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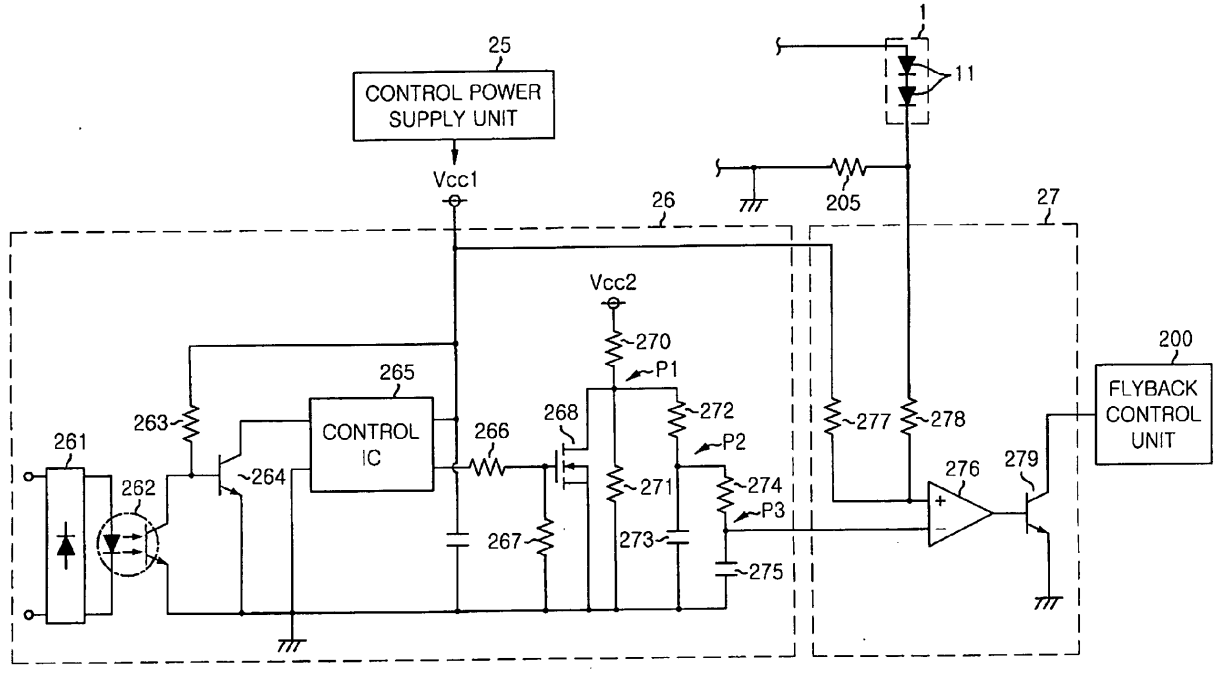
(54) Lighting device and illumination apparatus having the same

(57) A lighting device includes: a power supply unit for supplying a power to a light emitting element; and a dimming control unit for controlling the power supply unit in according to a control signal inputted from outside to dimming-control the light emitting element at a desired dimming ratio. The dimming control unit controls the power supply unit so that supply of the power from the power supply unit to the light emitting element is stopped when no control signal is inputted.

FIG. 1



EP 2 515 612 A1

Description

Field of the Invention

[0001] The present invention relates to a lighting device for lighting a light emitting element and an illumination apparatus having the lighting device.

Background of the Invention

[0002] An illumination apparatus used in, e.g., a shop or the like, includes a well-known illumination apparatus that has a dimming function of lighting a light emitting element, such as an LED (Light Emitting Diode), an OLED (Organic Light Emitting Diode) or the like depending on the output of a lighting device and arbitrarily changing the light output of the light emitting element. In this type of illumination apparatus, the lighting device receives a control signal from a control device that generates a control signal depending on the manipulation of a dimming manipulation unit such as a wall switch and dimming-controls the light emitting element. In general, in such an illumination apparatus, a user manipulates a wall switch or the like, so that a power is supplied to the control device for generating the control signal while a power is being supplied to the lighting device (e.g., refer to Japanese Patent Application Publication No. 2009-232625 (JP2009-232625A)).

[0003] There is no problem encountered when the control signal is immediately inputted to the lighting device after the power has been supplied to the illumination apparatus. However, there may occur cases where the input of the control signal is delayed from the starting of the lighting device. A lighting device for a typical discharge lamp having a filament is set such that in order to preheat the filament in advance immediately after a power has been supplied, a predetermined time is required for starting and the discharge lamp is not turned on for the predetermined time. Accordingly, no particular problems occur even if the input of the control signal is delayed. However, in a lighting device for a light emitting element, such as an LED, the circuit is started immediately after a power has been supplied, without performing preheating. Therefore, when the input of a control signal is delayed, there is a probability that before the light emitting element is dimming-controlled to a desired light output, the light emitting element will be fully turned on only for a moment, and then dimming-control will be performed.

[0004] Therefore, in the illumination apparatus disclosed in JP2009-232625A, a control signal (a dimming signal) is canceled temporarily for a predetermined period of time immediately after the supply of power to a lighting device (a power unit), thus avoiding a case in which a fully turned-on state (a full lighting state) occurs for a moment immediately after starting. Further, JP2009-232625A also discloses a turning off operation of the light emitting element by controlling a DC output based on a reference signal during the predetermined period of time in which the lighting device cancels the control signal.

[0005] However, in the lighting device disclosed in JP2009-232625A, since the control signal is canceled only for the predetermined period of time immediately after the supply of power, there is a probability that in case when the control signal is not inputted even when the predetermined period of time has passed from start of the supply of the power, the light emitting element may be fully turned on for a moment before dimming to a desired light output. Further, when the predetermined period of time is set to a time period longer than the maximum delay time ranging from the supply of power to the output of the control signal, since the delay times of respective control devices can vary significantly, the predetermined period of time may be unnecessarily lengthened. Consequently, the starting of the lighting device is delayed.

Summary of the Invention

[0006] Therefore, the present invention provides a lighting device and illumination apparatus having the lighting device, which can definitely avoid a phenomenon in which a light emitting element is fully turned on only for a moment before dimming to a desired light output, and which can prevent the starting of the lighting device from being delayed even if the delay times of the respective control devices vary, ranging from the supply of power to the output of a control signal.

[0007] In accordance with an aspect of the present invention, there is provided a lighting device including: a power supply unit for supplying a power to a light emitting element; and a dimming control unit for controlling the power supply unit according to a control signal inputted from outside to dimming-control the light emitting element at a desired dimming ratio. The dimming control unit controls the power supply unit so that supply of the power from the power supply unit to the light emitting element is stopped when no control signal is inputted.

[0008] The dimming control unit may be configured to dimming-control the light emitting element at a dimming ratio corresponding to the control signal when the control signal is inputted.

[0009] The dimming control unit may compare a dimming control voltage, magnitude of which is determined by the control signal, with a detected voltage indicative of intensity of power supplied from the power supply unit to the light emitting element, and the power supply unit preferably supplies the power to the light emitting element when the detected voltage is lower than the dimming control voltage and stops the supply of the power to the light emitting element when the detected voltage is equal to or higher than the dimming control voltage, and wherein a specific bias voltage is applied to the detected voltage in order to prevent the detected voltage from being lower than the dimming control voltage when

the control signal is not inputted.

[0010] A duty ratio of the control signal may change according to a target value of the dimming ratio, and the magnitude of the dimming control voltage changes according to the duty ratio of the control signal.

[0011] Herein, the magnitude of the dimming control voltage becomes smaller as the duty ratio of the control signal becomes smaller.

[0012] In accordance with another aspect of the present invention, there is provided an illumination apparatus including: the lighting device described above; and a light emitting unit having the light emitting element.

[0013] The present invention is advantageous in that it can definitely avoid a phenomenon in which the light emitting element is fully turned on only for a moment before dimming to a desired light output is controlled, and which can prevent the starting of the lighting device from being delayed even if significant differences are present between the delay times of the respective control devices, ranging from the supply of power to the output of a control signal.

Brief Description of the Drawings

[0014] The objects and features of the present invention will become apparent from the following description of embodiments, given in conjunction with the accompanying drawings, in which:

Fig. 1 is a circuit diagram showing a configuration of a primary part of an illumination apparatus in accordance with an embodiment of the present invention;
Fig. 2 is a circuit diagram showing an overall configuration of the illumination apparatus in accordance with the embodiment of the present invention;
Fig. 3 shows an operation of a flyback circuit of the illumination apparatus in accordance with the embodiment of the present invention; and
Fig. 4 illustrates an operation of a dimming control circuit of the illumination apparatus in accordance with the embodiment of the present invention.

Detailed Description of the Embodiments

[0015] Hereinafter, embodiments of the present invention will be described with reference to the accompanying drawings which form a part hereof.

[0016] As shown in Fig. 2, an illumination apparatus 10 in accordance with the embodiment of the present invention includes a light emitting unit 1 and a lighting device 2. The illumination apparatus 10 has a dimming function capable of arbitrarily changing the light output from the light emitting unit 1. The illumination apparatus 10 receives a control signal from a control device (not shown) that generates a control signal depending on the manipulation of a dimming manipulation unit, such as a wall switch, and dimming-controls the light emitting unit 1. In general, in such an illumination apparatus 10, a user manipulates the wall switch or the like, so that a power is supplied to the control device that generates the control signal while a power is being supplied simultaneously to the lighting device 2.

[0017] The lighting device 2 has a flyback circuit 20 as a power supply unit, and turns on the light emitting unit 1 by supplying a power from the flyback circuit 20 to the light emitting elements 11 of the light emitting unit 1. The light emitting unit 1 is implemented, e.g., as a series circuit of a plurality of the light emitting elements 11. Herein, each light emitting element refers to an element, such as an LED (Light Emitting Diode), an OLED (Organic Light Emitting Diode) or the like that is supplied with a power to emit a light. In the present embodiment, an LED is used as each light emitting element 11.

[0018] The lighting device 2 includes a filter circuit 21 connected to an AC power source (commercial power source) 3, a rectifier 22 implemented as a diode bridge for rectifying an output from the filter circuit 21, and a step-up chopper circuit 24 connected to the output from the rectifier 22 via an inrush current preventing circuit 23. The flyback circuit 20 is provided in a stage subsequent to the step-up chopper circuit 24, and is configured to receive as an input a DC voltage boosted by the step-up chopper circuit 24 to generate a DC voltage that is applied to the light emitting unit 1.

[0019] Further, the lighting device 2 includes a control power supply unit 25 for generating a power for a chopper control unit 240 and a flyback control unit 200, which will be described later, a dimming control circuit 26 capable of dimming-controlling the light emitting unit 1, and a feedback circuit 27 for feeding back the output from the light emitting unit 1. Although a detailed description will be given later, the dimming control circuit 26 controls the flyback circuit 20 in response to a control signal inputted from an external device (control device), thus dimming-controlling the light emitting unit 1 at a desired dimming ratio.

[0020] The step-up chopper circuit 24 has a capacitor 241 connected between input terminals of the step-up chopper circuit 24, and a series circuit including a chopper choke 242 and a first switching element 243, the series being connected between both ends of the capacitor 241, in addition to the chopper control unit 240. Here, the first switching element 243 is implemented as an N channel MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor). Further, the step-up chopper circuit 24 has a series circuit of a diode 244 and an electrolytic capacitor 245 that are connected between both ends (drain and source) of the first switching element 243. One end of the chopper choke 242 is connected to a connection node of the inrush current preventing circuit 23 and the capacitor 241, and the other end of the chopper choke 242 is connected to an anode of the diode 244. The chopper control unit 240 is connected to a gate of the first switching element 243.

[0021] In this case, the chopper control unit 240 performs switching control to turn on or off the first switching

element 243 in response to an output from the secondary side of the chopper choke 242. Accordingly, the step-up chopper circuit 24 stores an energy in the chopper choke 242 during the ON period of the first switching element 243, and charges the electrolytic capacitor 245 with an energy from the chopper choke 242 via the diode 244 during the OFF period of the first switching element 243. As a result, a desired DC voltage boosted from the peak of an AC voltage is generated at the output terminals of the step-up chopper circuit 24 (at both ends of the electrolytic capacitor 245).

[0022] The flyback circuit 20 includes a flyback transformer 201, a second switching element 202 implemented with an N channel MOSFET, a diode 203, an electrolytic capacitor 204, and a resistor 205, in addition to the flyback control unit 200. The primary coil of the flyback transformer 201 and the second switching element 202 are connected in series between the output terminals of the step-up chopper circuit 24. The diode 203, the electrolytic capacitor 204, and the resistor 205 are connected in series with the secondary coil of the flyback transformer 201. The light emitting unit 1 is connected between both ends of the electrolytic capacitor 204, and a connection node of the resistor 205 and the secondary coil of the flyback transformer 201 are connected to the ground of the circuit. The flyback control unit 200 is connected to a gate of the second switching element 202.

[0023] In this case, the flyback control unit 200 detects a current flowing through the primary side of the flyback transformer 201 and performs switching control to turn on or off the second switching element 202 in response to the detected current. Accordingly, when the second switching element 202 is turned on, the flyback circuit 20 stores an energy into the flyback transformer 201, whereas when the second switching element 202 is turned off, the flyback circuit 20 charges the electrolytic capacitor 204 with the energy stored in the flyback transformer 201 via the diode 203. As a result, a smoothed DC voltage is generated at the output terminals of the flyback circuit 20 (both ends of the electrolytic capacitor 204). As this DC voltage is applied to the light emitting unit 1, the light emitting unit 1 is turned on.

[0024] Next, the operation of the flyback circuit 20 will be described with reference to Fig. 3. Fig. 3 shows (a) a drain-source voltage Vds of the second switching element 202 9, (b) a drain current Id of the second switching element 202, and (c) an output voltage Vout of the flyback control unit 200.

[0025] As shown in Fig. 3, at time T1, when the output voltage Vout makes a transition from an L level to an H level, the second switching element 202 is turned on, and the drain current Id flowing through the primary side of the flyback transformer 201 gradually increases. Thereafter, at time T2, when the drain current Id reaches a predetermined threshold value, the output voltage Vout of the flyback control unit 200 makes a transition from the H level to the L level, and the second switching element 202 is turned off. Accordingly, the drain current Id is cut off, so that the drain-source voltage Vds of the second switching element 202 increases, and a current flows into the secondary side of the flyback transformer 201.

[0026] Thereafter, the current flowing through the secondary side of the flyback transformer 201 becomes zero, and the drain-source voltage Vds of the second switching element 202 starts to fall. In this case, since a delay time occurs due to an oscillation frequency or the like, at time T3 when the delay time has lapsed since the drain-source voltage Vds started to fall, the output voltage Vout makes a transition from the L level to the H level, and the second switching element 202 is turned on.

[0027] In this way, the second switching element 202 is turned on/off, so that the flyback circuit 20 generates a DC voltage at the output terminals thereof (both ends of the electrolytic capacitor 204), and applies the generated DC voltage to the light emitting unit 1.

[0028] Further, the light output from the light emitting unit 1 increases in proportion to an increase in the current flowing through the light emitting elements 11. The magnitude of the current flowing through the light emitting elements 11 is reflected in the voltage between two ends of the resistor 205 disposed between the secondary coil of the flyback transformer 201 and the electrolytic capacitor 204, as shown in Fig. 2. Accordingly, the voltage between two ends of the resistor 205 increases in proportion to the increase in the current of the light emitting elements 11. In this case, the feedback circuit 27 is connected to a connection node between the electrolytic capacitor 204 and the resistor 205 to detect the voltage between two ends of the resistor 205 and a resistor 278 in the feedback circuit 27, which will be described later, thus enabling a feedback signal, in which the light output from the light emitting unit 1 is reflected, to be fed back to the flyback control unit 200.

[0029] That is, the feedback circuit 27 receives the output from the dimming control circuit 26 and generates a feedback signal by comparing the voltage between two ends of the resistor 205 and the resister 278 with the output from the dimming control circuit 26 in order to adjust the light output from the light emitting unit 1 to a desired dimming ratio determined by the dimming control circuit 26. The flyback control unit 200 adjusts the output from the flyback circuit 20 by controlling the switching of the second switching element 202 in accordance with the feedback signal, thus dimming-controlling the light emitting unit 1 at the desired dimming ratio.

[0030] Hereinafter, the configuration of detailed circuits of the dimming control circuit 26 and the feedback circuit 27 for implementing the above dimming lighting will be described with reference to Fig. 1. The dimming control circuit 26 and the feedback circuit 27 form the dimming control unit.

[0031] The dimming control circuit 26 has a diode bridge 261 disposed at input terminals thereof, and a photo coupler 262 connected to an output of the diode bridge 261. A control signal as a PWM (Pulse Width Mod-

ulation) signal, the duty ratio of which changes in accordance with a target value of the dimming ratio, is inputted to the diode bridge 261 from an external control device (not shown). Since the control device changes the duty ratio of the control signal in accordance with the target value of the dimming ratio that has been determined by the manipulation of a dimming manipulation unit (not shown), the control device increases the duty ratio of the control signal as the target value of the dimming ratio increases (that is, as the target value is closer to a fully turned-on state). The control device has a power circuit different from that of the lighting device 2, but is supplied with a power simultaneously with the lighting device 2 when the illumination apparatus 10 is activated.

[0032] A control voltage Vcc1 outputted from the control power supply unit 25 is applied to the secondary side of the photo coupler 262 via a resistor 263, and the base of an npn transistor 264 is connected to a connection node between the resistor 263 and the photo coupler 262. Further, the dimming control circuit 26 has a control IC (Integrated Circuit) 265, of which input terminal is connected to the collector of the transistor 264, and the emitter of the transistor 264 is connected to the circuit ground. The control voltage Vcc1 is applied to the power terminal of the control IC 265.

[0033] An output terminal of the control IC 265 is connected to the circuit ground via a series circuit of resistors 266 and 267, and a connection node of the resistors 266 and 267 is connected to the gate of a third switching element 268. A series circuit of resistors 270 and 271 is connected between the output terminals of a reference power supply unit (not shown) for generating a reference voltage Vcc2. The third switching element 268 is disposed between a connection node of the resistors 270 and 271 and the circuit ground. Further, a series circuit of a resistor 272 and a capacitor 273 is connected in parallel with the third switching element 268, and a series circuit of a resistor 274 and a capacitor 275 is connected in parallel with the capacitor 273.

[0034] Accordingly, the dimming control circuit 26 is operated such that the control signal inputted from the control device is rectified by the diode bridge 261, the rectified control signal is insulated and inverted by the photo coupler 262 and is inverted again by the transistor 264 and then a resulting signal is inputted to the control IC 265. The control IC 265 shapes and inverts the waveform of the input signal and controls the ON/OFF operations of the third switching element 268 by using the resulting signal as a gate signal. That is, the third switching element 268 is turned off when the control signal is at an H level, whereas it is turned on when the control signal is at an L level.

[0035] When the third switching element 268 is turned on or off in response to the control signal, a pulse wave (a) shown in Fig. 4 is generated at a connection node P1 between the resistors 270 and 271. The pulse wave generated at the connection node P1 has a waveform having a same polarity and duty ratio as those of the control signal. That is, the pulse wave generated at the connection node P1 has an L level when the control signal is at an L level, and has an H level when the control signal is at an H level.

[0036] When such a pulse wave is generated at the connection node P1, a waveform (b) smoothed by an integral circuit including the resistor 272 and the capacitor 273 is generated at a connection node P2 between the resistor 272 and the capacitor 273, as shown in Fig. 4. Further, a waveform (c) further smoothed by an integral circuit including the resistor 274 and the capacitor 275 is generated at a connection node P3 between the resistor 274 and the capacitor 275, as shown in Fig. 4.

[0037] In brief, the pulse wave implemented with a PWM signal is converted into a DC voltage having relatively fewer ripple components by a two-step low pass filter (integral circuits), and is then outputted as a dimming control voltage from the connection node P3 between the resistor 274 and the capacitor 275 to the feedback circuit 27. In other words, the dimming control circuit 26 outputs the DC voltage, the magnitude of which has been determined in accordance with the duty ratio of the control signal, to the feedback circuit 27 as the dimming control voltage. With this regard, the dimming control circuit 26 reduces the dimming control voltage in proportion to a decrease in the duty ratio of the control signal.

[0038] The feedback circuit 27 includes an OP Amp (Operational Amplifier) 276 having an inverted input terminal to which the dimming control voltage is inputted, resistors 277 and 278 connected to the non-inverted input terminal of the OP Amp 276, and a transistor 279, the base of which is connected to an output terminal of the OP Amp 276. The non-inverted input terminal of the OP Amp 276 is connected to the control voltage Vcc1 of the control power supply unit 25 via the resistor 277 and is also connected to a connection node between the electrolytic capacitor 204 and the resistor 205 via the resistor 278. In Fig. 1, the electrolytic capacitor 204 is omitted.

[0039] That is, the control voltage Vcc1 outputted from the control power supply unit 25 is divided by a series circuit of the three resistors 277, 278, and 205 and then the voltage between two ends of the resistors 278 and 205 is inputted to the non-inverted input terminal of the OP Amp 276. In this case, the voltage between two ends of the resistor 205 changes in accordance with the light output of the light emitting unit 1, as described above, and the magnitude of the dimming control voltage is determined in accordance with the duty ratio of the control signal.

[0040] Therefore, the OP Amp 276 compares the voltage between two ends of the resistors 278 and 205 (hereinafter referred to as a "detected voltage"), which indicates the intensity of the power supplied from the flyback circuit 20 to the light emitting elements 11, with the dimming control voltage, the magnitude of which is determined in accordance with the control signal. Accordingly, the OP Amp 276 turns on the transistor 279 when the detected voltage is equal to or greater than the dimming

control voltage and turns off the transistor 279 when the detected voltage is lower than the dimming control voltage.

[0041] The transistor 279 is connected to the flyback control unit 200, and thus, the flyback control unit 200 controls the switching of the second switching element 202 depending on the ON/OFF operations of the transistor 279. Herein, the flyback control unit 200 performs the control of switching of the second switching element 202 only when the transistor 279 is turned off and stops the control of switching of the second switching element 202 when the transistor 279 is turned on. As a result, when the transistor 279 is turned on, the operation of the flyback circuit 20 is stopped, and thus, the light emitting unit 1 is turned off.

[0042] In brief, if, as a result of comparing the detected voltage with the dimming control voltage, the detected voltage is lower than the dimming control voltage, the feedback circuit 27 operates the flyback circuit 20, and then supplies power from the flyback circuit 20 to the light emitting elements. In contrast, if the detected voltage is higher than the dimming control voltage, the feedback circuit 27 stops the operation of the flyback circuit 20 and then stops the supply of power from the flyback circuit 20 to the light emitting elements.

[0043] By the above configuration, the lighting device 2 maintains the light emitting unit 1 in a turned-off state when the dimming control voltage outputted from the dimming control circuit 26 is zero. Meanwhile, when the dimming control voltage is maximized, the state of the light emitting unit 1 becomes a fully turned-on (rated lighting) state. Further, when the dimming control voltage changes in accordance with the duty ratio of the control signal, the lighting device 2 also changes the light output from the light emitting unit 1 depending on the change in the dimming control voltage. As a result, the lighting device 2 can dimming-control the light emitting unit 1 at the desired dimming ratio including a turned-off state and a fully turned-on state, in response to the control signal from the control device.

[0044] However, in the present embodiment, since the dimming control circuit 26 controls the flyback circuit 20 in response to the control signal inputted from an external device (control device), the case where the input of the control signal is delayed from the starting of the lighting device 2 may occur. Further, in the lighting device 2 for the light emitting elements 11, it is considered that when the input of the control signal is delayed, the state of the light emitting unit 1 becomes unstable until the control signal is inputted, because the circuit immediately starts after the power has been supplied.

[0045] Therefore, in the present embodiment, the dimming control unit including the dimming control circuit 26 and the feedback circuit 27 controls the flyback circuit 20 in such a way as to stop the supply of power from the flyback circuit 20 that is a power supply unit to the light emitting unit 1 when the control signal is not inputted. That is, as described above, the lighting device 2 stops the operation of the flyback circuit 20 by turning on the transistor 279 when the dimming control voltage outputted from the dimming control circuit 26 is zero, thus stopping the supply of power to the light emitting unit 1 with the result that the light emitting unit 1 is maintained in a turned-off state.

[0046] With this regard, the feedback circuit 27 operates the flyback circuit 20 when the detected voltage is lower than the dimming control voltage. Therefore, in order to make the detected voltage not to be lower than the dimming control voltage when the control signal is not inputted, a specific bias voltage is applied to the detected voltage. In detail, as described above, the control voltage Vcc1 outputted from the control power supply unit 25 is divided by the series circuit of the three resistors 277, 278, and 205, and the voltage between the two ends of the resistors 278 and 205 is inputted as the detected voltage to the OP Amp 276. Accordingly, since the specific bias voltage is applied to the detected voltage by the control voltage Vcc1, the detected voltage is not changed into zero even when the power is not supplied to the light emitting elements 11. As a result, when the control signal is not inputted, the detected voltage becomes equal to or greater than the dimming control voltage.

[0047] In accordance with the lighting device 2 of the present embodiment, the light emitting elements 11 are maintained in a turned-off state when the control signal is not inputted. Accordingly, the generation of a flash occurring when the light emitting elements 11 are fully turned on only for a moment before dimming to the desired light output is controlled can be definitely avoided. Further, in the lighting device 2, the control signal is not canceled for a predetermined period of time immediately after the supply of power, as in the case of the configuration disclosed in JP2009-232625A, the lighting device 2 may dimming-control the light emitting unit 1 at the dimming ratio based on a control signal immediately when the control signal is inputted. That is, the starting of the lighting device 2 is prevented from being delayed even if significant differences are present between the delay times of the respective control devices, each delay time ranging from the supply of power to the output of the control signal.

[0048] Consequently, even if the input of the control signal is delayed from the time of starting the supply of power, the lighting device 2 causes the light emitting unit 1 to be in a turned-off state until the control signal is inputted, and immediately dimming-control the light emitting unit 1 when the control signal is inputted, thus realizing the gentle dimming-up. Such a lighting device 2 is provided in the illumination apparatus 10, and thus it is possible to provide the illumination apparatus 10 of high quality having a smooth dimming-up.

[0049] Further, with the specific bias voltage applied to the detected voltage, although the dimming control voltage is not zero due to the influence of noise or the like when the control signal is not inputted may occur, the case where the detected voltage is lower than the

dimming control voltage does not occur, and thus, the operation of the flyback circuit 20 may be surely stopped. Therefore, the lighting device 2 can definitely maintain the light emitting elements 11 in a turned-off state even if the influence of noise or the like is present when the control signal is not inputted.

[0050] Next, in the present embodiment, the control signal is implemented as a PWM signal, the duty ratio of which changes according to the target value of the dimming ratio, and the magnitude of the dimming control voltage changes according to the duty ratio of the control signal. Owing to this, the lighting device 2 can be used in combination with general control devices which output a PWM signal as a control signal, and enables precise dimming control because the magnitude of the dimming control voltage can be set in detail.

[0051] Furthermore, in accordance with the lighting device 2 of the present embodiment, regardless of time elapsed from a time point at which a power is supplied, when no control signal is inputted, the light emitting unit 1 is always maintained in a turned-off state. For example, even if an abnormality occurs in the control device and the control signal is interrupted, the light emitting unit 1 can be maintained in a turned-off state. Further, as in cases of an illumination apparatus 10 that makes a transition from a dimming state to a fully turned-on state after the supply of power, an illumination apparatus 10 that initially starts in the fully turned-on state or the like, if a plurality of illumination apparatuses 10 performing different starting operations are simultaneously turned on, advantages can be obtained by applying the lighting device 2 in accordance with the present embodiment.

[0052] That is, when the control signal is not inputted to the lighting device 2, all the illumination apparatuses 10 are maintained in a turned-off state. Therefore, there is an advantage in that even if predetermined times are not individually set for the illumination apparatuses 10 using a microcomputer or the like, the illumination apparatuses 10 can be easily controlled at a desired light output or at desired lighting timing.

[0053] While the invention has been shown and described with respect to the embodiments, the present invention is not limited thereto. It will be understood by those skilled in the art that various changes and modifications may be made without departing from the scope of the invention as defined in the following claims.

Claims

1. A lighting device, comprising:

a power supply unit for supplying a power to a light emitting element; and
a dimming control unit for controlling the power supply unit according to a control signal inputted from outside to dimming-control the light emitting element at a desired dimming ratio,
wherein the dimming control unit controls the power supply unit so that supply of the power from the power supply unit to the light emitting element is stopped when no control signal is inputted.

2. The lighting device of claim 1, wherein the dimming control unit is configured to dimming-control the light emitting element at a dimming ratio corresponding to the control signal when the control signal is inputted.

3. The lighting device of claim 1 or 2, wherein the dimming control unit compares a dimming control voltage, magnitude of which is determined by the control signal, with a detected voltage indicative of intensity of power supplied from the power supply unit to the light emitting element, and the power supply unit supplies the power to the light emitting element when the detected voltage is lower than the dimming control voltage and stops the supply of the power to the light emitting element when the detected voltage is equal to or higher than the dimming control voltage, and wherein a specific bias voltage is applied to the detected voltage in order to prevent the detected voltage from being lower than the dimming control voltage when the control signal is not inputted.

4. The lighting apparatus of claim 3, wherein a duty ratio of the control signal changes according to a target value of the dimming ratio, and the magnitude of the dimming control voltage changes according to the duty ratio of the control signal.

5. The lighting apparatus of claim 4, wherein the magnitude of the dimming control voltage becomes smaller as the duty ratio of the control signal becomes smaller.

6. An illumination apparatus, comprising:

the lighting device described in any one of claims 1 to 5; and
a light emitting unit having the light emitting element.

FIG. 1

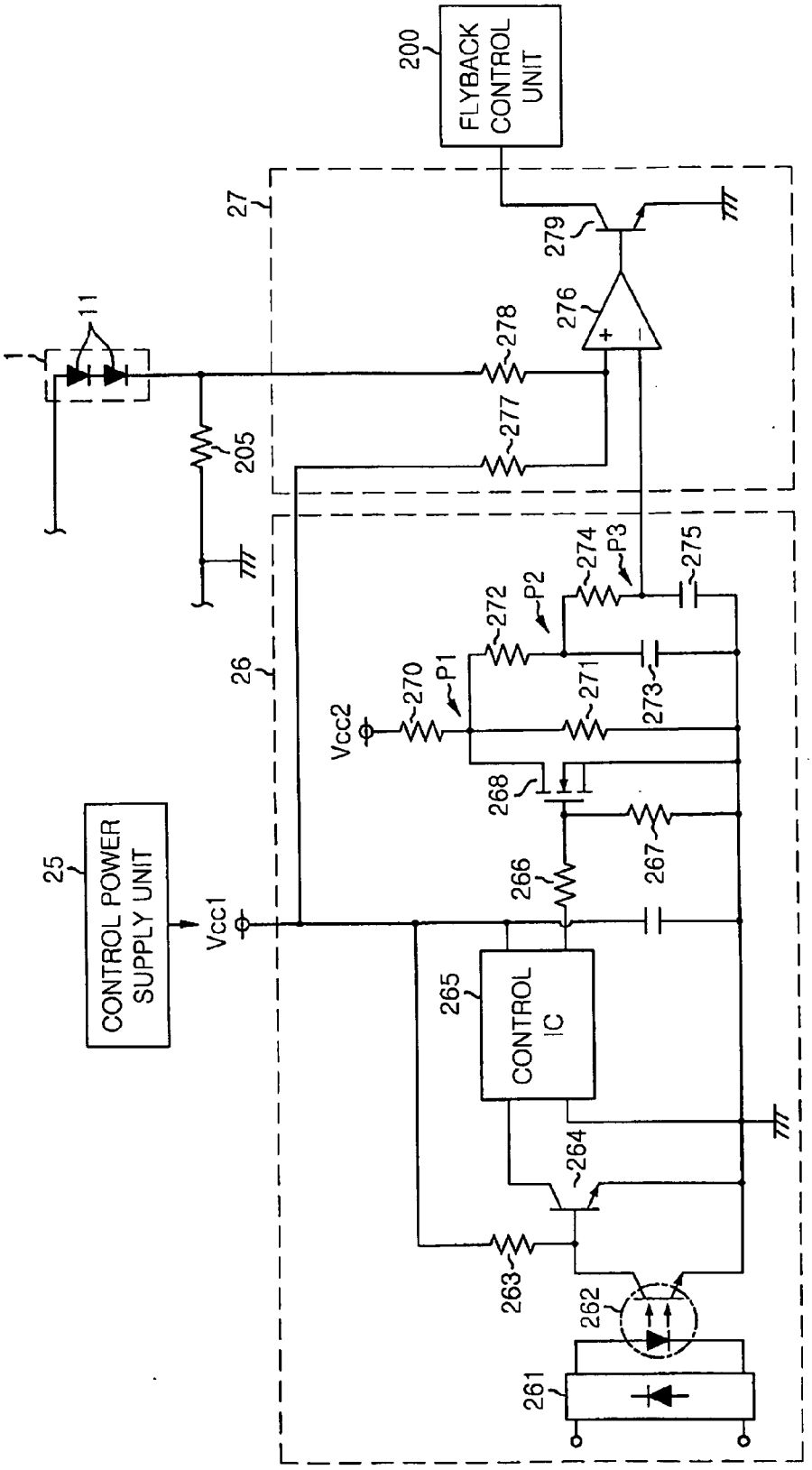

200
FLYBACK CONTROL UNIT
27
279
276
278
277
11
1
205
274
P3
275
272
P2
271
273
270
P1
Vcc2
26
268
267
266
25
CONTROL POWER SUPPLY UNIT
Vcc1
265
CONTROL IC
264
263
262
261

FIG. 2

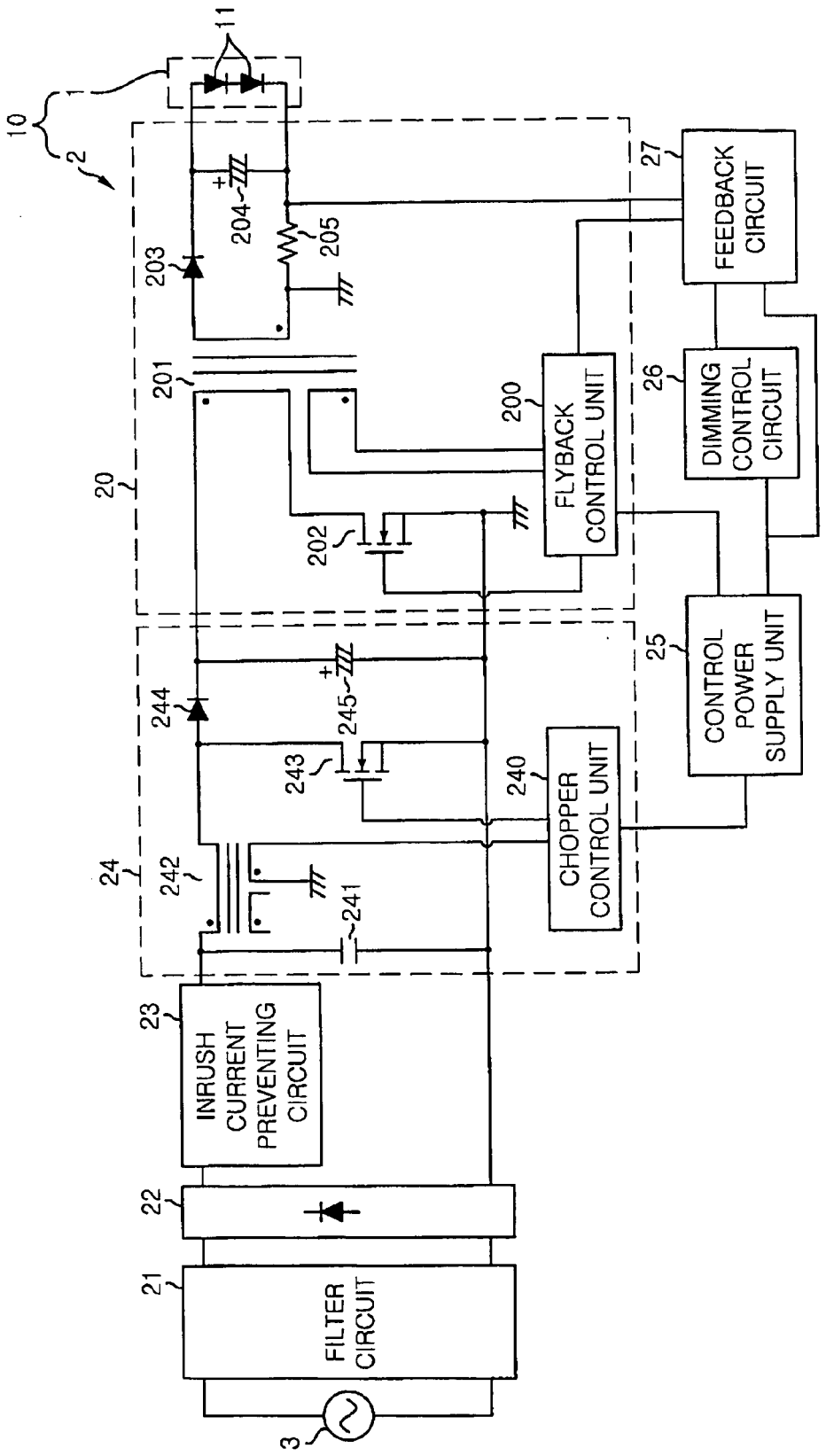

10
1
2
11
204
205
203
201
200
FLYBACK CONTROL UNIT
27
FEEDBACK CIRCUIT
26
DIMMING CONTROL CIRCUIT
20
202
25
CONTROL POWER SUPPLY UNIT
244
245
243
240
CHOPPER CONTROL UNIT
24
242
241
23
INRUSH CURRENT PREVENTING CIRCUIT
22
21
FILTER CIRCUIT
3

FIG. 3

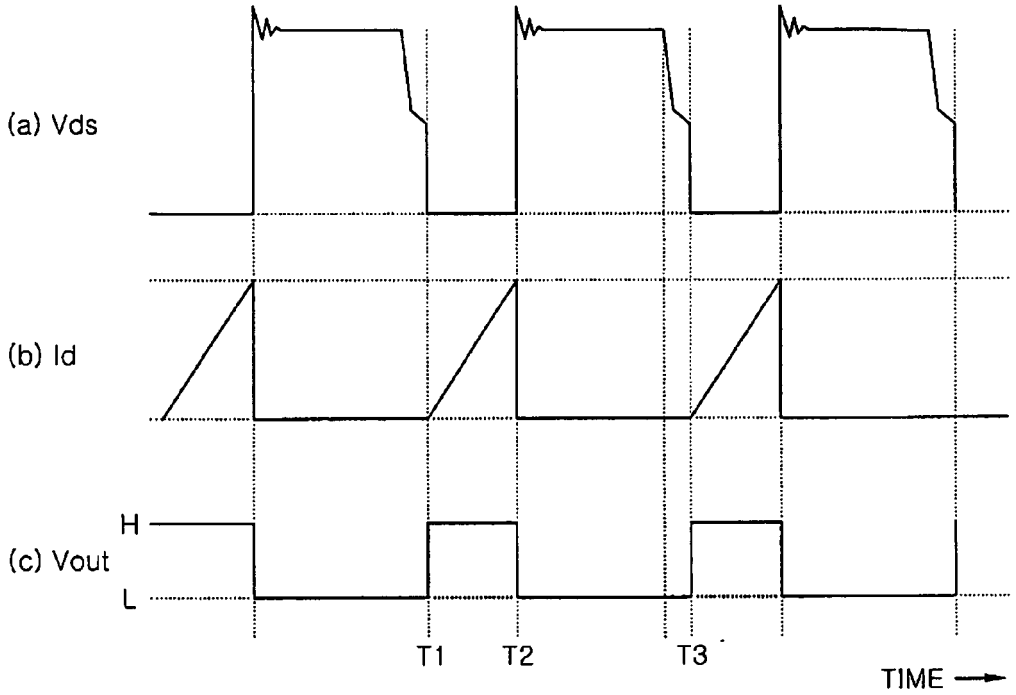
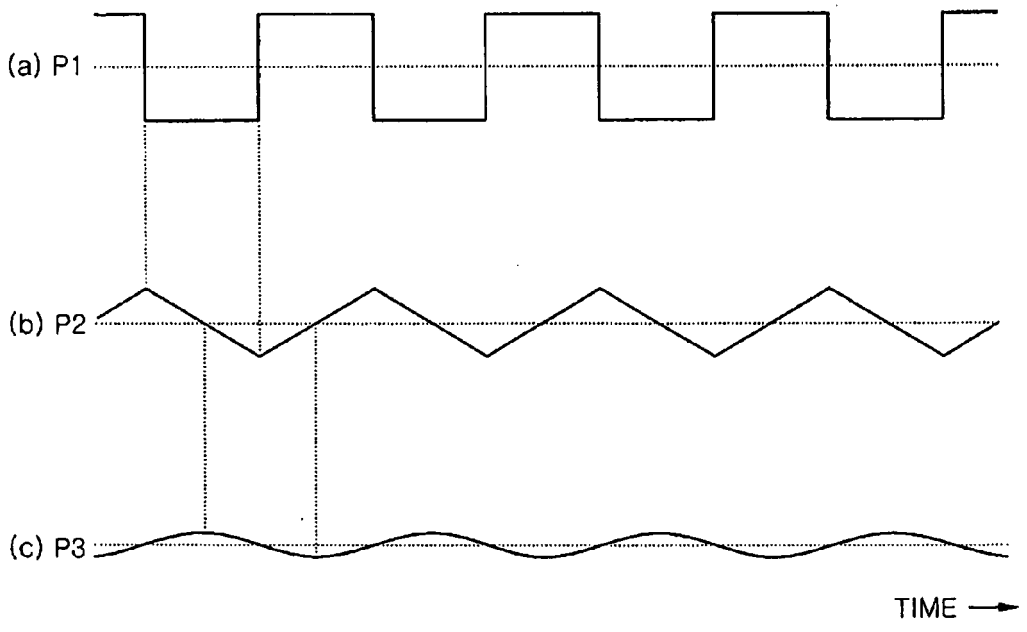


FIG. 4



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EUROPEAN SEARCH REPORT

Application Number
EP 12 00 2223

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H05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 September 2012	Brosa, Anna-Maria

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