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(54) CONTROL CIRCUIT, LIGHTING APPARATUS, AND LIGHTING SYSTEM

(57) Provided in the present application are a control circuit, a lighting apparatus, and a lighting system. The control circuit is applied to a lighting apparatus (200), and comprises a main control circuit (10), an electric motor drive circuit (20), a lighting circuit (30), and a power supply circuit (40) for providing a power source for the control circuit (100), wherein an output end of the main control circuit (10) is respectively connected to an input end of the electric motor drive circuit (20) and an input end of the lighting circuit (30), and the main control circuit (10) adjusts the rotation speed of an electric motor in the lighting apparatus (200) by means of the electric motor drive circuit (20); the lighting circuit (30) comprises a first chip (31) and a second chip (32), and the first chip (31) controls the brightness of the lighting apparatus (200) by detecting the duty ratio of PWM that is output by the main control circuit (10); and the second chip (32) comprises at least two toning circuits with different color temperatures, and the second chip (32) controls the switching of the color temperature of the lighting apparatus (200) by controlling the connection of the toning circuits. Compared with the prior art, the control circuit in the present invention can directly control an electric motor drive circuit and a lighting circuit, such that by means of a main control circuit, the color temperature of a lighting apparatus is adjusted while stepless speed regulation and stepless dimming are implemented.

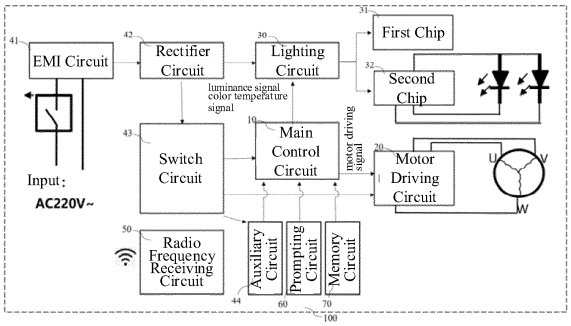

FIG.1

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Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority of the Chinese Patent Application No. 202111410757.4 filed on November 25, 2023 and entitled "Control Circuit, Lighting Apparatus and Lighting System", and priority of the Chinese Patent Application No. 202122911163.3 filed on November 25, 2023 and entitled "Control Circuit, Lighting Apparatus and Lighting System", the contents of which are incorporated herein by reference in its entirety as part of the present application.

TECHNICAL FIELD

[0002] The present application relates to the technical field of household appliances, in particular to a control circuit, a lighting apparatus and a lighting system.

BACKGROUND

[0003] The fan lamp is a commonly used household appliance, which is a combination of a lighting fixture and a fan. It has both the lighting performance of the lighting fixture and the heat dissipation performance of the fan, and has become the most common lighting fixture for indoor lighting, and has been widely used in various occasions such as homes, offices and entertainment places, etc..

[0004] Because the existing fan lamps have many functions to be controlled, they usually adopt two main control circuits to control lighting and the rotating speed of the motor, respectively. This approach requires a large number of main control chips and is not easy to integrate when designing for remote control. Moreover, the existing fan lamps adopt AC asynchronous motors in the function of controlling the rotating speed of the motor of the fan, which is relatively single in terms of control and cannot perform stepless speed adjustment, and the gear position can only be changed by tapping. In terms of lighting control, most of them have single color temperature and three color dimming, their functions are simple and single, and the luminance cannot be adjusted, thus failing to meet the control needs of consumers for fan lamps.

[0005] In view of this, it is necessary to provide a control circuit, a lighting apparatus and a lighting system to solve the above problems.

SUMMARY

[0006] The first purpose of the present application is to provide an integrated control circuit that can directly control the motor driving circuit and the lighting circuit. The control circuit is simple in design and can adjust the color temperature while realizing stepless speed adjustment and stepless luminance adjustment.

[0007] In order to achieve above purpose, the invention provides a control circuit, applied to a lighting apparatus, including a main control circuit, a motor driving circuit, a lighting circuit, and a power supply circuit for supplying power to the control circuit. Output ends of the main control circuit are respectively connected with an input end of the motor driving circuit and an input end of the lighting circuit; the main control circuit is configured to adjust a rotating speed of a motor in the lighting apparatus through the motor driving circuit; the lighting circuit includes a first chip and a second chip, and the first chip is configured to detect a duty ratio of PWM output by the main control circuit, so as to control luminance of the lighting apparatus; the second chip includes at least two color adjustment circuits with different color temperatures, and the second chip is configured to control switching of a color temperature of the lighting apparatus by controlling connection of the color adjustment circuits.

[0008] As a further improvement of the invention, the first chip includes an identification circuit and a first detection circuit; the identification circuit is configured to identify an output signal of the main control circuit and control connection of the first detection circuit; and the first detection circuit is configured to detect the duty ratio of PWM output by the main control circuit, so as to control the luminance of the lighting circuit.

[0009] As a further improvement of the invention, the first chip is in signal connection or electrical connection with the main control circuit, and the second chip is in signal connection with the main control circuit through the first chip.

[0010] As a further improvement of the invention, the motor driving circuit and the lighting circuit are directly connected with the main control circuit through a wire harness.

[0011] As a further improvement of the invention, the motor is a DC brushless motor, and the motor driving circuit is configured to detect the duty ratio of PWM output by the main control circuit, so as to control a rotating speed of the DC brushless motor.

[0012] As a further improvement of the invention, the control circuit further includes a radio frequency receiving circuit, an output end of the radio frequency receiving circuit is connected with a signal input end of the main control circuit, and the main control circuit is configured to receive a signal of the radio frequency receiving circuit, and send a motor driving signal to the motor driving circuit, and/or send a luminance signal and/or a color temperature signal to the lighting circuit for lighting.

[0013] As a further improvement of the invention, the control circuit further includes a prompting circuit, an input end of the prompting circuit is connected with the output end of the radio frequency receiving circuit, and the output end of the prompting circuit is connected with an input end of the main control circuit.

[0014] As a further improvement of the invention, the control circuit further includes a memory circuit, and the motor driving circuit and/or the lighting circuit is connected with the memory circuit; the memory circuit includes

a storage circuit and a timing circuit, the storage circuit is configured to store a working state of the lighting apparatus before being turned off, the timing circuit is configured to record a turning-off time of the lighting apparatus, and the main control circuit is configured to compare the turning-off time with a state switching window time in length, and control switching of the working state of the lighting apparatus according to a comparison result.

[0015] The second purpose of the invention is to provide a lighting apparatus with simple structure and low cost.

[0016] In order to realize the above purpose, the invention provides a lighting apparatus, and the above control circuit is applied in the lighting apparatus.

[0017] The third purpose of the invention is to provide a lighting system, meeting the requirements of diversified functions of the lighting apparatus and having a simple structure.

[0018] In order to realize the above purpose, the invention provides a lighting system, including the above lighting apparatus, a first control terminal and/or a second control terminal. The first control terminal is electrically connected with the main control circuit of the lighting apparatus, the second control terminal is in signal connection with the main control circuit of the lighting apparatus, and the lighting system is configured to control a working state of the lighting apparatus through the first control terminal and/or the second control terminal.

[0019] As a further improvement of the invention, the working state of the lighting apparatus includes one or more of color temperature, luminance and a rotating speed of a motor of the lighting apparatus.

[0020] As a further improvement of the invention, the lighting system further includes a memory circuit, the first control terminal and the second control terminal are respectively configured to control the working state of the lighting apparatus, and the working state of the lighting apparatus is synchronized through the memory circuit.

[0021] As a further improvement of the invention, a switching order of the color temperature of the lighting apparatus is: a first color temperature > a second color temperature > an average value of the first color temperature and the second color temperature.

[0022] As a further improvement of the invention, the first control terminal is a wall switch, and the wall switch is configured to adjust the working state of the lighting apparatus by a count of times the wall switch being pressed and comparing a turning-off time of the wall switch.

[0023] As a further improvement of the invention, the second control terminal is a remote controller, and the remote controller is configured to: realize switching of color temperature of the lighting apparatus by continuously operating a switch button on the remote controller; realize changing of luminance of the lighting apparatus by continuously operating a luminance adjustment button on the remote controller; realize changing of a rotating speed of a motor of the lighting apparatus by continuously operating a wind speed adjustment button on the remote controller; the second control terminal is configured to control a stepless change of the luminance of the lighting apparatus; and/or the second control terminal is configured to control a stepless change of the rotating speed of the motor of the lighting apparatus.

[0024] The beneficial effects of the present invention are: compared with the prior art, the control circuit of the present invention integrates a motor driving circuit and a lighting circuit, the motor driving circuit and the lighting circuit are directly controlled through a main control circuit, the rotating speed of the motor in the lighting apparatus is controlled through the motor driving circuit, and the color temperature and luminance of the lighting apparatus are controlled through a first chip and a second chip, thus realizing stepless speed adjustment and stepless luminance adjustment of the lighting apparatus while adjusting the color temperature, and meeting the requirements of diversified functions of the lighting apparatus. In addition, through the integration design, the relay and part of the filter rectifier circuit are removed, which simplifies the structure of the control circuit and reduces the cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The technical solutions and beneficial effects of the present application are obvious from the detailed description of specific embodiments of the present application below with reference to the accompanying drawings.

FIG. 1 is a schematic diagram of a control circuit according to a preferred embodiment of the present invention;

FIG. 2 is a circuit diagram of a control circuit according to a preferred embodiment of the present invention;

FIG. 3 is a circuit diagram of a power supply circuit according to a preferred embodiment of the present invention;

FIG. 4 is a circuit diagram of an auxiliary circuit according to a preferred embodiment of the present invention;

FIG. 5 is a circuit diagram of a radio frequency receiving circuit according to a preferred embodiment of the present invention;

FIG. 6 is a circuit diagram of a prompting circuit according to a preferred embodiment of the present invention;

FIG. 7 is a circuit diagram of a motor driving circuit and a main control circuit according to a preferred embodiment of the present invention;

FIG. 8 is a circuit diagram of a lighting circuit according to a preferred embodiment of the present invention;

FIG. 9 is a circuit diagram of a color adjustment circuit according to a preferred embodiment of the present

invention;

FIG. 10 is a perspective view of a lighting apparatus according to a preferred embodiment of the present invention;

FIG. 11 is a schematic diagram of a lighting system according to a preferred embodiment of the present invention;

FIG. 12 is a schematic diagram of control of the first control terminal of the lighting system in FIG. 11; and

FIG. 13 is a schematic diagram of control of the second control terminal of the lighting system in FIG. 11.

DETAILED DESCRIPTION

[0026] In order to make the objects, technical solutions and advantages of the present invention more apparent, the present invention will be described in detail with reference to the accompanying drawings and specific embodiments.

[0027] It should be noted herein that, in order to avoid obscuring the present invention with unnecessary details, only the structures and/or processing steps closely related to the solutions of the present invention are shown in the accompanying drawings, and other details not closely related to the present invention are omitted.

[0028] In addition, it is also to be noted that the terms "comprise," "include," or any variations thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or device that includes a series of elements does not include only those elements but may include other elements not expressly listed or include other elements inherent to such process, method, article, or device.

[0029] Referring to FIGS. 1-9, a control circuit 100 according to a preferred embodiment of the present invention is shown. The control circuit 100 is applied to a lighting apparatus 200, and is configured to control the motor rotation of the lighting apparatus 200 and adjust the luminance and color temperature of the lighting apparatus 200. The control circuit 100 includes a main control circuit 10, a motor driving circuit 20, a lighting circuit 30, and a power supply circuit 40 for supplying power to the control circuit 100.

[0030] The power supply circuit 40 includes an EMI circuit 41, a rectifier circuit 42 and a switch circuit 43. The EMI circuit 41 is configured to suppress the interference of induction and radiation on external devices, prevent the mutual interference of peripheral electronic products, and improve the immunity of the lighting apparatus 200, thus ensuring the working stability of the lighting apparatus 200. The rectifier circuit 42 converts AC voltage into DC voltage after bridge rectification. The output end of the rectified power supply circuit 40 is directly connected with the lighting circuit 30, and the lighting circuit 30 supplies power to the light source assembly 240 in the lighting apparatus 200 by stepping down the rectified high voltage to a constant current through an inductor. In a preferred embodiment of the present invention, the light source assembly 240 is an LED lamp bead. In other embodiments, the light source assembly 240 can also be other light-emitting assemblies, such as a light bulb, a fluorescent lamp, a light bar or a light sheet, etc.. The present invention is not limited thereto. The output end of the rectified power supply circuit 40 is electrically connected with the input end of the motor driving circuit 20 and the input end of the auxiliary circuit 44 respectively through the switch circuit 43, so that the rectified high voltage can be supplied in the form of a constant output of 24V through a transformer to the motor driving circuit 20 and the auxiliary circuit 44. The auxiliary circuit 44 steps down the voltage from 24V to 5V and then supplies power to the main control circuit 10. That is, the power supply system of the main control circuit 10 is 5V, so as to reduce the power consumption of the control circuit 100.

[0031] The output ends of the main control circuit 10 are connected with the input end of the motor driving circuit 20 and the input end of the lighting circuit 30 respectively, and the main control circuit 10 is configured to adjust the rotating speed of the motor in the lighting apparatus 200 through the motor driving circuit 20, so as to realize stepless speed adjustment of the lighting apparatus 200. The lighting circuit 30 includes a first chip 31 and a second chip 32. The first chip 31 is configured to detect the duty ratio of PWM output by the main control circuit 10, so as to control the luminance of the lighting apparatus 200. The second chip 32 includes at least two color adjustment circuits with different color temperatures. The second chip 32 is configured to control switching of the color temperature of the lighting apparatus 200 by controlling the connection of the color adjustment circuits. In this way, the motor driving circuit 20 and the lighting circuit 30 are directly controlled by one main control circuit 10, and the rotating speed of the motor in the lighting apparatus 200 is controlled through the motor driving circuit 20, so as to realize stepless speed adjustment and stepless luminance adjustment of the lighting apparatus 200 while adjusting the color temperature. The color temperature and luminance of the lighting apparatus 200 are controlled through the first chip 31 and the second chip 32, so as to reduce the use of relays, meet the requirements of diversified functions of the lighting apparatus 200 and meanwhile reduce the cost of the lighting apparatus 200.

[0032] In a preferred embodiment of the present invention, the main control circuit 10 is included in the motor driving circuit 20, and the main control circuit 10 in the motor driving circuit 20 controls the motor driving circuit 20 while also controlling the lighting circuit 30, so that the design of the main control circuit 10 in the lighting circuit 30 is simplified. In other embodiments, the main control circuit 10 may also be included in the lighting circuit 30, or the main control circuit 10 may be separately provided. The present invention is not limited thereto. One main control circuit 10 can control the motor driving circuit 20 and the lighting circuit 30 at the same time, so as to re-

duce the relay and part of AC/DC filter rectifier circuit, to reduce the cost. By integrating the motor driving circuit 20 and the lighting circuit 30, the color temperature and luminance of the lighting apparatus 200 and the rotating speed of the motor of the lighting apparatus 200 can be directly controlled by the main control circuit 10, so as to simplify the structure of the control circuit 100 and reduce the cost.

[0033] In an alternative embodiment of the present invention, the main control circuit 10 can be a programmable circuit module, and a plurality of IO ports are provided by programming the chip of the main control circuit 10 to realize output and input of different control signal. Those skilled in the art can carry out corresponding programming procedures according to the specific conditions of the circuit structure, which is not limited in the present invention.

[0034] In an alternative embodiment of the present invention, the control circuit 100 further includes a radio frequency receiving circuit 50, the output end of the radio frequency receiving circuit 50 is connected with the signal input end of the main control circuit 10, and the main control circuit 10 is configured to receive the signal of the radio frequency receiving circuit 50, and send a motor driving signal to the motor driving circuit 20, and/or send a luminance signal and/or a color temperature signal to the lighting circuit 30 for lighting. That is, the radio frequency receiving circuit 50 is in signal connection with the main control circuit 10, and is in signal connection with the motor driving circuit 20 and/or the lighting circuit 30 through the main control circuit 10. According to the signal from the radio frequency receiving circuit 50, the main control circuit 10 can send a motor driving signal to the motor driving circuit 20 alone, or send a luminance signal or a color temperature signal for lighting to the lighting circuit 30 alone, or can select any combination of signals to send. The radio frequency receiving circuit 50 can receive a radio frequency signal such as WIFI, Bluetooth, etc., and convert the radio frequency signal into a digital signal and output it to the main control circuit 10, so as to control the rotating speed of the motor in the lighting apparatus 200 and the color temperature and luminance of the lighting apparatus 200 through the main control circuit 10. In a preferred embodiment, the radio frequency receiving circuit 50 adopts the frequency band of 433.92MHz to receive signals from a remote controller. In other embodiments, other frequency bands can also be adopted, which is not limited in the present invention. By providing the radio frequency receiving circuit 50, the remote control of the lighting apparatus 200 can be improved, and the user's convenience can be improved.

[0035] Optionally, the control circuit 100 further includes a prompting circuit 60, the input end of the prompting circuit 60 is connected with the output end of the radio frequency receiving circuit 50, and the output end of the prompting circuit 60 is connected with the input end of the main control circuit 10. Preferably, the prompting circuit 60 is a buzzer, and the buzzer is in signal connection with the radio frequency receiving circuit 50 and the main control circuit 10. When the buzzer receives a radio frequency signal, the buzzer emits a "beep" sound to prompt the user, and executes the corresponding function.

[0036] Further, the motor of the lighting apparatus 200 is a DC brushless motor, and the output end of the motor driving circuit 20 is connected to the three-phase connection terminal of the DC brushless motor. The motor driving circuit 20 is configured to drive a MOSFET by detecting the duty ratio of PWM output by the main control circuit 10, and then control the three-phase current of the motor, and further control the rotating speed of the DC brushless motor. The AC motor of the lighting apparatus 200 is replaced by the DC brushless motor, so that the lighting apparatus 200 have the advantages of small starting current, low noise and convenient speed adjustment, and can realize stepless speed adjustment.

[0037] Further, the lighting apparatus 200 includes a first chip 31 and a second chip 32. The first chip 31 is configured to detect the duty ratio of PWM output by the main control circuit 10, so as to control the luminance of the lighting apparatus 200. The second chip 32 includes at least two color adjustment circuits with different color temperatures, and the second chip 32 is configured to control switching of the color temperature of the lighting apparatus 200 by controlling the connection of the color adjustment circuits. By providing the first chip 31 and the second chip 32 instead of the relay, the color temperature of the lighting apparatus 200 can be adjusted, and at the same time, the stepless luminance adjustment of the lighting apparatus 200 can be realized. In addition, the cost of the control circuit 100 can also be reduced by removing the relay.

[0038] In an alternative embodiment of the present invention, the first chip 31 is in signal connection with the radio frequency receiving circuit 50 and the main control circuit 10, respectively. The first chip 31 includes an identification circuit and a first detection circuit. The identification circuit is configured to identify an output signal of the main control circuit 10 and control the connection of the first detection circuit. After the main control circuit 10 receives a signal from the radio frequency receiving circuit 50, the main control circuit 10 decodes the signal, outputs a corresponding ON/OFF/dimming signal according to the protocol, and controls the connection of the first detection circuit in the first chip 31. When the identification circuit of the first chip 31 identifies a low-level voltage, the first detection circuit is not turned on. When the identification circuit of the first chip 31 identifies a high-level voltage, the first detection circuit is turned on. When the identification circuit of the first chip 31 identifies a dimming signal, the first detection circuit detects the duty ratio of the PWM output by the main control circuit 10 to output a corresponding current, so as to control the luminance of the lighting circuit 30. The luminance can be adjusted from 0 to 100%, thus realizing the stepless luminance adjustment of the lighting apparatus 200.

[0039] In another alternative embodiment of the

present invention, the first chip 31 is electrically connected with the main control circuit 10, and in this case, the main control circuit 10 outputs a high-level voltage by default, that is, the first detection circuit is in an on state. At this time, the luminance of the lighting apparatus 200 is 100%. When the main control circuit 10 is turned off, the identification circuit of the first chip 31 identifies a low-level voltage or fails to identify a level voltage. At this time, the first detection circuit is not turned on, and the luminance of the lighting apparatus 200 is 0, that is, the light source assembly 240 of the lighting apparatus 200 is in an off state.

[0040] In another alternative embodiment of the present invention, the first chip 31 can also realize the constant current output control of the lighting apparatus 200. That is, when the first chip 31 detects an output overvoltage, short circuit or overtemperature of the lighting apparatus 200, the first chip 31 can turn off the main control circuit 10, thereby protecting the lighting apparatus 200 and prolonging the service life of the lighting apparatus 200. When the first chip 31 detects that the voltage, current and temperature of the lighting apparatus 200 are normal, the main control circuit 10 can be turned on, so that the lighting apparatus 200 can continue to be used. It can be known that the first chip 31 can also realize the constant current output control of the lighting apparatus 200 in other ways, which is not limited in the present invention.

[0041] In an alternative embodiment of the present invention, the first chip 31 is in signal connection with the main control circuit 10, and the second chip 32 is in signal connection with the main control circuit 10 through the first chip 31. The second chip 32 is configured to switch the color temperature of the lighting apparatus 200 by detecting a pin signal of the first chip 31. By the second chip 32 being in signal connection with the main control circuit 10 through the first chip 31, the design complexity of the lighting circuit 30 is reduced, thereby reducing the cost of the control circuit 100. In other embodiments, the second chip 32 can also be directly in signal connection with the main control circuit 10, and the color temperature of the lighting apparatus 200 can be switched by the signal of the main control circuit 10, which is not limited in the present invention.

[0042] The second chip 32 includes at least two color adjustment circuits with different color temperatures, and the second chip 32 is configured to control switching of the color temperature of the lighting apparatus 200 by controlling the connection of the color adjustment circuits.

[0043] In a preferred embodiment of the present invention, the second chip 32 includes two color adjustment circuits with different color temperatures, that is, the second chip 32 is integrated with two thyristors of different color temperatures, and includes a color adjustment circuit with a first color temperature and a color adjustment circuit with a second color temperature, and the first color temperature is less than the second color temperature. When a lower color temperature is needed, the second chip 32 controls the color adjustment circuit with the first color temperature to be connected, and simultaneously controls the color adjustment circuit with the second color temperature to be disconnected, and at this time, the color temperature output by the lighting apparatus 200 is the first color temperature. When an intermediate color temperature is needed, the second chip 32 controls the color adjustment circuit of the first color temperature to be connected, and simultaneously controls the color adjustment circuit with the second color temperature to be connected, and at this time, the color temperature output by the lighting apparatus 200 is an average value of the first color temperature and the second color temperature. When a higher color temperature is needed, the second chip 32 controls the color adjustment circuit with the first color temperature to be disconnected, and simultaneously controls the color adjustment circuit with the second color temperature to be connected, and at this time, the color temperature output by the lighting apparatus 200 is the second color temperature.

[0044] Optionally, the control circuit 100 further includes a memory circuit 70, and the motor driving circuit 20 and/or the lighting circuit 30 is connected with the memory circuit 70. In other words, the memory circuit 70 may only be connected with the motor driving circuit 20, so as to memorize the rotating speed of the motor of the lighting apparatus 200; or, the memory circuit 70 may only be connected with the first chip 31 in the lighting circuit 30, so as to memorize the luminance of the lighting apparatus 200; or, the memory circuit 70 may only be connected with the second chip 32 in the lighting circuit 30, so as to memorize the color temperature of the lighting apparatus 200; or, the memory circuit 70 may only be connected with both the first chip 31 and the second chip 32 in the lighting circuit 30, so as to memorize the luminance and color temperature of the lighting apparatus 200; or, the memory circuit 70 may be connected with both the motor driving circuit 20 and the lighting circuit 30, so as to memorize the rotating speed of the motor of the lighting apparatus 200 and the color temperature and luminance of the lighting apparatus 200. The present invention is not limited thereto.

[0045] The memory circuit 70 includes a storage circuit and a timing circuit. The storage circuit is configured to store a working state of the lighting apparatus 200 before being turned off, and the timing circuit is configured to record a turning-off time of the lighting apparatus 200. The main control circuit 10 is configured to compare the turning-off time with a state switching window time in length, and control switching of the working state of the lighting apparatus 200 according to a comparison result. The state switching window time can be set by oneself, preferably 1-2s. In the case where the turning-off time of the lighting apparatus 200 exceeds the state switching window time, the memory circuit 70 memorizes the working state of the lighting apparatus 200 before being turned off, and the next time the lighting apparatus 200 is turned on, it presents the working state of the lighting apparatus

200 before being turned off. In the case where the turning-off time of the lighting apparatus 200 is less than the state switching window time, the next time the lighting apparatus 200 is turned on, it presents a new working state of the lighting apparatus 200. The working state includes, but is not limited to, the rotating speed of the motor of the lighting apparatus 200, the color temperature of the lighting apparatus 200 and the luminance of the lighting apparatus 200. By providing the memory circuit 70, the first chip 31, whether it is in signal or electrical connection with the main control circuit 10, can synchronously realize the working state of the lighting apparatus 200.

[0046] In an alternative embodiment of the present invention, the memory circuit 70 is connected with the second chip 32 in the lighting circuit 30, so as to memorize the color temperature of the lighting apparatus 200. In the case where the turning-off time of the lighting apparatus 200 exceeds the state switching window time, the memory circuit 70 memorizes the color temperature of the lighting apparatus 200 before being turned off, and the next time the lighting apparatus 200 is turned on, it presents the color temperature of the lighting apparatus 200 before being turned off. In the case where the turning-off time of the lighting apparatus 200 is less than the state switching window time, the next time the lighting apparatus 200 is turned on, it switches to a next color temperature of the lighting apparatus 200. Preferably, the switching order of the color temperature is first color temperature > second color temperature > an average value of the first color temperature and the second color temperature.

[0047] Referring to FIG. 10, FIG. 10 shows a lighting apparatus 200 according to a preferred embodiment of the present invention. In the present embodiment, the lighting apparatus 200 is a fan lamp. In other embodiments, the lighting apparatus 200 can also be any other apparatus with a motor and a light-emitting component, which is not limited in the present invention. For the sake of clarity, in the following description, the lighting apparatus 200 is described by taking a fan lamp as an example.

[0048] The fan lamp includes a ceiling assembly 210, a suspension assembly 220, a fan assembly 230, a light source assembly 240 and a control assembly 250. The ceiling assembly 210 is used to connect with an installation foundation, and the installation foundation is used to hang the fan lamp. For example, the installation foundation can be a ceiling of a house, etc.. One end of the suspension assembly 220 is accommodated in the ceiling assembly 210, the other end of the suspension assembly 220 is connected to the fan assembly 230 and the light source assembly 240, and the light source assembly 240 is located at one side of the fan assembly 230 away from the suspension assembly 220. The control circuit 100 described above is applied in the control assembly 250. The rotating speed of the motor in the fan assembly 230 and the color temperature and luminance of the light source assembly 240 are controlled by the above control circuit 100. In the present embodiment, the control assembly 250 is installed above the fan assembly 230. In other embodiments, the control assembly 250 can also be installed in other locations, such as within the ceiling assembly 210, which is not limited in the present invention.

[0049] Referring to FIGS. 11-13, FIGS. 11-13 show a lighting system according to a preferred embodiment of the present invention. The lighting system includes the lighting apparatus 200 described above, a first control terminal 310 and/or a second control terminal 320. The first control terminal 310 is electrically connected with the main control circuit 10 of the lighting apparatus 200, the second control terminal 320 is in signal connection with the main control circuit 10 of the lighting apparatus 200, and the lighting system is configured to control the working state of the lighting apparatus 200 through the first control terminal 310 and/or the second control terminal 320. The working state of the lighting apparatus 200 includes, but is not limited to, the rotating speed of the motor of the lighting apparatus 200 and the color temperature and luminance of the light source assembly 240 in the lighting apparatus 200; and the working state of the lighting apparatus 200 can be one or a combination of several of the rotating speed of the motor, the color temperature and the luminance of the light source assembly 240.

[0050] In an alternative embodiment of the present invention, the first control terminal 310 is a wall switch, and the wall switch is electrically connected with the main control circuit 10 of the lighting apparatus 200. The wall switch is configured to: when the color temperature of the lighting apparatus 200 needs to be adjusted, adjust the color temperature of the lighting apparatus 200 by the number of times the wall switch being pressed and the turning-off time of the wall switch. When the luminance of the lighting apparatus 200 needs to be adjusted, the wall switch is turned on, and at this time, the main control circuit 10 outputs a high-level voltage by default, and the luminance of the lighting apparatus 200 is 100%. The wall switch is turned off, and at this time, the identification circuit of the first chip 31 identifies a low-level voltage or fails to identify a level voltage, and the luminance of the lighting apparatus 200 is 0, that is, the lighting apparatus 200 is turned off. When the rotating speed of the lighting apparatus 200 needs to be adjusted, the wall switch is turned on, and at this time, the main control circuit 10 outputs a high-level voltage by default, and the motor of the lighting apparatus 200 is turned on at a preset speed. The wall switch is turned off, and at this time, the lighting apparatus 200 is turned off and the rotating speed is zero. Of course, in other embodiments, the wall switch can also be configured to adjust the luminance, color temperature and rotating speed of the lighting apparatus 200 by the number of times the wall switch being pressed and comparing the turning-off time of the wall switch. This principle is the same as that of adjusting the color temperature, and will not be repeated here.

[0051] In an alternative embodiment of the present invention, the second control terminal 320 is a remote controller, and the remote controller is in signal connection with the main control circuit 10 of the lighting apparatus 200. The remote controller is configured to: realize switching of the color temperature of the lighting apparatus 200 by continuously operating a switch button on the remote controller; realize changing of luminance of the lighting apparatus 200 by continuously operating a luminance adjustment button on the remote controller; realize changing of the rotating speed of the motor of the lighting apparatus 200 by continuously operating a wind speed adjustment button on the remote controller. It can be known that the change of the luminance of the lighting apparatus 200 can be a stepless change or a segmented change. The change of the rotating speed of the motor of the lighting apparatus 200 can be a stepless change or a segmented change. The present application is not limited thereto. In a preferred embodiment of the present invention, the luminance of the lighting apparatus 200 is controlled by the second control terminal 320 to change steplessly, that is, the luminance of the lighting apparatus 200 can range from 0 to 100%. The rotating speed of the motor of the lighting apparatus 200 is controlled by the second control terminal 320 to change steplessly, that is, the rotating speed of the motor of the lighting apparatus 200 can range from 0 to 100%. The remote controller is in signal connection with the main control circuit 10 through radio frequency signals, so as to realize stepless speed adjustment, stepless luminance adjustment and color temperature switching of the lighting apparatus 200.

[0052] Taking luminance adjustment by the second control terminal 320 as an example, when the main control circuit 10 receives a luminance adjustment signal from the second control terminal 320, the main control circuit 10 decodes the signal, outputs a corresponding ON/OFF/dimming signal according to the protocol, and controls the connection of the first detection circuit in the first chip 31. When the identification circuit of the first chip 31 identifies a low-level voltage, the first detection circuit is not turned on. When the identification circuit of the first chip 31 identifies a high-level voltage, the first detection circuit is turned on. When the identification circuit of the first chip 31 identifies a dimming signal, the first detection circuit detects the duty ratio of the PWM output by the main control circuit 10 to output a corresponding current, so as to control the luminance of the lighting circuit 30. The luminance can be adjusted from 0 to 100%, thus realizing the stepless luminance adjustment of the lighting apparatus 200. The principles of adjusting the color temperature and adjusting the rotating speed by the second control terminal 320 are the same as the principles of adjusting the color temperature and adjusting the rotating speed by the main control circuit 10 itself, which will not be repeated herein.

[0053] Optionally, the second control terminal 320 can also be other terminals or a combination of various terminals, such as a mobile phone, a computer, etc.. The terminal is connected with the control circuit 100 through the radio frequency receiving circuit 50, and the terminal sends a control signal. After the radio frequency receiving circuit 50 receives the signal sent by the terminal, the rotating speed of the motor of the lighting apparatus 200 and the color temperature and luminance of the lighting apparatus 200 are controlled and adjusted.

[0054] In an alternative embodiment, the lighting system includes a memory circuit 70, and the memory circuit 70 is connected with the first control terminal 310 and also connected with the second control terminal 320 at the same time. The memory circuit 70 is configured to memorize the working state of the lighting apparatus 200 under the control of the first control terminal 310 and the working state of the lighting apparatus 200 under the control of the second control terminal 320, respectively, so as to synchronize the control of the first control terminal 310 and the second control terminal 320. The user can adjust the rotating speed, luminance and color temperature of the lighting apparatus 200 whether using the first control terminal 310 or using the second control terminal 320, so as to improve the convenience of the lighting system.

[0055] In summary, the control circuit 100 of the present invention integrates the motor driving circuit 20 and the lighting circuit 30, the motor driving circuit 20 and the lighting circuit 30 are directly controlled through one main control circuit 10, the rotating speed of the motor in the lighting apparatus 200 is controlled through the motor driving circuit 20, and the color temperature and luminance of the lighting apparatus 200 are controlled through the first chip 31 and the second chip 32, thus realizing stepless speed adjustment and stepless luminance adjustment of the lighting apparatus 200 while adjusting the color temperature, and meeting the requirements of diversified functions of the lighting apparatus 200. In addition, through the integration design, the relay and part of the filter rectifier circuit are removed, which simplifies the structure of the control circuit 100 and reduces the cost.

[0056] The above embodiments are merely intended to illustrate rather than to limit the technical solutions of the present application. Although the present application is described in detail with reference to the preferred embodiments, those skilled in the art should understand that modifications or equivalent substitutions may be made to the technical solutions of the present application without departing from the spirit and scope of the technical solutions of the present application.

Claims

1. A control circuit, applied to a lighting apparatus (200), comprising a main control circuit (10), a motor driving circuit (20), a lighting circuit (30), and a power supply circuit (40) for supplying power to the control circuit (100), wherein output ends of the main control circuit

(10) are respectively connected with an input end of the motor driving circuit (20) and an input end of the lighting circuit (30); the main control circuit (10) is configured to adjust a rotating speed of a motor in the lighting apparatus (200) through the motor driving circuit (20); the lighting circuit (30) comprises a first chip (31) and a second chip (32), and the first chip (31) is configured to detect a duty ratio of PWM output by the main control circuit (10), so as to control luminance of the lighting apparatus (200); the second chip (32) comprises at least two color adjustment circuits with different color temperatures, and the second chip (32) is configured to control switching of a color temperature of the lighting apparatus (200) by controlling connection of the color adjustment circuits.

2. The control circuit according to claim 1, wherein the first chip (31) comprises an identification circuit and a first detection circuit; the identification circuit is configured to identify an output signal of the main control circuit (10) and control connection of the first detection circuit; and the first detection circuit is configured to detect the duty ratio of PWM output by the main control circuit (10), so as to control the luminance of the lighting circuit (30).

3. The control circuit according to claim 1, wherein the first chip (31) is in signal connection or electrical connection with the main control circuit (10), and the second chip (32) is in signal connection with the main control circuit (10) through the first chip (31).

4. The control circuit according to claim 1, wherein the motor driving circuit (20) and the lighting circuit (30) are directly connected with the main control circuit (10) through a wire harness.

5. The control circuit according to claim 1, wherein the motor is a DC brushless motor, and the motor driving circuit (20) is configured to detect the duty ratio of PWM output by the main control circuit (10), so as to control a rotating speed of the DC brushless motor.

6. The control circuit according to claim 1, wherein the control circuit (100) further comprises a radio frequency receiving circuit (50), an output end of the radio frequency receiving circuit (50) is connected with a signal input end of the main control circuit (10), and the main control circuit (10) is configured to receive a signal of the radio frequency receiving circuit (50), and send a motor driving signal to the motor driving circuit (20), and/or send a luminance signal and/or a color temperature signal to the lighting circuit (30) for lighting.

7. The control circuit according to claim 6, wherein the control circuit (100) further comprises a prompting circuit (60), an input end of the prompting circuit (60) is connected with the output end of the radio frequency receiving circuit (50), and the output end of the prompting circuit (60) is connected with an input end of the main control circuit (10).

8. The control circuit according to claim 1, wherein the control circuit (100) further comprises a memory circuit (70), and the motor driving circuit (20) and/or the lighting circuit (30) is connected with the memory circuit (70); the memory circuit (70) comprises a storage circuit and a timing circuit, the storage circuit is configured to store a working state of the lighting apparatus (200) before being turned off, the timing circuit is configured to record a turning-off time of the lighting apparatus (200), and the main control circuit (10) is configured to compare the turning-off time with a state switching window time in length, and control switching of the working state of the lighting apparatus (200) according to a comparison result.

9. A lighting apparatus, wherein the control circuit (100) according to any one of claims 1-8 is applied.

10. A lighting system, comprising the lighting apparatus (200) according to claim 9, a first control terminal (310) and/or a second control terminal (320), wherein the first control terminal (310) is electrically connected with the main control circuit (10) of the lighting apparatus (200), the second control terminal (320) is in signal connection with the main control circuit (10) of the lighting apparatus (200), and the lighting system is configured to control a working state of the lighting apparatus (200) through the first control terminal (310) and/or the second control terminal (320).

11. The lighting system according to claim 10, wherein the working state of the lighting apparatus (200) comprises one or more of color temperature, luminance and a rotating speed of a motor of the lighting apparatus (200).

12. The lighting system according to claim 10, wherein the lighting system further comprises a memory circuit (70), the first control terminal (310) and the second control terminal (320) are respectively configured to control the working state of the lighting apparatus (200), and the working state of the lighting apparatus (200) is synchronized through the memory circuit (70).

13. The lighting system according to claim 10, wherein a switching order of the color temperature of the lighting apparatus (200) is: a first color temperature > a second color temperature > an average value of the first color temperature and the second color temperature.

14. The lighting system according to claim 10, wherein the first control terminal (310) is a wall switch, and the wall switch is configured to adjust the working state of the lighting apparatus (200) by a count of times the wall switch being pressed and comparing a turning-off time of the wall switch.

15. The lighting system according to claim 10, wherein the second control terminal (320) is a remote controller, and the remote controller is configured to: realize switching of color temperature of the lighting apparatus (200) by continuously operating a switch button on the remote controller; realize changing of luminance of the lighting apparatus (200) by continuously operating a luminance adjustment button on the remote controller; realize changing of a rotating speed of a motor of the lighting apparatus (200) by continuously operating a wind speed adjustment button on the remote controller; the second control terminal (320) is configured to control a stepless change of the luminance of the lighting apparatus (200); and/or the second control terminal (320) is configured to control a stepless change of the rotating speed of the motor of the lighting apparatus (200).

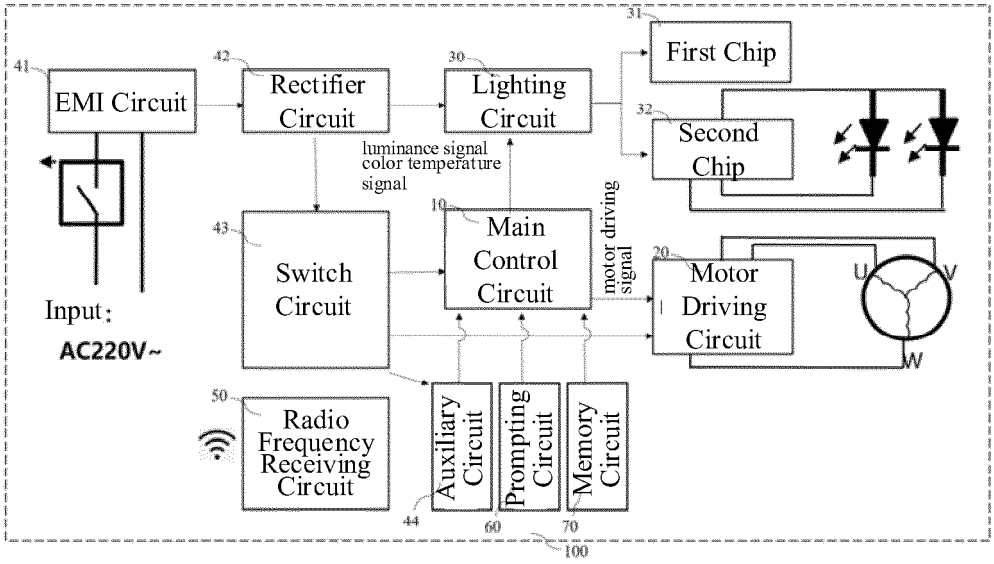
41
EMI Circuit
Input:
AC220V~
42
Rectifier Circuit
30
Lighting Circuit
31
First Chip
32
Second Chip
luminance signal
color temperature signal
43
Switch Circuit
10
Main Control Circuit
motor driving signal
20
Motor Driving Circuit
U
V
W
50
Radio Frequency Receiving Circuit
Auxiliary Circuit
Prompting Circuit
Memory Circuit
44
60
70
100

FIG.1

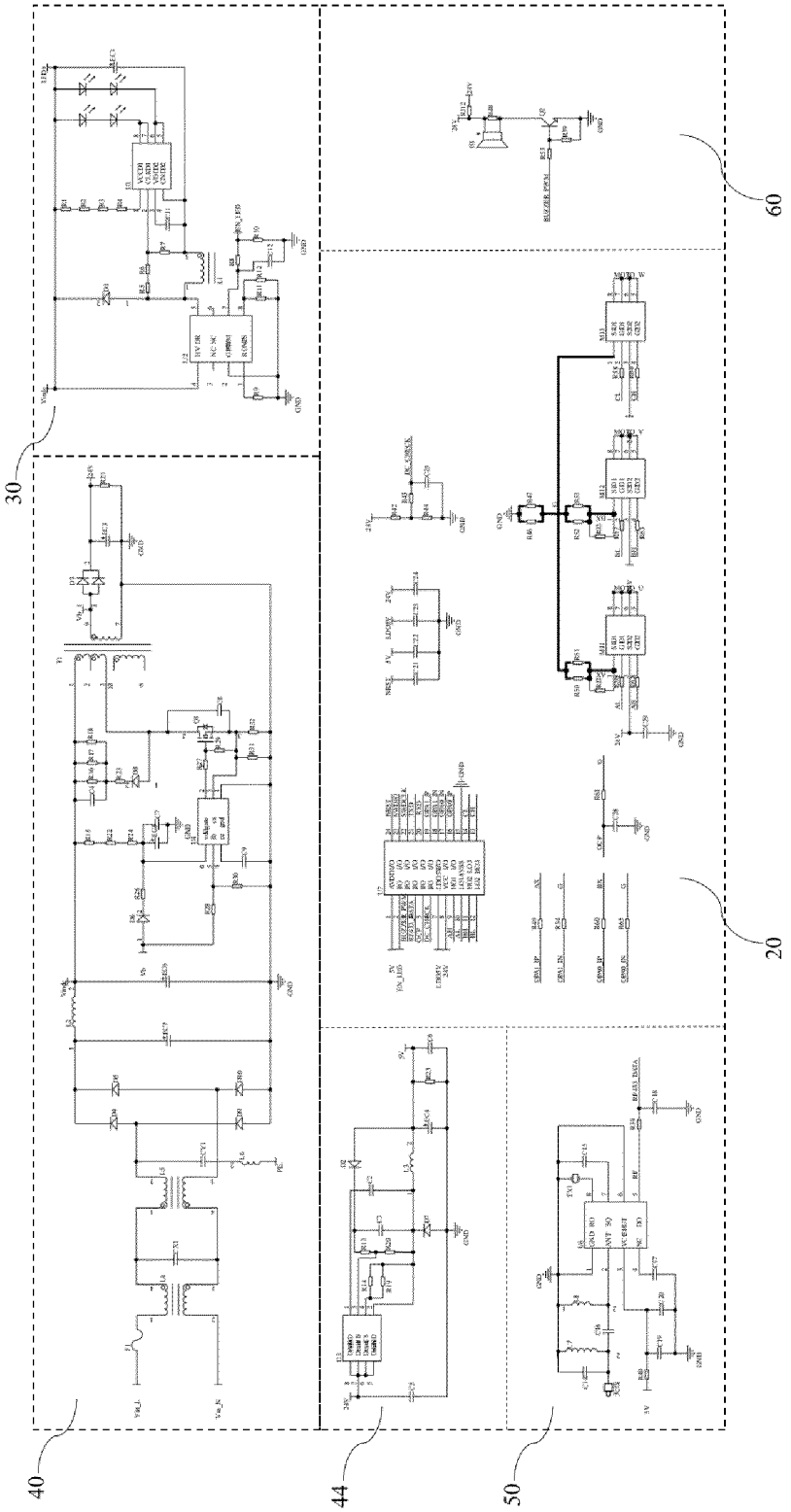

FIG.2

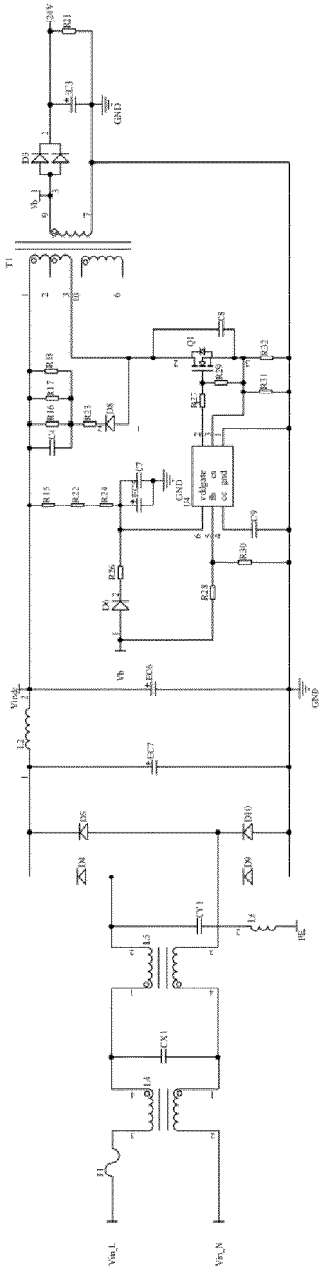

FIG.3

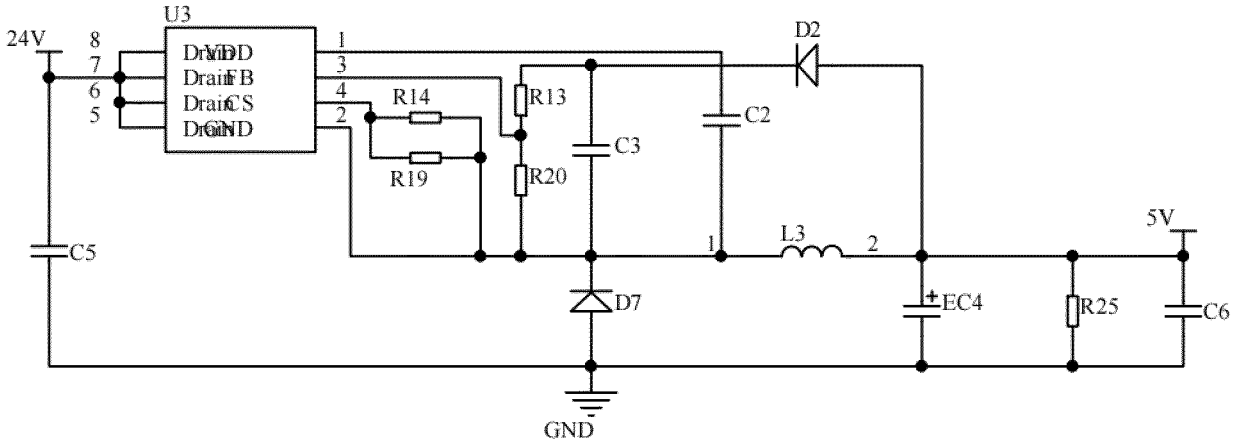
U3
24V
8
7
6
5
1
3
4
2
R14
R19
R13
R20
C3
C2
D2
C5
L3
5V
D7
EC4
R25
C6
GND

FIG.4

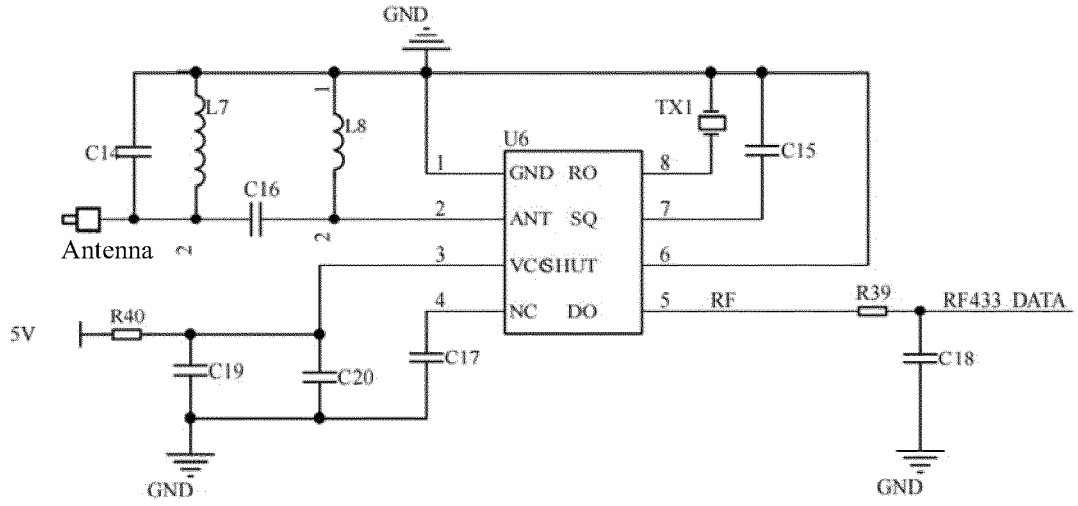
GND
L7
L8
C1
C16
Antenna
U6
TX1
C15
1
2
3
4
GND RO
ANT SQ
VCC SHUT
NC DO
8
7
6
5
RF
R39
RF433_DATA
5V
R40
C19
C20
C17
C18
GND
GND

FIG.5

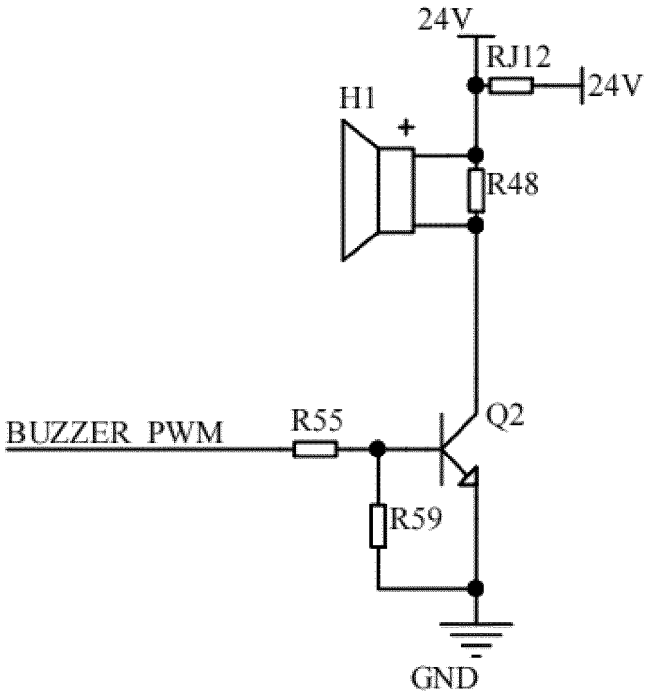
24V
RJ12
24V
H1
+
R48
BUZZER_PWM
R55
Q2
R59
GND

FIG.6

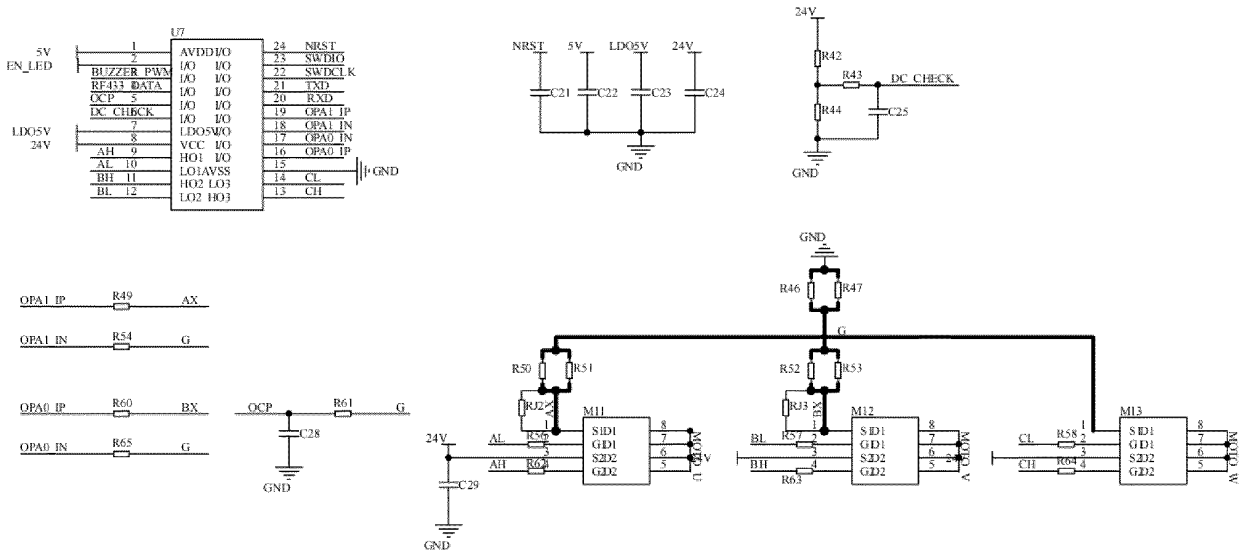
U7
5V
EN_LED
BUZZER_PWM
RF433_DATA
OCP
DC_CHECK
LDO5V
24V
AH
AL
BH
BL
AVDD I/O
I/O I/O
VCC I/O
HO1 I/O
LO1 AVSS
HO2 LO3
LO2 HO3
NRST
SWDIO
SWDCLK
TXD
RXD
OPA1_IP
OPA1_IN
OPA0_IN
OPA0_IP
CL
CH
GND
C21
C22
C23
C24
R42
R43
R44
C25
DC_CHECK
R46
R47
G
R50
R51
R52
R53
M11
M12
M13
R56
R57
R58
R62
R63
R64
C28
C29
OPA1_IP
OPA1_IN
OPA0_IP
OPA0_IN
R49
R54
R60
R65
AX
BX
OCP
R61

FIG.7

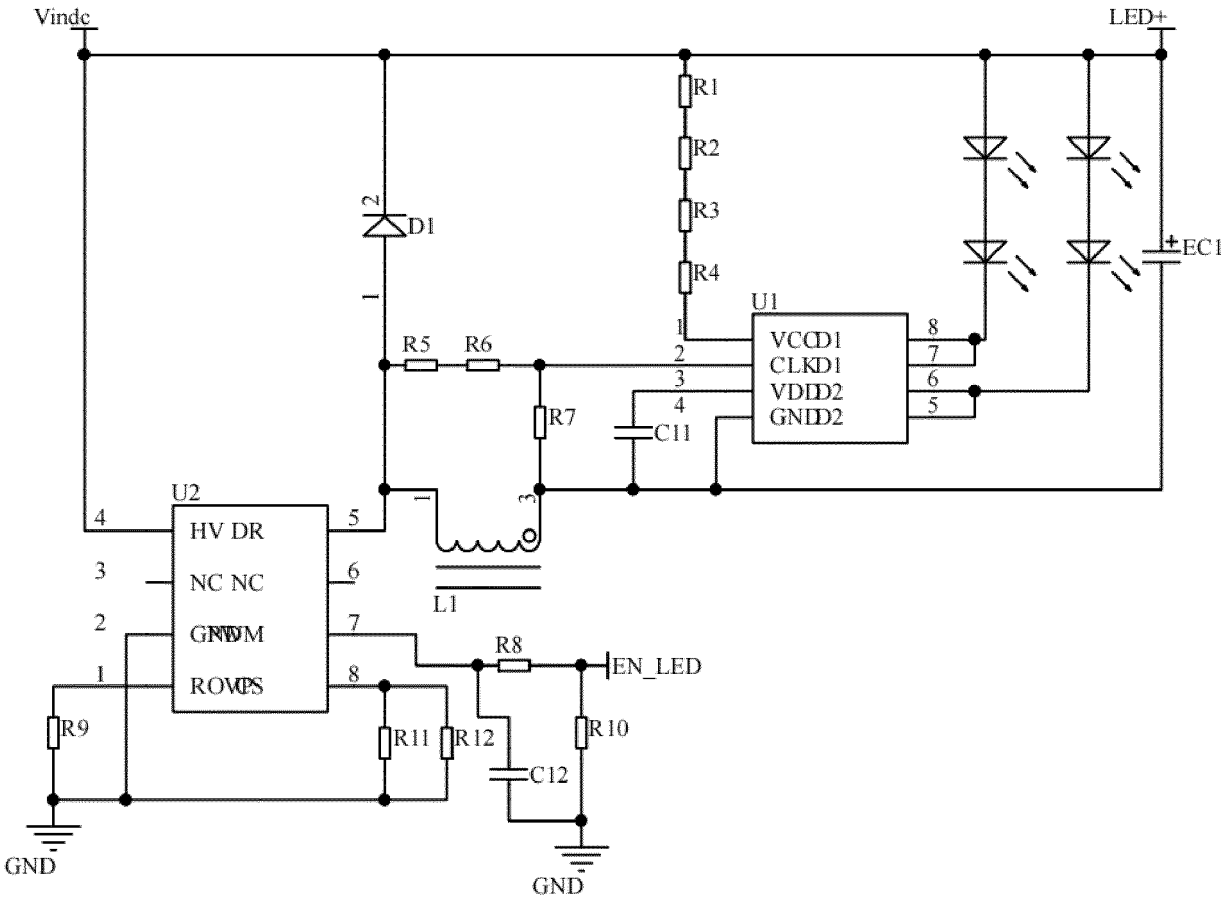
Vindc
LED+
R1
R2
R3
R4
D1
EC1
U1
VCCD1
CLKD1
VDDD2
GNDD2
R5
R6
R7
C11
U2
HV DR
NC NC
L1
R8
EN_LED
R9
R11
R12
R10
C12
GND
GND

FIG.8

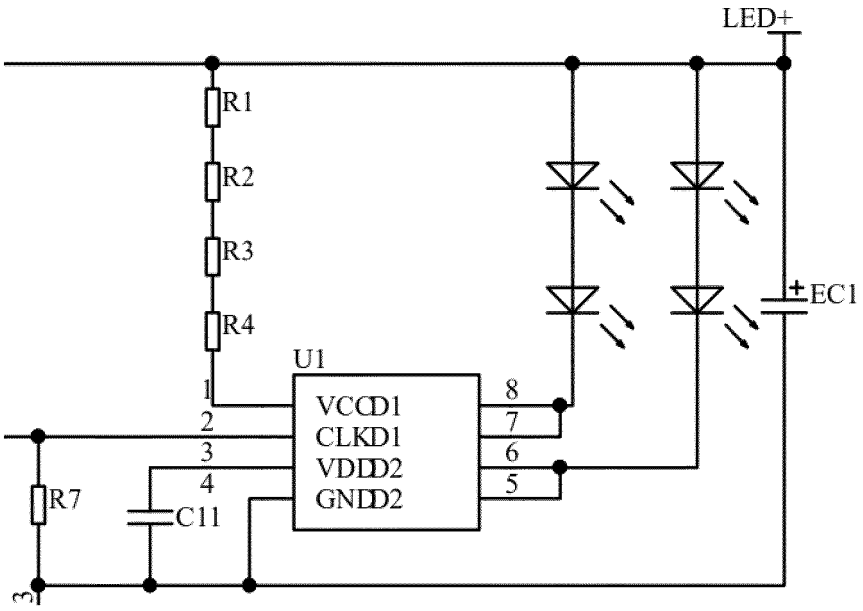
LED+
R1
R2
R3
R4
U1
VCCD1
CLKD1
VDDD2
GNDD2
EC1
R7
C11

FIG.9

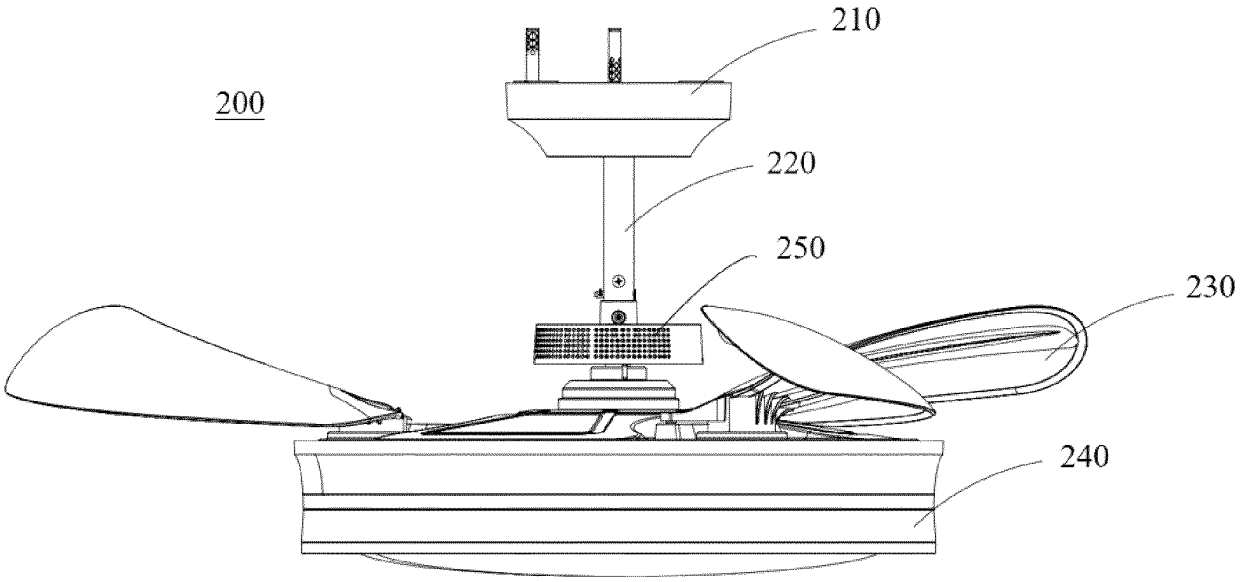
200
210
220
250
230
240

FIG.10

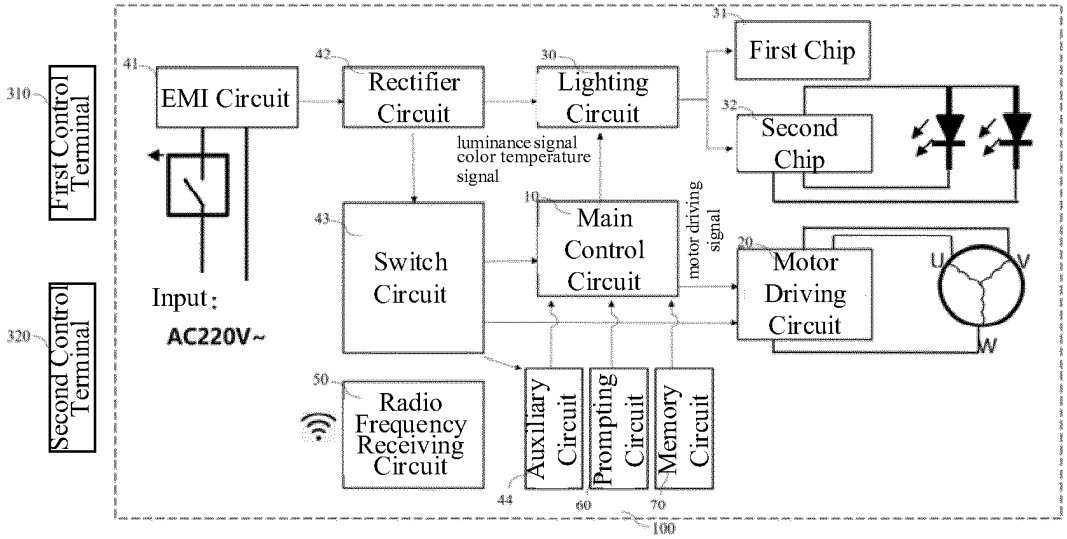
First Control Terminal
Second Control Terminal
Input:
AC220V~
EMI Circuit
Rectifier Circuit
Lighting Circuit
First Chip
Second Chip
luminance signal
color temperature signal
Switch Circuit
Main Control Circuit
motor driving signal
Motor Driving Circuit
U
V
W
Radio Frequency Receiving Circuit
Auxiliary Circuit
Prompting Circuit
Memory Circuit
41
42
30
31
32
310
320
43
10
20
50
44
60
70
100

FIG.11

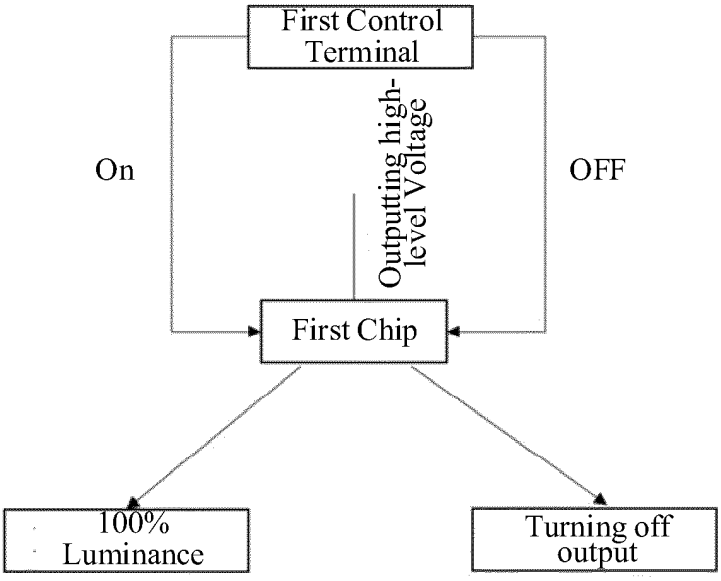
First Control Terminal
On
Outputting high-level Voltage
OFF
First Chip
100% Luminance
Turning off output

FIG.12

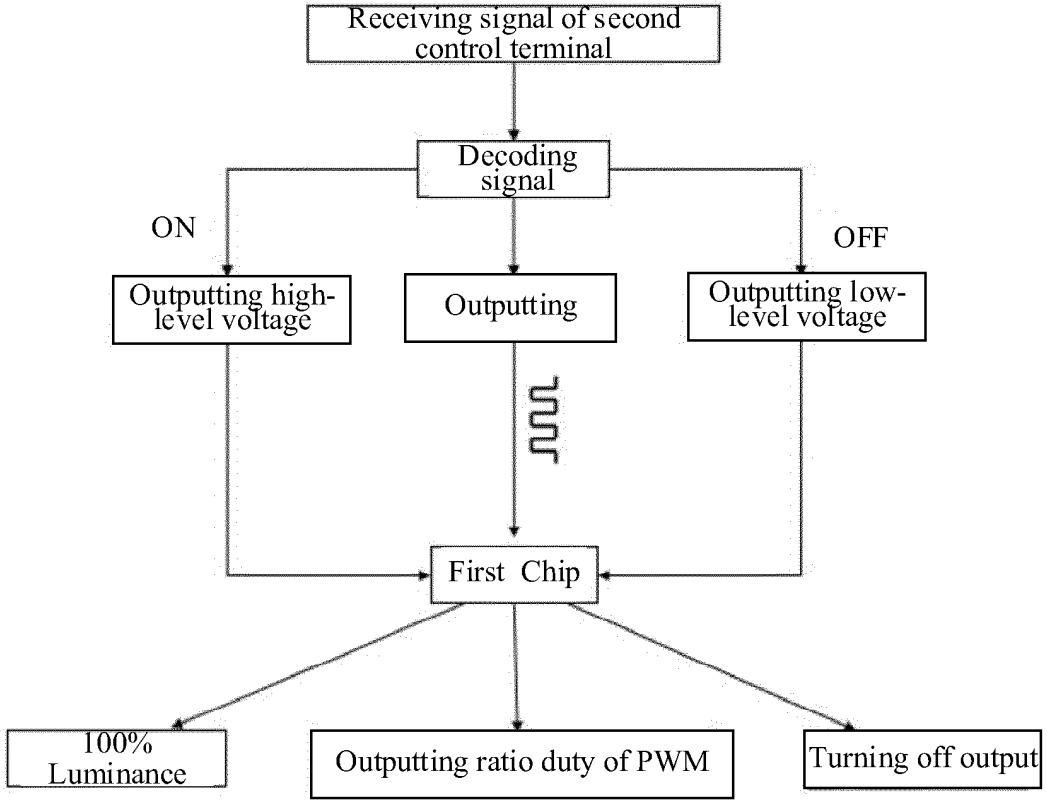
Receiving signal of second control terminal
Decoding signal
ON
OFF
Outputting high-level voltage
Outputting
Outputting low-level voltage
First Chip
100% Luminance
Outputting ratio duty of PWM
Turning off output

FIG.13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/127608

A. CLASSIFICATION OF SUBJECT MATTER

H05B 45/10(2020.01)i; H05B 45/20(2020.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

CNABS; CNTXT; VEN; EPTXT; USTXT; WOTXT; CNKI; IEEE: 灯, 照明, 发光二极管, 风扇, 吊扇, 无极, 旋钮, 脉冲宽度调制, 调整, 控制, 亮度, 颜色, 速度, 电机, light, lighting, LED, fan, ceil+ 3d fan, non-polar, knob, PWM, adjust+, control+, brightness, color, speed, electric machinery

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 114071825 A (OPPLE LIGHTING CO., LTD. et al.) 18 February 2022 (2022-02-18) claims 1-17	1-15
X	CN 110784958 A (FOSHAN CARRO ELECTRICAL CO., LTD.) 11 February 2020 (2020-02-11) description, paragraphs 37-55, and figure 2	1-15
X	CN 211509343 U (ZHONGSHAN MAIDI ELECTRIC CO., LTD.) 15 September 2020 (2020-09-15) description, paragraphs 22-32, and figure 1	1-15
X	CN 214544162 U (JIANGMEN HONGJI ANPU ELECTRONICS CO., LTD.) 29 October 2021 (2021-10-29) description, paragraphs 441-81, and figures 1-2	1-15
X	CN 212785952 U (FORTIOR TECHNOLOGY (SHENZHEN) CO., LTD.) 23 March 2021 (2021-03-23) description, paragraphs 51-62 and paragraphs 75-92, and figures 1 and 6	1-15
A	US 2010007291 A1 (LIN MINGHUI) 14 January 2010 (2010-01-14) entire document	1-15

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

* Special categories of cited documents:
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"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 December 2022	**18 January 2023**

Name and mailing address of the ISA/CN	Authorized officer
China National Intellectual Property Administration (ISA/CN) **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China**	
Facsimile No. **(86-10)62019451**	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/127608

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 206600294 U (JIANG JIANLONG) 31 October 2017 (2017-10-31) entire document	1-15

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2022/127608

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 114071825 A	18 February 2022	CN 216673336 U	03 June 2022
CN 110784958 A	11 February 2020	CN 211090040 U	24 July 2020
		CN 211406361 U	01 September 2020
CN 211509343 U	15 September 2020	None	
CN 214544162 U	29 October 2021	None	
CN 212785952 U	23 March 2021	None	
US 2010007291 A1	14 January 2010	US 8035316 B2	11 October 2011
CN 206600294 U	31 October 2017	None	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 202111410757 **[0001]**
- CN 202122911163 **[0001]**