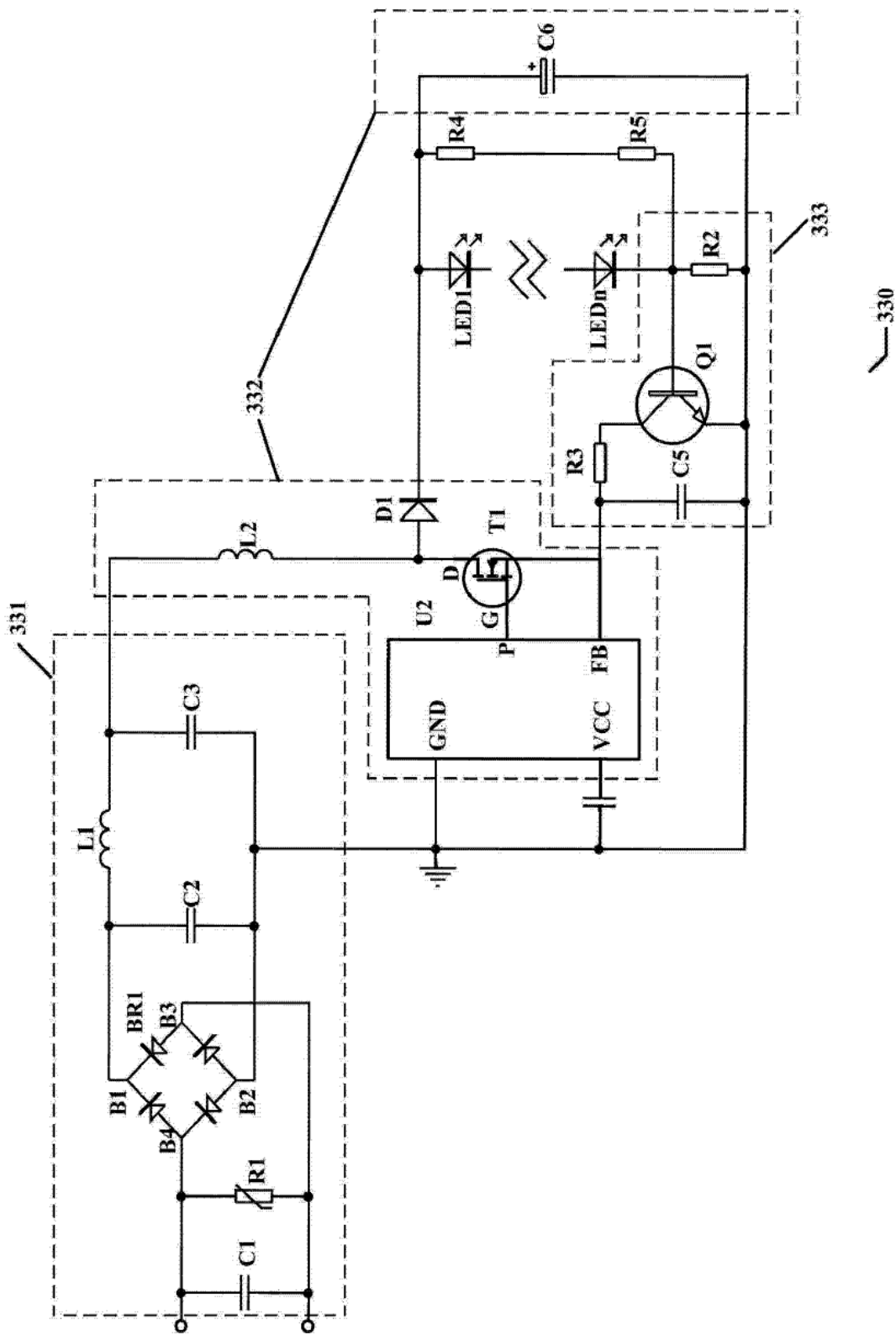


Fig. 7

TRANSLATOR CERTIFICATION

Date: November 8, 2022

To whom it may concern:

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Signature

Samuel Chong

Print



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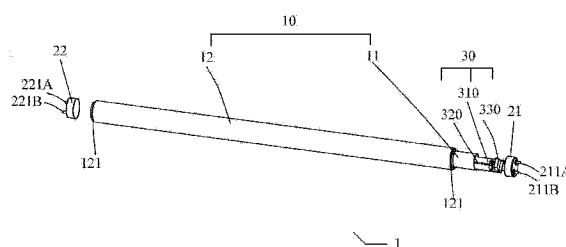
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(54) 发明名称

LED 日光灯及其安装方法

(57) 摘要

本发明涉及半导体照明技术,特别涉及 LED 日光灯以及该日光灯的安装方法。按照本发明实施例的 LED 日光灯包括:玻璃内管;套在所述玻璃内管外的玻璃外管;封闭所述玻璃内管两端的端盖,其上设置有适配日光灯座的插脚;LED 驱动电源,包括:固定在所述玻璃内管内部的条状基板;多个设置在所述条状基板上的 LED 单元;驱动电路模块,其被布置在所述条状基板的一端或两端并且与所述 LED 单元和所述插脚电气连接。



1. 一种 LED 日光灯,其特征在于,包括:
玻璃内管;
套在所述玻璃内管外的玻璃外管;
封闭所述玻璃内管两端的端盖,其上设置有适配日光灯座的插脚;
LED 驱动电源,包括:
固定在所述玻璃内管内部的条状基板;
多个设置在所述条状基板上的 LED 单元;
驱动电路模块,其被布置在所述条状基板的一端或两端并且与所述 LED 单元和所述插脚电气连接。
2. 如权利要求 1 所述的 LED 日光灯,其中,所述玻璃外管端部的外表面向内收缩。
3. 如权利要求 1 所述的 LED 日光灯,其中,所述玻璃内管的内表面和 / 或外表面为经过磨砂处理的表面。
4. 如权利要求 1 所述的 LED 日光灯,其中,所述玻璃外管的内表面覆盖光扩散粉。
5. 如权利要求 1 所述的 LED 日光灯,其中,所述 LED 单元以串联、并联或混联方式耦合。
6. 如权利要求 1 所述的 LED 日光灯,其中,所述驱动电路模块包括:
桥式整流滤波单元;
DC-DC 升压变换单元,包括电感器、开关二极管、PWM 控制器和 MOS 管,其中,所述电感器和开关二极管串联在所述桥式整流滤波单元与 LED 负载之间,所述 MOS 管的漏极电气连接在所述电感器与开关二极管的正极之间,栅极与所述 PWM 控制器的输出端电气连接;以及
反馈单元,包括晶体三极管,其基极电气连接至所述 LED 单元的回路,集电极电气连接至所述 PWM 控制器的控制端。
7. 如权利要求 1 所述的 LED 日光灯,其中,所述驱动电路模块还包括设置在所述条状基板的第一端的一对电极引脚,其经所述插脚分别与外部交流电源的火线和零线电气连接。
8. 如权利要求 7 所述的 LED 日光灯,其中,所述驱动电路模块还包括一对直接相连的引脚,其设置在与所述第一端相对的第二端。
9. 一种如权利要求 8 所述 LED 日光灯的安装方法,灯座包含第一对插口和第二对插口,其特征在于,在所述第一对插口中的其中一个插口与所述第二对插口中的其中一个插口之间电气连接有连接器,所述第一对插口中的另一个插口电气连接至外部交流电源的火线,并且所述第二对插口中的另一个插口经电感镇流器电气连接至外部交流电源的零线。
10. 如权利要求 9 所述的安装方法,其中,所述连接器是可移除的并且包括与所述电感镇流器上的启辉器插座相匹配的接口端子。

LED 日光灯及其安装方法

技术领域

[0001] 本发明涉及半导体照明技术,特别涉及 LED 日光灯以及该日光灯的安装方法。

背景技术

[0002] 目前在照明装置中用作光源的发光二极管(LED)是一种固态的半导体器件,它的基本结构一般包括带引线的支架、设置在支架上的半导体晶片以及将该晶片四周密封起来的封装材料(例如硅胶或环氧树脂)。上述半导体晶片包含有 P-N 结构,当电流通过时,电子被推向 P 区,在 P 区里电子跟空穴复合,然后以光子的形式发出能量,而光的波长则是由形成 P-N 结构的材料决定的。

[0003] 与传统日光灯相比,LED 日光灯具有光电转换效率高、光源亮度恒定、无频闪和不含有害重金属等诸多优点。典型的 LED 日光灯管由灯管管体、端盖、灯板和驱动电源组成,其中驱动电源可以内置于管体或者安装在管体外部。

[0004] 中国实用新型专利 200920134372.8 公开了一种将 LED 电源外置的日光灯,其包括 LED 日光灯体,该灯体上连接有外置的 LED 电源,该 LED 电源包括 PCB 电路板、输入和输出端子、电源盒,PCB 电路板内置于电源盒中,输入端子通过 PCB 电路板、输出端子与 LED 日光灯体连接。采用外置电源需要对日光灯的接线方式作较大的改动,而且安装也不方便。

[0005] 中国发明专利申请 201110037855.9 公开了一种 LED 日光灯,其包括灯管和安装在灯管两端的端盖,其中灯管包括灯板、阵列在灯板上的多颗 LED 以及位于 LED 上方的出光罩壳,端盖内安装有向 LED 提供恒定电流的降压恒流源模块,灯板的正负极导电端被连接至降压恒流源模块的输出端。对于上述日光灯,在灯板安装过程中,灯板边缘容易与灯管内壁碰擦,从而刮掉涂覆在内壁上的光扩散粉。此外,上述 LED 日光灯在设计上完全摒弃了原有日光灯座的束缚,虽然这有利于优化日光灯结构和电路设计,但是与已有日光灯座的兼容性不佳。

发明内容

[0006] 本发明的一个目的是提供一种 LED 日光灯,其具有结构紧凑和制造工艺简单等优点。

[0007] 按照本发明一个实施例的 LED 日光灯包括:

[0008] 玻璃内管;

[0009] 套在所述玻璃内管外的玻璃外管;

[0010] 封闭所述玻璃内管两端的端盖,其上设置有适配日光灯座的插脚;

[0011] LED 驱动电源,包括:

[0012] 固定在所述玻璃内管内部的条状基板;

[0013] 多个设置在所述条状基板上的 LED 单元;

[0014] 驱动电路模块,其被布置在所述条状基板的一端或两端并且与所述 LED 单元和所述插脚电气连接。

[0015] 在上述实施例中,通过将基板设置在玻璃内管内,可以保护玻璃外管内表面上的光扩散粉不被刮擦掉。此外,LED 单元与驱动电路模块被集成在同一块基板上减小了光电单元的体积,这有利于 LED 日光灯总体结构的优化。

[0016] 优选地,在上述 LED 日光灯中,所述玻璃外管端部向内收缩。更好地,在上述 LED 日光灯中,所述玻璃外管端部的外表面向内收缩以形成台阶,并且所述端盖覆盖住所述台阶。经过收缩处理之后,玻璃管的应力得到有效释放,因此提高了管体强度。

[0017] 优选地,在上述 LED 日光灯中,所述玻璃内管的内表面和 / 或外表面为经过磨砂处理的表面。

[0018] 优选地,在上述 LED 日光灯中,所述玻璃外管的内表面覆盖光扩散粉。

[0019] 优选地,在上述 LED 日光灯中,所述玻璃外管的内表面和 / 或外表面为经过磨砂处理的表面。

[0020] 优选地,在上述 LED 日光灯中,所述条状基板被粘合在所述玻璃内管的两端。

[0021] 优选地,在上述 LED 日光灯中,所述条状基板为铝基板或双面印刷电路板。

[0022] 优选地,在上述 LED 日光灯中,所述 LED 单元以串联、并联或混联方式耦合。

[0023] 优选地,在上述 LED 日光灯中,所述驱动电路模块包括:

[0024] 桥式整流滤波单元;

[0025] DC-DC 升压变换单元,包括电感器、开关二极管、PWM 控制器和 MOS 管,其中,所述电感器和开关二极管串联在所述桥式整流滤波单元与串联耦合的 LED 单元之间,所述 MOS 管的漏极电气连接在所述电感器与开关二极管的正极之间,栅极与所述 PWM 控制器的输出端电气连接;以及

[0026] 反馈单元,包括晶体三极管,其基极电气连接至所述串联耦合的 LED 单元的回路,集电极电气连接至所述 PWM 控制器的控制端。

[0027] 在上述实施例中,通过晶体三极管向 PWM 控制器提供反馈信号,同时实现了恒流和恒压的功能。此外,在上述结构的驱动电路模块中,元器件数量较少并且可以实现小型化,因此使得将 LED 单元与驱动电路模块集成在同一块基板上成为可能。

[0028] 优选地,在上述实施例中,所述驱动电路模块还包含电气连接在所述 PWM 控制器的控制端与接地之间的电容器。通过选择大容量电容器,可以使反馈回路响应变缓,从而达到功率因子校正的目的。

[0029] 优选地,在上述实施例中,所述 PWM 控制器和 MOS 管被集成在同一集成电路芯片中。或者,优选地,所述 PWM 控制器、MOS 管和晶体三极管被集成在同一集成电路芯片中。上述多个半导体器件的集成化提高了可靠性,并有助于驱动电路模块的小型化。

[0030] 优选地,在上述 LED 日光灯中,所述驱动电路模块还包括设置在所述条状基板的第一端的一对引脚,其经所述插脚分别与外部交流电源的火线和零线电气连接。

[0031] 优选地,在上述 LED 日光灯中,所述驱动电路模块还包括一对直接相连的引脚,其设置在与所述第一端相对的第二端。

[0032] 本发明的还有一个目的是提供一种安装上述 LED 日光灯的方法,其具有安装简便的优点。

[0033] 在上述 LED 日光灯的安装方法中,灯座包含第一对插口和第二对插口,其中,在所述第一对插口中的其中一个插口与所述第二对插口中的其中一个插口之间电气连接有连

接器,所述第一对插口中的另一个插口电气连接至外部交流电源的火线,并且所述第二对插口中的另一个插口经电感镇流器电气连接至外部交流电源的零线。

[0034] 优选地,所述连接器是可移除的并且包括与所述电感镇流器上的启辉器插座相匹配的接口端子。

附图说明

[0035] 本发明的上述和 / 或其它方面和优点将通过以下结合附图的各个方面的描述变得更加清晰和更容易理解,附图中相同或相似的单元采用相同的标号表示。

[0036] 图 1 为按照本发明一个实施例的 LED 日光灯的分解示意图。

[0037] 图 2 为可用于图 1 所示 LED 日光灯的 LED 驱动电源的示意图。

[0038] 图 3 为图 1 所示 LED 日光灯的局部示意图。

[0039] 图 4A 为采用电感镇流器的普通日光灯的接线图,图 4B 为图 1 所示实施例的 LED 日光灯替代图 4A 所示普通日光灯时的接线图。

[0040] 图 5A 为采用电子镇流器的普通日光灯的接线图,图 5B 为图 1 所示实施例的 LED 日光灯替代图 5A 所示普通日光灯时的接线图。

[0041] 图 6 为图 2 所示 LED 驱动电源中所包含的一种驱动电路模块的电路原理图。

[0042] 图 7 为图 2 所示 LED 驱动电源中所包含的另一种驱动电路模块的电路原理图。

[0043] 附图标号列表:

[0044] 1LED 日光灯

[0045] 10 管体

[0046] 11 内管

[0047] 12 外管

[0048] 21、22 端盖

[0049] 211A、211B、212A、212B 插脚

[0050] 30LED 驱动电源

[0051] 310 基板

[0052] 320 发光二极管(LED)单元

[0053] 330 驱动电源模块

[0054] 331 桥式整流滤波单元

[0055] 332DC-DC 升压变换单元

[0056] 333 反馈单元

[0057] BR1 全桥整流器

[0058] C1、C2、C3、C4、C5、C6 电容器

[0059] D1 开关二极管

[0060] L1、L2 电感器

[0061] LED1-LEDn LED 负载

[0062] Q1 晶体三极管

[0063] R1、R2、R3、R4、R5 电阻器

[0064] T1 MOS 管

- [0065] U1 开关调整器
- [0066] U2 PWM 控制器
- [0067] 340A、340B、350A、350B 引脚
- [0068] 40 粘合剂
- [0069] 2 普通日光灯
- [0070] 3 启辉器
- [0071] 4 电感镇流器
- [0072] 5 连接器
- [0073] 6 电子镇流器

具体实施方式

[0074] 下面参照其中图示了本发明示意性实施例的附图更为全面地说明本发明。但本发明可以按不同形式来实现,而不应解读为仅限于本文给出的各实施例。给出的上述各实施例旨在使本文的披露全面完整,更为全面地传达给本领域技术人员本发明的保护范围。

[0075] 在本说明书中,除非特别说明,术语“半导体晶圆”指的是在半导体材料(例如硅、砷化镓等)上形成的多个独立的单个电路,“半导体晶片”或“晶片(die)”指的是这种单个电路,而“封装芯片”指的是半导体晶片经过封装后的物理结构,在典型的这种物理结构中,半导体晶片例如被安装在支架上并且用密封材料封装。

[0076] 术语“发光二极管单元”指的是包含电致发光材料的单元,这种单元的例子包括但不限于 P-N 结无机半导体发光二极管和有机发光二极管(OLED 和聚合物发光二极管(PLED))。

[0077] P-N 结无机半导体发光二极管可以具有不同的结构形式,例如包括但不限于发光二极管管芯和发光二极管单体。其中,“发光二极管管芯”指的是包含有 P-N 结构的、具有电致发光能力的半导体晶片,而“发光二极管单体”指的是将管芯封装后形成的物理结构,在典型的这种物理结构中,管芯例如被安装在支架上并且用密封材料封装。

[0078] 术语“布线”、“布线图案”和“布线层”指的是在绝缘表面上布置的用于元器件间电气连接的导电图案,包括但不限于走线(trace)和孔(如焊盘、元件孔、紧固孔和金属化孔等)。

[0079] 术语“热辐射”指的是物体由于具有温度而辐射电磁波的现象。

[0080] 术语“热传导”指的是热量在固体中从温度较高的部分传送到温度较低的部分的传递方式。

[0081] “电气连接”和“耦合”应当理解为包括在两个单元之间直接传送电能量或电信号的情形,或者经过一个或多个第三单元间接传送电能量或电信号的情形。

[0082] “驱动电源”或“LED 驱动电源”指的是连接在照明装置外部的交流(AC)或直流(DC)电源与作为光源的发光二极管之间的“电子控制装置”,用于为发光二极管提供所需的电流或电压(例如恒定电流、恒定电压或恒定功率等)。在具体的实施方案中,驱动电源可以模块化的结构实现,例如其包含印刷电路板和一個或多个安装在印刷电路板上并通过布线电气连接在一起的元器件,这些元器件的例子包括但不限于 LED 驱动控制器芯片、整流芯片、电阻器、电容器和电感器或线圈等。

[0083] 诸如“包含”和“包括”之类的用语表示除了具有在说明书和权利要求书中有直接和明确表述的单元和步骤以外,本发明的技术方案也不排除具有未被直接或明确表述的其它单元和步骤的情形。

[0084] 诸如“第一”、“第二”、“第三”和“第四”之类的用语并不表示单元在时间、空间、大小等方面的顺序而仅仅是作区分各单元之用。

[0085] 诸如“物体 A 设置在物体 B 的表面”之类的用语应该广义地理解为将物体 A 直接放置在物体 B 的表面,或者将物体 A 放置在与物体 B 有接触的其它物体的表面。

[0086] 以下借助附图描述本发明的实施例。

[0087] 图 1 为按照本发明一个实施例的 LED 日光灯的分解示意图。

[0088] 图 1 所示的 LED 日光灯 1 包括管体 10、位于管体 10 两端的一对端盖 21、22 以及位于管体 10 内的 LED 驱动电源 30。

[0089] 如图 1 所示,管体 10 包括内管 11 和套在内管 11 外的外管 12,它们可由玻璃材料制成。需要理解的是,外管 12 套在内管 11 外的布置应该宽泛地理解为至少包含下列情形:内管 11 的外表面与外管 12 的内表面完全接触;以及内管 11 与外管 12 之间至少有一部分存在间隙。

[0090] 为了避免眩光效应,可以对内管 11 的内表面和外表面中的至少一个表面作磨砂处理(例如使用酸溶液使内管表面粗糙化)。可选地,也可以考虑在外管 12 的内表面涂覆光扩散粉或对外管内外表面中的至少一个作磨砂处理。在本实施例中,由于 LED 驱动电源 30 的印刷电路板被设置在内管 11 内,所以在装配过程中能够避免电路板挂擦掉外管 12 内表面上的光扩散粉。

[0091] 继续参见图 1,外管 12 在其端部 121 处向内收缩,使得外管端部处的外径小于其余部分的外径。在使外管端部向内收缩的过程中,外管管壁的应力得到有效释放,由此提高了强度,从而有利于减少运输和装配过程中的损耗。需要指出的是,收缩的目的旨在释放应力,因此外管 12 的内径并不一定需要缩小。在本实施例中,内管 11 比外管 12 的长度略短,使得在装配完成之后的 LED 日光灯中,内管 11 完全位于外管 12 内部。但是为了在图 1 中将内管 11 也表示出来,这里的内管 11 的右端部延伸到了外管 21 的外部。可选地,内管 11 的长度也可长于外管 12,因此在装配完成之后内管 11 的两端延伸出外管 12。

[0092] 在端盖 21 和 22 的每一个上设置有与普通日光灯灯座适配的插脚,即图 1 中位于端盖 21 外表面上的一对插脚 211A、211B 和位于端盖 22 外表面上的另一对插脚 221A、221B。插脚一方面提供了 LED 驱动电源 30 与外部电源之间的电气连接,另一方面使 LED 日光灯能固定于灯座。应该理解的是,图 1 所示的是分解状态下的示意图,当 LED 日光灯 1 完成装配时,端盖 21 和 22 将分别封闭内管 11 的两端。在本实施例中,可以借助粘合剂(例如灯泥)将端盖 21 和 22 的内表面与外管 12 的外表面粘合在一起,从而实现端盖的固定。

[0093] 在本实施例中,LED 驱动电源 30 可采用下面借助图 2-5 所述的结构和形式,其中作为光源的 LED 单元与驱动电源模块被集成在同一基板上。

[0094] 图 2 为可用于图 1 所示 LED 日光灯的 LED 驱动电源的示意图。

[0095] 图 2 所示的 LED 驱动电源 30 包括基板 310、多个发光二极管(LED)单元 320 和驱动电源模块 330。以下对各个组成单元作进一步的描述。

[0096] 基板 310 如图 2 所示呈条状,其可以采用由模具压制法制作的陶瓷基板,这种方法

制造的板材较厚(例如 1.5-3mm)并且硬度高。可选地,基板 310 也可以采用导热绝缘高分子复合材料制作。此外,为了提高散热能力,可以在基板表面覆盖红外辐射材料,或者采用兼具优良的绝缘导热性能和红外辐射性能的材料制作基板,从而使得来自 LED 单元和驱动电源模块的热量同时以热传导和热辐射的方式散发。需要指出的是,除了上述陶瓷、导热绝缘高分子复合材料和红外辐射材料以外,基板 310 也可以是铝基板或玻璃纤维板。另外,LED 电源的元器件可以布置在基板 310 的一个表面,也可以布置在其两个表面上。

[0097] LED 电源 30 的基板 310 被固定于内管 11 的内部,为此例如可以借助硅胶之类的粘合剂将基板 310 固定于内管 11 端部的内表面。

[0098] 继续参见图 2,多个 LED 单元 320 沿着基板 310 纵向排列以形成均匀的发光带。虽然图中所示的 LED 单元以直列的形式排布在基板上,但是排布方式并不局限于此,例如 LED 单元还可以以多列或 S 形的方式排布。LED 单元 320 可以采用封装芯片或管芯的形式,其例如通过表面贴装工艺被安装在基板 310 上。另外,也可以采用表面贴装工艺将下面将要详细描述驱动电源模块 330 的元器件安装在基板 310 上。

[0099] 在图 2 所示的 LED 驱动电源中,多个 LED 单元 320 被串联耦合在一起,驱动电路模块 330 例如通过基板 310 上的布线与 LED 单元 320 电气连接,从而向后者提供恒定的电流和 / 或电压。值得指出的是,虽然这里的多个 LED 单元以串联方式耦合在一起,但是它们也可以并联、混联或交叉阵列的形式耦合在一起。

[0100] 如图 2 所示,驱动电路模块 330 的元器件被排布在基板 310 的两端。此外,在基板 310 的其中一端设置有引脚 340A 和 340B,分别作为 LED 驱动电路模块 330 的第一电极和第二电极(因此以下将引脚 340A 和 340B 又称为“电极引脚”)。在完成装配之后,电极引脚 340A 和 340B 分别与端盖 21 上的插脚 211A 和 211B 电气连接。在工作时,引脚 340A 和 340B 中的其中一个经端盖 21 上相应的插脚与外部交流电源(例如市电)的火线电气连接,而另一个引脚经端盖 21 上的插脚与外部交流电源的零线电气连接,从而使外部交流电源向驱动电路模块 330 供电。在图 2 所示的实施例中,电极引脚 340A 和 340B 被焊接在基板 310 上。为了加固电极引脚,可以使电极引脚穿过基板 310 并焊接在基板 310 的另一面上。

[0101] 可选地,如图 3 所示,在基板 310 的另一端设置一对分别与端盖 22 上的插脚 221A 和 221B 电气连接的引脚 350A 和 350B,这两个引脚穿过基板 310 之后连接在一起,从而被牢固地固定在基板 310 上。优选地,引脚 350A 和 350B 可以是一体化的部件。此外,基板 310 的端部借助粘合剂 40 被固定于内管 11 的内表面。

[0102] 从下面的描述中将会认识到,在与设置电极引脚 340A 和 340B 的一端相对的另一端上设置一对直接相连的引脚 350A 和 350B 可以大大方便 LED 日光灯的安装。

[0103] 图 4A 为采用电感镇流器的普通日光灯的接线图,图 4B 为图 1 所示实施例的 LED 日光灯替代图 4A 所示普通日光灯时的接线图。

[0104] 在普通的日光灯照明线路中,灯座一般包含两对插口,日光灯两对插脚分别插入两对插口中。如图 4A 所示,在分属不同对插口的插口 B、D 之间连接启辉器 3,插口 A 电气连接至外部电源的火线 L,而插口 C 经电感镇流器 4 电气连接至外部电源的零线 N,安装完成后,普通日光灯 2 的两对插脚分别与插口 A、B 和插口 C 和 D 电气连接。与图 4A 相比,在图 4B 所示接线方式下,启辉器 3 被连接器 5 替代。优选地,该连接器 5 是可移除的并且采用类似启辉器的形式,即,其包括与电感镇流器上的启辉器插座相匹配的接口端子。

[0105] 虽然在上述借助图 1-3 所述的实施例中, LED 驱动电源的电极引脚 340A 和 340B 被直接连接到同一端盖的两个插脚上,但是在将 LED 日光灯 1 安装到灯座上时,对电极引脚的位置并无特别的要求。也就是说,连接电极引脚的插脚无论是位于图 4B 所示接线图中的火线侧(即与插口 A 和 B 电气连接)还是零线侧(即与插口 C 和 D 电气连接),外部电源都能向 LED 日光灯 1 正常供电。具体而言,例如当电极引脚 340A 和 340B 分别与插口 A 和 B 电气连接而引脚 350A 和 350B 分别与插口 C 和 D 电气连接时,电极引脚 340A 与火线 L 电气连接,与此同时,由于位于基板 310 另一端的引脚 350A 和 350B 被短接在一起,所以电极引脚 340B 能够经连接器 5、引脚 350A 和 350B 以及电感镇流器 4 电气连接至零线 N,由此实现了外部电源向 LED 驱动电源的供电。另一方面,当电极引脚 340A 和 340B 分别与插口 C 和 D 电气连接而引脚 350A 和 350B 分别与插口 A 和 B 电气连接时,电极引脚 340A 能够经电感镇流器 4 电气连接至零线 N,与此同时,由于位于基板 310 另一端的引脚 350A 和 350B 被短接在一起,所以电极引脚 340B 能够经连接器 5、引脚 350A 和 350B 与火线 L 电气连接,从而同样实现了外部电源向 LED 驱动电源的供电。

[0106] 图 5A 为采用电子镇流器的普通日光灯的接线图,图 5B 为图 1 所示实施例的 LED 日光灯替代图 5A 所示普通日光灯时的接线图。

[0107] 如图 5A 所示,外部交流电源的火线 L 和零线 N 电气连接至电子镇流器 6,灯座的插口 A、B、C 和 D 则与电子镇流器 6 的输出端子电气连接。安装完成后,普通日光灯 2 的两对插脚分别与插口 A、B 和插口 C 和 D 电气连接。与图 5A 相比,在图 5B 所示接线方式下,电子镇流器 6 被去除,插口 B 与 D 之间直接相连,而另一对插口 C 和 D 分别电气连接至外部交流电源的火线 L 和零线 N。同样,在图 5B 中,连接电极引脚的插脚无论是位于火线侧(即与插口 A 和 B 电气连接)还是零线侧(即与插口 C 和 D 电气连接),外部交流电源都能向 LED 日光灯 1 正常供电。例如如果电极引脚 340A 和 340B 分别与插口 A 和 B 电气连接而引脚 350A 和 350B 分别与插口 C 和 D 电气连接,则电极引脚 340A 与火线 L 电气连接,与此同时,电极引脚 340B 经引脚 350A 和 350B 电气连接至零线 N,由此实现了外部电源向 LED 驱动电源的供电。另一方面,如果电极引脚 340A 和 340B 分别与插口 C 和 D 电气连接而引脚 350A 和 350B 分别与插口 A 和 B 电气连接,则电极引脚 340A 电气连接至零线 N,而电极引脚 340B 能够经引脚 350A 和 350B 与火线 L 电气连接,从而同样实现了外部电源向 LED 驱动电源的供电。

[0108] 需要指出的是,虽然驱动电路模块 330 的元器件如图 2 所示被设置在基板 310 的两端,但是将这些元器件仅设置在一端也是可行的。还需要指出的是,作为 LED 驱动电源电极的引脚 340A 和 340B 也可以设置在基板 310 的两端,在这种设置布局下,引脚 340A 和 330B 分别经不同端盖上的插脚与外部交流电源的火线和零线电气连接。

[0109] 驱动电源模块 330 可采用各种拓扑架构的电路,例如包括但不限于非隔离降压型拓扑电路结构、反激式拓扑电路结构和半桥 LLC 拓扑电路结构等。有关驱动电源模块的详细描述可参见人民邮电出版社 2011 年 5 月第 1 版的《LED 照明驱动电源与灯具设计》一书,该出版物以全文引用方式包含在本说明书中。

[0110] 驱动电源模块 330 可以多种驱动方式(例如恒压供电、恒流供电和恒压恒流供电等方式)向 LED 单元提供合适的电流或电压,其可以由一个或多个独立的部件组成。在图 2 所示的 LED 驱动电源中,驱动电源模块的一个或多个部件以晶片或封装芯片的形式实现。

[0111] 图 6 为图 2 所示 LED 驱动电源中所包含的一种驱动电路模块的电路原理图。

[0112] 图 6 所示的驱动电路模块 330 包括桥式整流滤波单元 331、DC-DC 升压变换单元 332 和反馈单元 333,以下对各个单元作进一步的描述。

[0113] 如图 4 所示,桥式整流滤波单元 331 包括全桥整流器 BR1、电容器 C1、C2、C3、压敏电阻器 R1 和电感器 L1。交流电(例如市电)经全桥整流器 BR1 整流后在正极端 1 上输出全波脉动电压。滤波电容器 C1、C2、C3、压敏电阻器 R1 和电感器 L1 构成 EMI 滤波电路,其一方面抑制交流电网中的高频干扰对驱动电路的影响,另一方面抑制驱动电路对交流电网的电磁干扰。

[0114] 值得指出的是,虽然这里示出的是全波整流方式,但是半波整流也是可用的。

[0115] 参见图 6,滤波电容器 C1 和压敏电阻器 R1 并联在全桥整流器 BR1 的交流输入端 B3 和 B4 之间,其中压敏电阻器 R1 通过抑制电路中出现的异常过电压而将全桥整流器 BR1 的输入电压钳制在预定的水平。滤波电容器 C2、C3 和电感器 L1 组成 π 型滤波回路并且电气连接在全桥整流器 BR1 的正极端 B1 与负极端 B2 之间,以对全桥整流器 BR1 输出的脉动电压进行低通滤波。

[0116] DC-DC 升压变换单元 332 与桥式整流滤波单元 331、反馈单元 333 和 LED 负载 LED1-LEDn (也即图 2 所示 LED 驱动电源中的串联耦合在一起的多个 LED 单元 320) 电气连接,其将桥式整流滤波单元 331 输出的脉动电压提升至所需的电压和电流水平并提供给 LED 负载。此外,DC-DC 升压变换单元 332 还与反馈单元 333 协同工作,以使提供给 LED 负载的电流和电压保持恒定并实现功率因子校正功能。在典型的应用场合下,多个 LED 单元串联后的总电压被设计为超过电网输入的电压最高值,因此电压的提升是必需的。以波动范围为 $\pm 10\%$ 的 220V 交流电为例,其最高电压约为 342V,则 LED 串联电压将超过 342V。

[0117] 在图 6 所示的驱动电源模块中,DC-DC 升压变换单元 332 包括电感器 L2、开关二极管 D1、电容器 C6 和开关调整器 U1。

[0118] 优选地,可以采用集成有脉宽调制(PWM)控制器和金属氧化物半导体场效应管(以下又简称为 MOS 管)的集成电路芯片作为开关调整器 U1,其中 PWM 控制器的输出端与 MOS 管的栅极电气连接以实现 MOS 管导通和关断的控制。在具体的开关调整器芯片中,为了简化占空比的调节,可保持 MOS 管的开关频率为定值(例如大约 1MHz),而 MOS 管的关断时间是可调节的;或者可保持 MOS 管的关断时间为定值(例如大约 320ns),而 MOS 管的开关频率是可调节的。典型地,这类开关调整器芯片一般都配置与 MOS 管的漏极电气连接的漏极引脚、与 PWM 控制器的控制端电气连接的反馈引脚。上述开关调整器的例子包括但不限于中国普芯达电子有限公司生产的 CW12L30 和 CW12L40 芯片等。

[0119] 如图 6 所示,电感器 L2 和开关二极管 D1 被串联在桥式整流滤波单元 331 与 LED 负载之间,其中开关二极管 D1 的正极与电感器 L2 电气连接,负极与 LED 负载电气连接。优选地,可采用速度快、压降小的肖特基二极管作为开关二极管 D1。继续参见图 6,开关调整器 U1 的漏极引脚 D 电气连接在电感器 L2 与开关二极管 D1 的正极之间,并且反馈引脚 FB 与反馈单元 333 电气连接。此外,在图 6 所示的电路中,电容器 C6 与 LED 负载共接于开关二极管 D1 的负极以在开关二极管 D1 截止时向 LED 负载放电。

[0120] 参见图 6,开关调整器 U1 包括电源引脚 VCC 和接地引脚 GND,其中电源引脚 VCC 经电容器 C4 接地。

[0121] 反馈单元 333 包括晶体三极管 Q1、电阻器 R2、R3 和电容器 C5。如图 6 所示,晶体

三极管 Q1 采用共射极放大电路的连接形式,其中,集电极经电阻器 R3 电气连接至开关调整器 U1 的反馈引脚以将反馈信号提供至开关调整器 U1,其射极与接地电气连接以作为输入回路和输出回路的共同接地端,并且基极接入 LED 负载的回路以提取检测信号。电阻器 R2 电气连接在基极与接地之间以构成输入回路。另外,开关调整器 U1 的反馈引脚 FB 还经电容器 C5 接地。

[0122] 以下描述图 6 所示驱动电路模块 330 的工作原理。

[0123] 当接通交流电源时,桥式整流滤波单元 331 将输入的交流电变换为脉动电压并输出至 DC-DC 升压变换单元 332 的电感器 L2。开关调整器 U1 内部的 MOS 管在 PWM 控制器信号的控制下以很高的频率导通和关断。

[0124] 当 MOS 导通时,在桥式整流滤波单元 331 的输出电压的作用下,电流流经电感器 L2 和 MOS 管,开关二极管 D1 因为电容器 C6 上的电压而截止。随着流经电感器 L2 的电流不断增大,电感器内存储的能量也不断增多。此时,LED 负载由电容器 C6 供电,其依靠电容器 C6 的放电电流工作。

[0125] 当 MOS 管切换至关断状态时,流经电感器 L2 的电流开始减小,从而在电感器 L2 的两端诱发感应电动势,其极性为上正右负。感应电动势与桥式整流滤波单元 331 的输出电压相叠加后提升了桥式整流滤波单元 331 的输出电压。此时,叠加的电压高于电容器 C6 上的电压,因此开关二极管 D1 进入导通状态,LED 负载改由电感器 L2 供电,并且电容器 C6 也由电感器 L2 充电并且直至 MOS 管再度切换至导通状态。在本实施例中,感应电动势的大小取决于 MOS 管的占空比,因此可以通过调节 PWM 控制器输出信号的占空比获得所希望的电压提升幅度。

[0126] 当 MOS 管再度被切换回导通状态时,开关二极管 D1 处的叠加电压开始减小并将再次低于电容器 C6 上的电压,因此开关二极管 D1 进入截止状态,LED 负载改由电容器 C6 以提升的电压供电,而电感器 L2 又开始存储电能。

[0127] 由上可见,在 PWM 控制器的控制下,MOS 管在上述导通和关断状态之间不断切换,从而使 LED 负载正极上的电压始终保持在较高的电压水平。

[0128] 参见图 6,LED 负载与电阻器 R4、R5 并联在开关二极管 D1 的负极与电阻器 R2 之间,并且 LED 负载的负极电气连接至晶体三极管 Q1 的基极。当流经 LED 负载的电流和 / 或电压发生波动时,流经晶体三极管 Q1 的基极的电流也会改变,经过晶体三极管 Q1 放大后的反馈信号从集电极经电阻器 R3 输出至开关调整器 U1 的反馈引脚,PWM 控制器由此可以根据反馈信号对输出信号的占空比进行调整,由此使提供给 LED 负载的电流和电压保持恒定。

[0129] 在图 6 所示的实施例中,开关调整器 U1 的反馈引脚 FB 还经大容量的电容器 C5 接地,这可以使反馈环路的响应变缓,反馈电平在交流线路半周期中接近于恒定。基本恒定的反馈电平表示在 MOS 管中的电流对应于在交流线路半周期内传送到 LED 负载上的平均能量。由于开关调整器 U1 在固定频率上工作,在 MOS 管导通时间结束之前,电流的增加不会超出一定的范围。通过在输入的交流电压增加时减少流经 MOS 管的开关电流,并且在输入的交流电压减少时增加流经 MOS 管的开关电流,使 LED 负载输入端的纹波最小化,并且交流输入电流能时刻跟踪交流输入电压的变化,从而实现功率因子校正的功能。

[0130] 需要指出的是,在图 6 所示的实施例中,PWM 控制器与 MOS 管被集成在同一集成电路芯片中,为了进一步提高集成度,还可以考虑将晶体三极管 Q1、PWM 控制器和 MOS 管三者

集成在同一集成电路芯片中。

[0131] 可选地,PWM控制器和MOS管也可以以分立的电路元件的形式被提供于按照图2所示实施例的LED驱动电源中。图7所示的驱动电路模块示出了这种形式的一个例子,其中与图6中相同或相似的单元采用相同的标号表示。

[0132] 图7所示的驱动电路模块330同样包括桥式整流滤波单元331、DC-DC升压变换单元332和反馈单元333。桥式整流滤波单元331和反馈单元333采用与图3所示相同的形式和结构,此处不再赘述。

[0133] 参见图7,DC-DC升压变换单元332包括电感器L2、开关二极管D1、电容器C6、PWM控制器U2和MOS管T1,其中,电感器L2和开关二极管D1被串联在桥式整流滤波单元331与LED负载之间,开关二极管D1的正极与电感器L2电气连接,负极与LED负载电气连接。在本实施例中,MOS管T1的漏极D电气连接在电感器L2与开关二极管D1的正极之间,源极S电气连接至接地,栅极G与PWM控制器U2的输出端P相连。PWM控制器U2一般以集成电路芯片的形式提供,其控制端FB与反馈单元333电气连接。如图4所示,电容器C6被电气连接在开关二极管D1的负极与LED负载之间以在开关二极管D1截止时向LED负载放电。

[0134] 反馈单元133同样包括晶体三极管Q1、电阻器R2、R3和电容器C5。晶体三极管Q1采用共射极放大电路的连接形式,其中,集电极经电阻器R3电气连接至PWM控制器U2的控制端FB以将反馈信号提供给PWM控制器U2,其射极与接地电气连接以作为输入回路和输出回路的共同接地端,并且基极接入LED负载的回路以提取检测信号。PWM控制器的控制端FB还经电容器C5接地。

[0135] 图7所示驱动电路模块的工作原理与图6所示的相似,因此此处不再赘述。

[0136] 可选地,在上述图6和7所示的驱动电源模块中还可以集成实现其它功能的电路,例如调光控制电路、传感电路、智能照明控制电路、通信电路和保护电路等。这些电路可以与驱动控制器集成在同一半导体晶片或封装芯片内,或者这些电路可以单独地以半导体晶片或封装芯片的形式提供,或者这些电路中的一些或全部可以组合在一起并以半导体晶片或封装芯片的形式提供。

[0137] 虽然已经展现和讨论了本发明的一些方面,但是本领域内的技术人员应该意识到:可以在不背离本发明原理和精神的条件下对上述方面进行改变,因此本发明的范围将由权利要求以及等同的内容所限定。

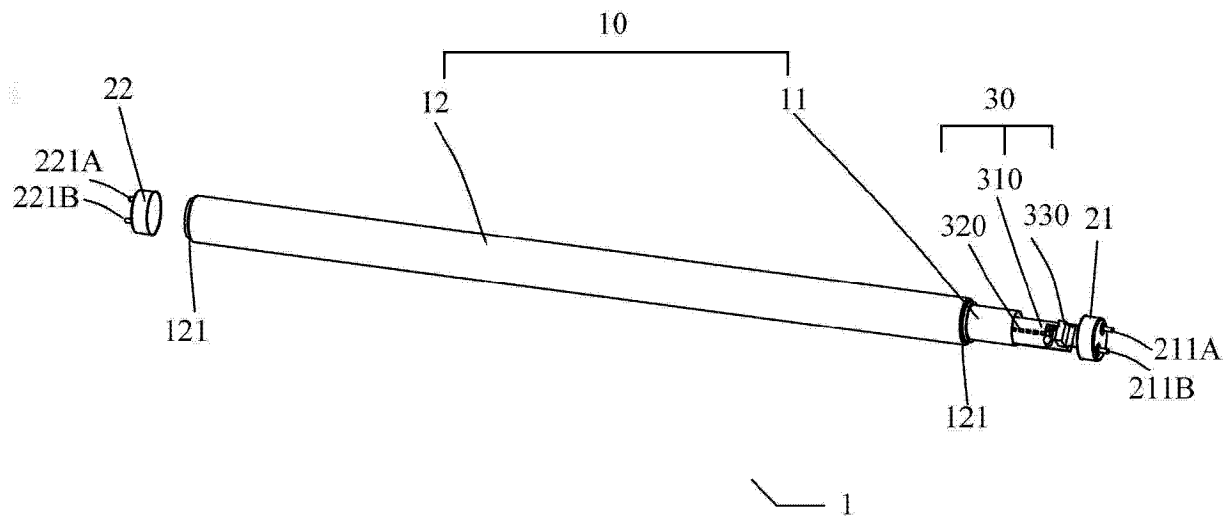


图 1

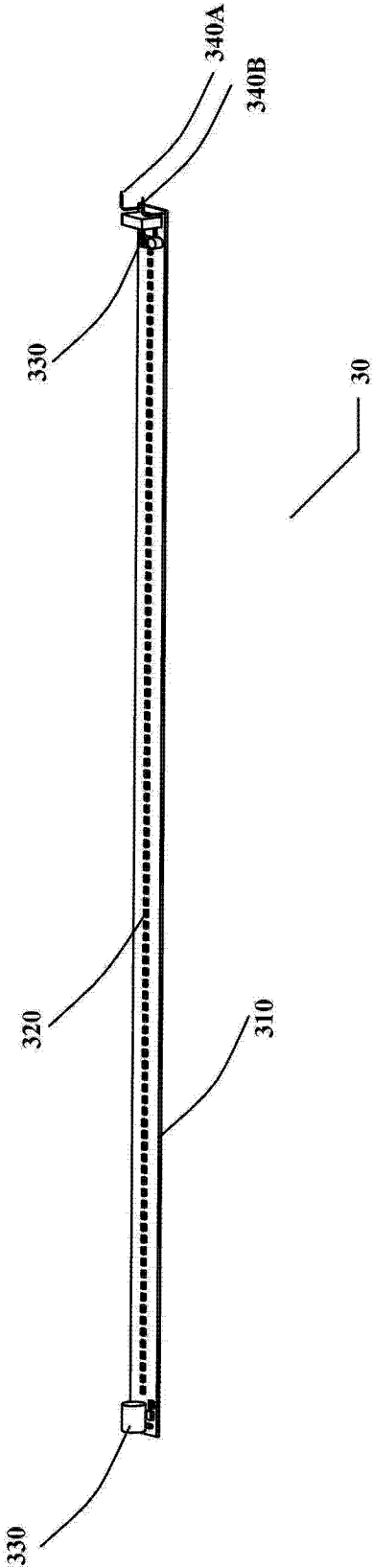


图 2

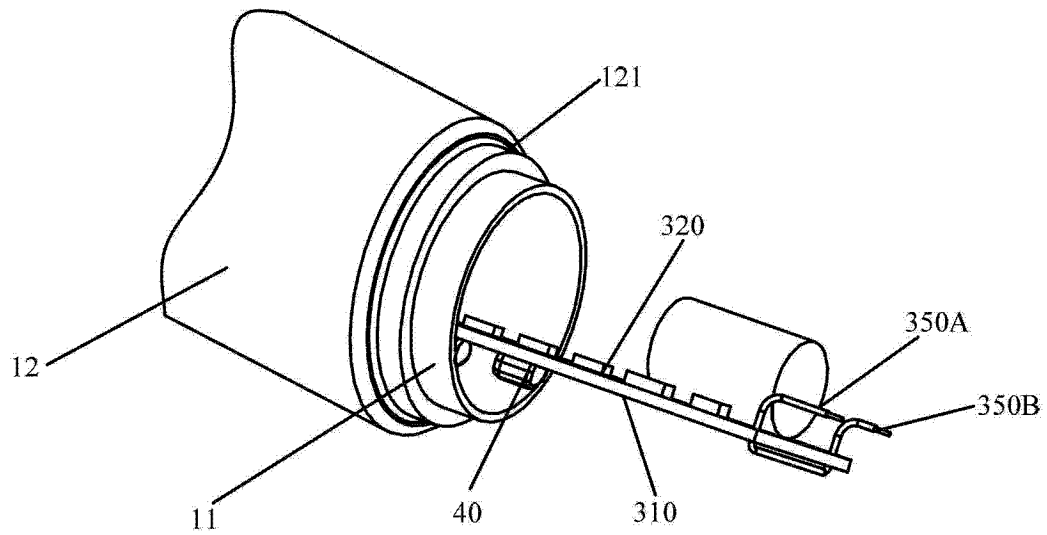


图 3

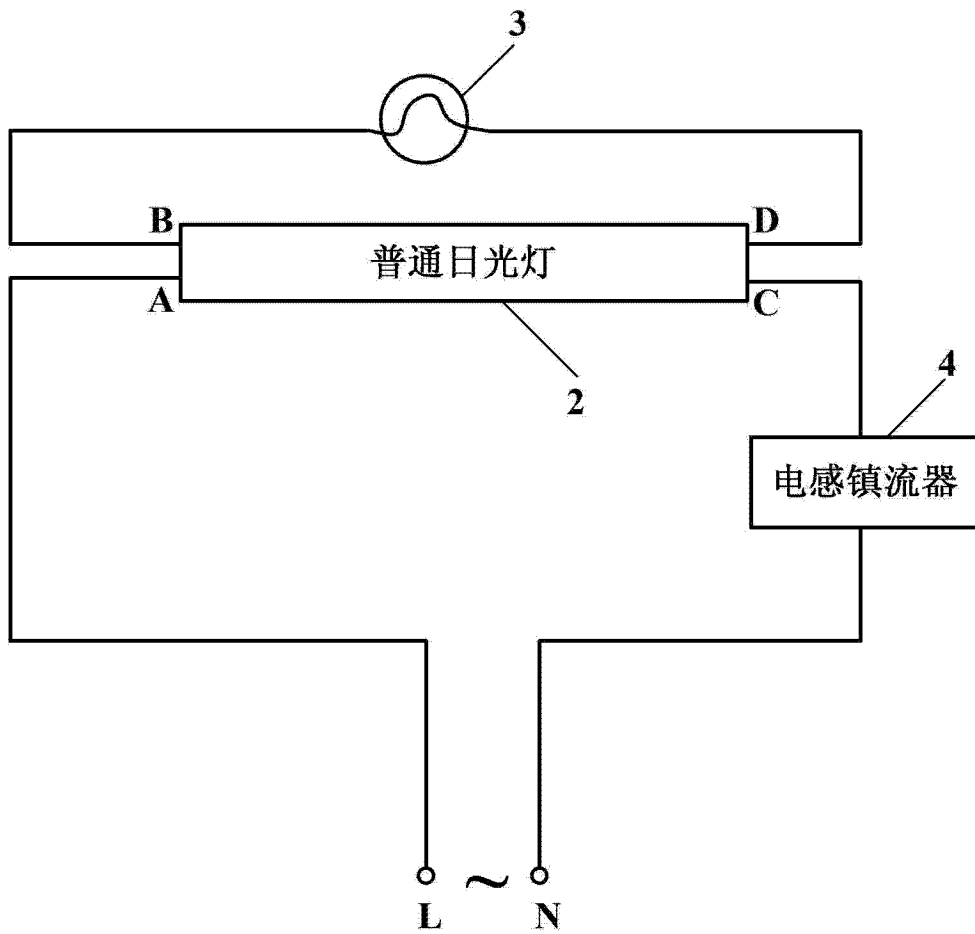


图 4A

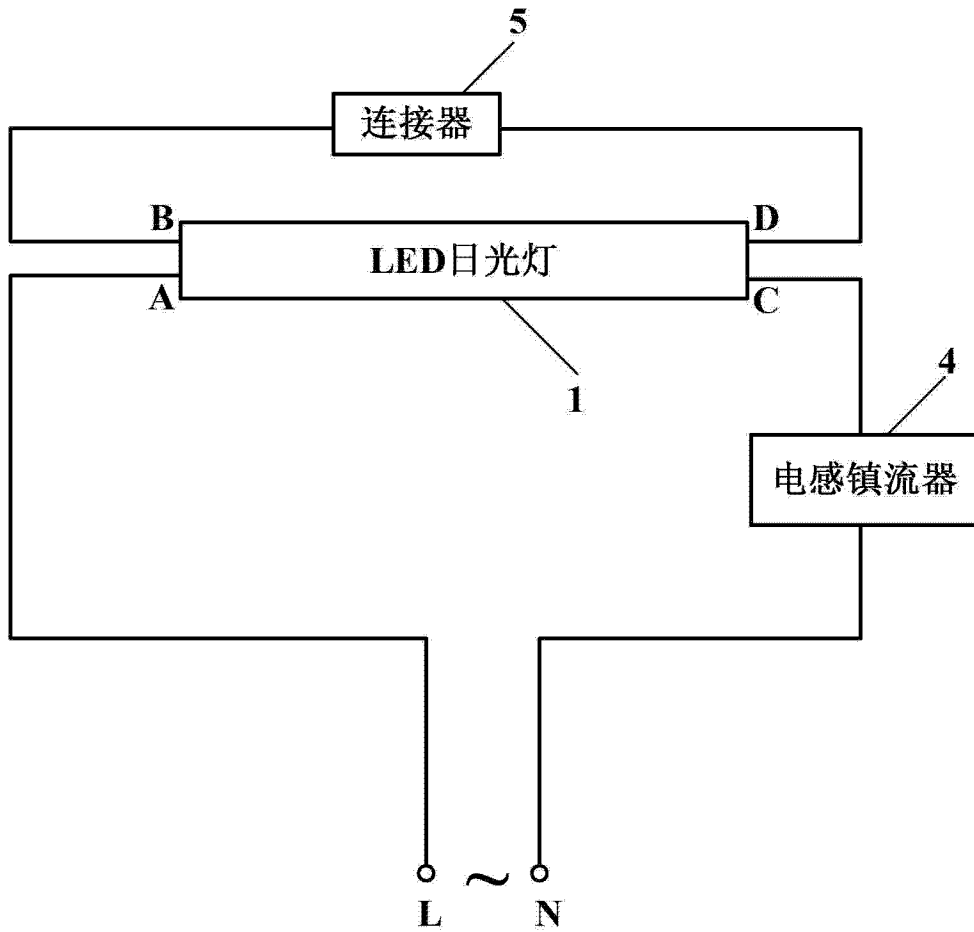


图 4B

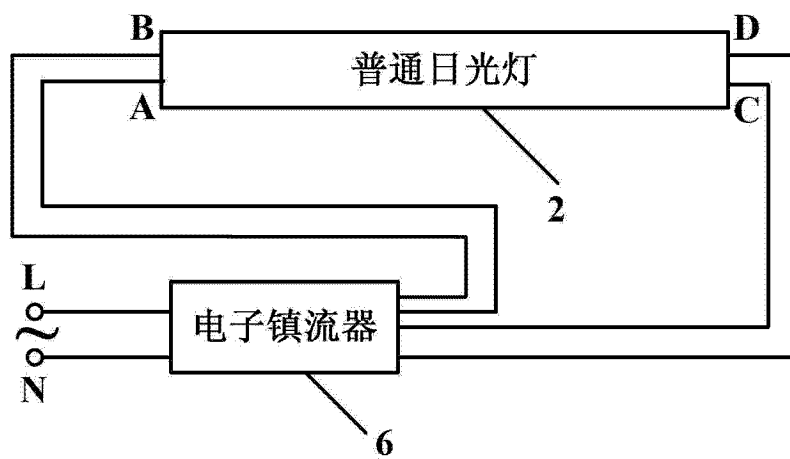


图 5A



图 5B

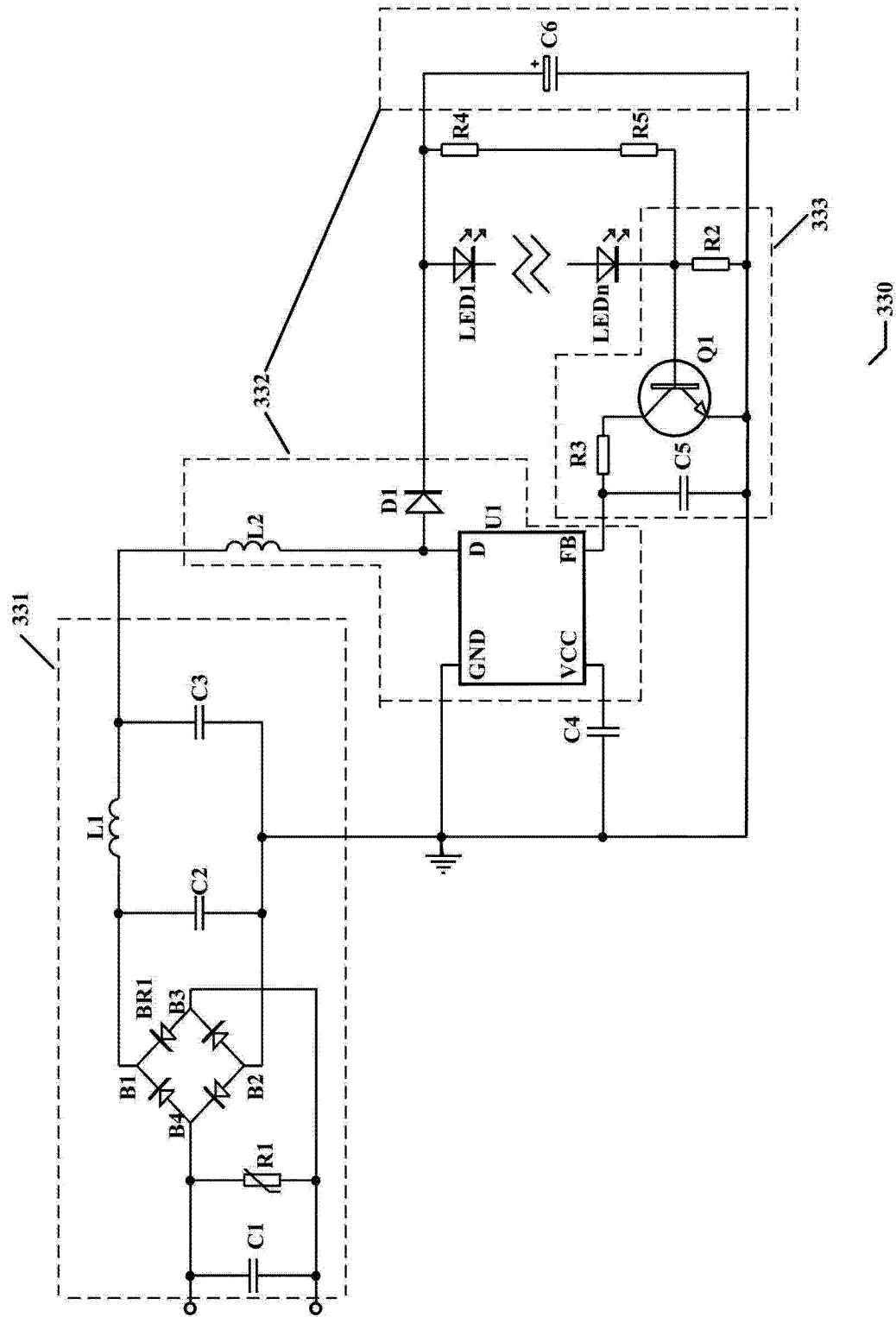


图 6

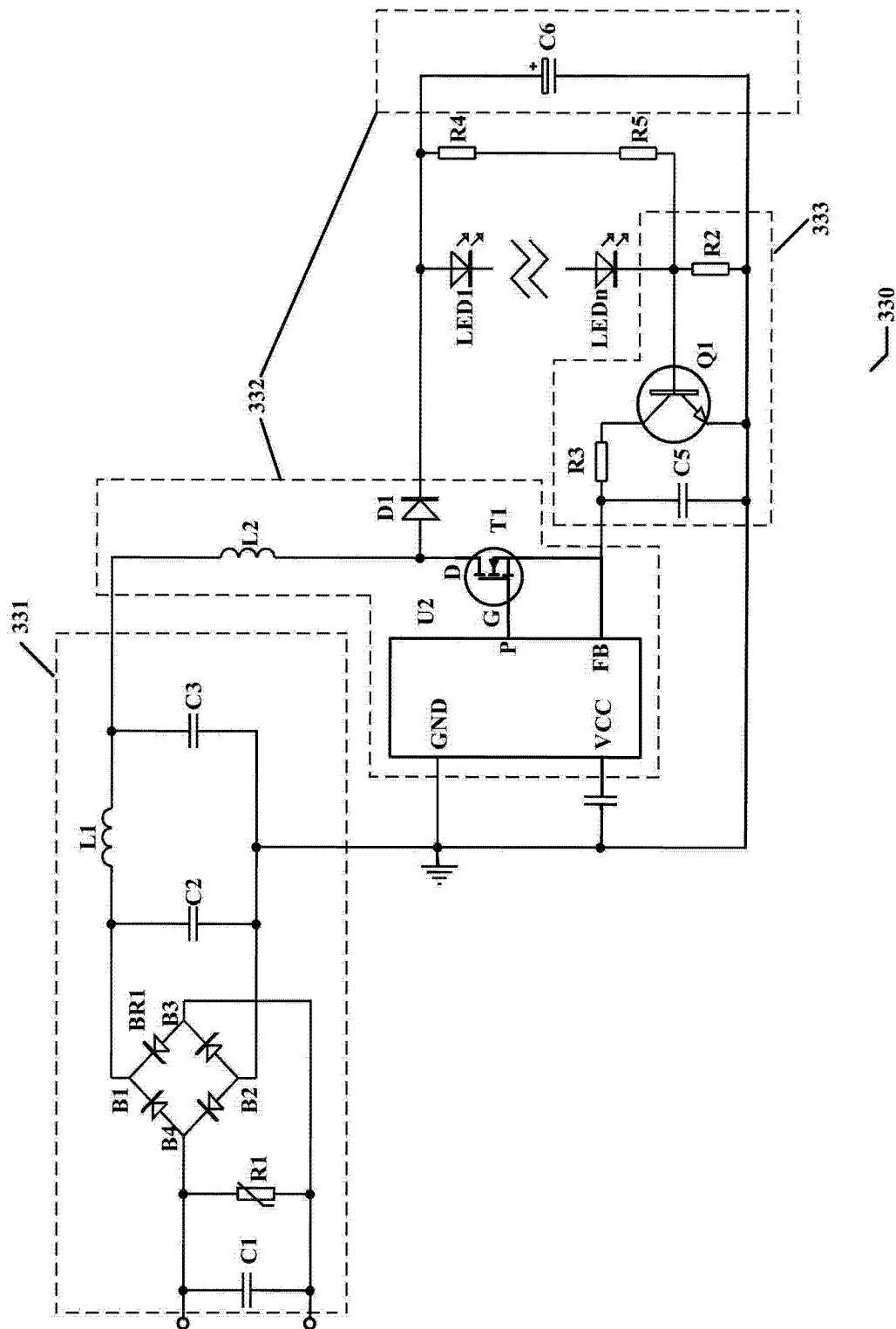


图 7