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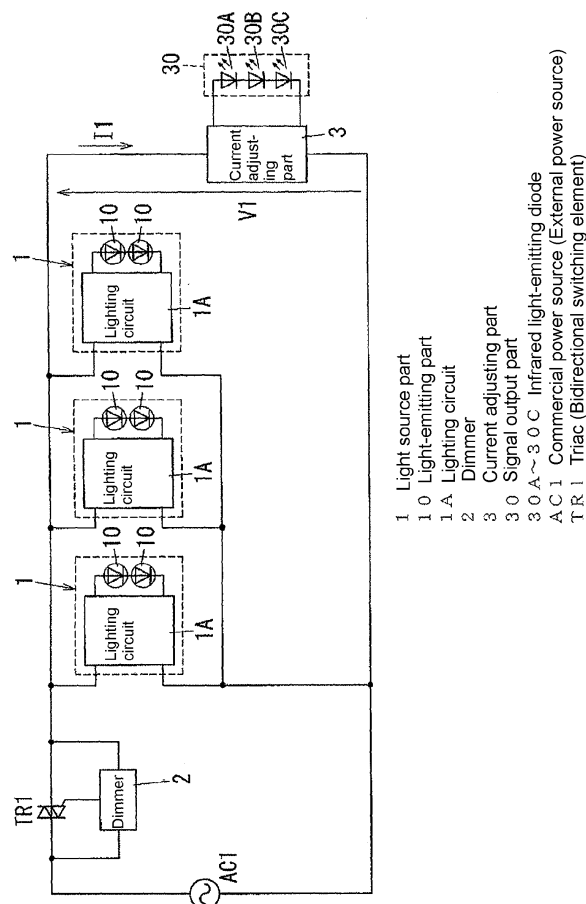
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(54) **Illumination fixture**

(57) [Object] To provide an illumination fixture capable of reducing power loss and improving convenience of a lighting control operation.

[Means for Settlement] There are provided a plurality of light source parts 1 each including a light-emitting diode 10, a triac TR1 serially connected to a commercial power source AC1, a dimmer 2 for controlling the triac TR1 to make a conduction angle of a power source voltage of the commercial power source AC1 variable, and a current adjusting part 3 for keeping a holding current flowing through the triac TR1 to be a certain value or larger in a conductive period of the triac TR1, and the current adjusting part 3 includes a resistor R13 that is connected to each of the light source parts 1 in parallel when the power source voltage of the commercial power source AC1 falls below a predetermined threshold value, and is released in connection to each of the light source parts 1 when the power source voltage of the commercial power source AC1 exceeds the predetermined threshold value, and a signal outputting part 30 for outputting a signal to an external device according to an input current I1 inputted to the current adjusting part 3.

Figure 1



Description

[Field of the Invention]

[0001] The present invention relates to an illumination fixture for controlling lighting using a bidirectional switching element.

[Background Art]

[0002] An illumination fixture in which only an incandescent lamp is replaced with a light-emitting diode lamp having longer life and small power consumption and an AC power source and a control board are shared has been conventionally known and is disclosed in, for example, Patent Literature 1. In the conventional example described in Patent Literature 1, the AC power source and a triac as a triode directional thyristor for turning on/off the AC power source are electrically connected. In the conventional example, a diode bridge circuit for rectifying an AC current from the triac to a DC current and a light-emitting diode lamp lighted by the DC current from the bridge circuit are provided. Accordingly, in this conventional example, the light-emitting diode lamp is lighted on/off by turning on/off the triac.

[Conventional Technique Document]

[Patent Literature]

[0003]

[Patent Literature 1] JP-A-Heisei 5-66718

[Disclosure of the Invention]

[Problems to be solved by the Invention]

[0004] In the above-mentioned conventional example, since power consumption of the light-emitting diode lamp is smaller than that of the incandescent lamp, a holding current flowing through the triac is easy to fall below a certain value. For this reason, the triac may be suddenly switched to a non-conductive state (turned off) without being able to keep a conductive state and accordingly, can perform a lighting control operation that is different from an intended lighting control operation. Further, since an input current to a light source part may become discontinuous depending on a configuration of a circuit including the light-emitting diode lamp (light source part), the holding current flowing through the triac can fall below the certain value, thereby suddenly turning off the triac.

[0005] Thus, it can be considered that the holding current is ensured by increasing the holding current flowing through the triac to some extent. As means adapted to ensure the holding current, it may be considered that, for example, a diverting circuit formed of a resistor is provided in the light source part, or a power factor improving

circuit employing a dither method or the like is provided so that the input current may not become discontinuous. Alternatively, it may be considered that a resistor or an incandescent lamp may be connected in parallel to the light source part.

[0006] However, in a case where the diverting circuit is provided in the light source part, there occurs a problem that thermal stress caused by heat generation of the resistor is applied to elements constituting the circuit. In other words, the light source part using a light-emitting diode as a light source requires reduction in size and costs, and in order to achieve this, a heat radiating configuration and a circuit are simplified. Thus, when heat is generated by the resistor as the diverting circuit, design to radiate heat is required, resulting in that reduction of the light source part in size and costs becomes difficult. Also when the power factor improving circuit is provided in the light source part, it is difficult to achieve reduction of the light source part in size and costs.

[0007] On the other hand, when the resistor or the like is connected to the light source part in parallel, since there is no need to provide a new circuit in the light source part, it is possible to achieve reduction of the light source part in size and costs. However, an input voltage to the light source part varies and therefore, the lighting control operation that is different from the intended lighting control operation may be performed. This problem is caused by the fact that a current flowing to the resistor connected in parallel becomes small when a power source voltage of an external power source such as a commercial power source is low. In consideration of this variation in the input voltage, it can be considered to design a resistance value of the resistor connected in parallel to be low. However, in such a case, problem occurs that power loss increases as the power source voltage is high.

[0008] In addition, when lighting of the light source part is controlled by the triac, lighting of only the light source part connected to a power supply line to which the triac is connected can be controlled, and lighting of other surrounding illumination fixtures that are not connected to the same power supply line cannot be controlled, which is poor in convenience.

[0009] In consideration of the above-mentioned matters, an object of the present invention is to provide an illumination fixture that can reduce power loss and improve convenience of the lighting control operation.

[Means adapted to solve the Problems]

[0010] An illumination fixture according to the present invention includes one or more light source parts each having a solid-state light-emitting element and a lighting circuit for receiving an AC voltage from an external power source and lighting the solid-state light-emitting element, a bidirectional switching element having a self holding function serially connected to the external power source, a dimmer for controlling the bidirectional switching element to make a conduction angle of the AC voltage of

the external power source variable, and a current adjusting part for keeping a holding current flowing through the bidirectional switching element to a certain value or larger in a conductive period of the bidirectional switching element, and the current adjusting part includes a resistor that is connected to each of the light source parts in parallel when the power source voltage of the external power source falls below a predetermined threshold value, and is released in connection to each of the light source parts when the power source voltage of the external power source exceeds the predetermined threshold value, and a signal output part for outputting a signal to an external device according to an input current inputted to the current adjusting part.

[0011] In the illumination fixture, it is preferred that the signal output part outputs the signal in the conductive period of the bidirectional switching element.

[0012] In the illumination fixture, it is preferred that the current adjusting part includes a microcomputer, and the microcomputer has a receiving part for receiving a signal externally transmitted and performs control according to the signal received by the receiving part.

[0013] In the illumination fixture, it is preferred that the signal output part includes an infrared light-emitting diode.

[0014] In the illumination fixture, it is preferred that the infrared light-emitting diode is plural in number, and arranged so that the infrared light-emitting diodes each output the infrared signal in different directions from each other.

[Effect of the Invention]

[0015] The present invention achieves effects of reducing power loss and improving convenience of the lighting control operation.

[Brief Description of the Drawings]

[0016]

[Fig. 1] Fig. 1 is a schematic view showing a first embodiment of an illumination fixture according to the present invention.

[Fig. 2] Fig. 2 is a schematic view of a light source part in the illumination fixture.

[Fig. 3] Fig. 3 is a schematic view of a current adjusting part in the illumination fixture.

[Fig. 4] Fig. 4 is a waveform chart for describing an operation of the illumination fixture.

[Fig. 5] Figs. 5(a) to (c) are diagrams showing an installation example of the current adjusting part of the illumination fixture.

[Fig. 6] Fig. 6 is a schematic view showing a current adjusting part in a second embodiment of an illumination fixture according to the present invention.

[Best Mode for Carrying Out the Invention]

(First embodiment)

[0017] A first embodiment of an illumination fixture according to the present invention will be described below referring to figures. The present embodiment includes, as shown in Fig. 1, a plurality of (two in this figure) light-emitting diodes 10, a plurality of (three in this figure) light source parts 1 each having a lighting circuit 1A for each of the light-emitting diodes 10, and a triac TR1 serially connected to a commercial power source AC1 as an external power source. The present embodiment further includes a dimmer 2 for controlling the triac TR1 and a current adjusting part 3 connected to each of the light source parts 1 in parallel. In following description, a voltage applied to the current adjusting part 3 is referred to as an "input voltage V1" and a current flowing through the current adjusting part 3 is referred to as an "input current I1".

[0018] Each of the light source part 1 includes, as shown in Fig. 2, the plurality of (two in this figure) serially connected light-emitting diodes 10 as solid-state light-emitting elements, and a current control resistor R1, a lighting control switch part 11 for turning on/off supply power to each of the light-emitting diodes 10. The light source part 1 further includes a rectifying part 12 for rectifying an AC voltage supplied from the commercial power source AC1, a smoothing part 13 for smoothing an output of the rectifying part 12 and outputting it to each of the light-emitting diodes 10, and a voltage detecting part 14 for detecting an output voltage of the rectifying part 12. The light source part 1 further includes a lighting control part 15 for detecting a conduction angle of the power source voltage of the commercial power source AC1 based on a period when the voltage is detected by the voltage detecting part 14. The lighting control part 15 turns on/off of the lighting control switch part 11 with a duty ratio based on the detected conduction angle, thereby controlling lighting of each of the light-emitting diodes 10.

[0019] The rectifying part 12 includes a diode bridge for full-wave rectifying the AC voltage supplied from the commercial power source AC1. The smoothing part 13 includes a diode D1 and a smoothing capacitor C1 connected between output ends of the rectifying part 12 via the diode D1. The voltage detecting part 14 is configured of a series circuit including resistors R2, R3 connected between the output ends of the rectifying part 12. Accordingly, in the voltage detecting part 14, the output voltage of the rectifying part 12 is divided by the resistors R2, R3, and the lighting control part 15 detects the conduction angle based on a potential at a connection point of the resistors R2, R3. The lighting circuit 1A includes the rectifying part 12, the smoothing part 13, the voltage detecting part 14 and the lighting control part 15.

[0020] The triac TR1 is a bidirectional switching element having a self holding function. When the triac TR1

is in a conductive state (is turned on), AC power is supplied from the commercial power source AC1 to each of the light source parts 1 and the current adjusting part 3. Although the triac TR1 is used in the present embodiment, for example, thyristors having different polarities, in place of the triac TR1, may be provided in parallel.

[0021] The dimmer 2 transmits a trigger signal to a gate terminal of the triac TR1 in sync with the power source voltage of the commercial power source AC1, thereby switching the triac TR1 to the conductive state (turning on the triac TR 1). Here, the dimmer 2 can vary timing at which the trigger signal is transmitted to the gate terminal of the triac TR1 according to an operation of its operating part (not shown) or an external lighting control signal. Therefore, the dimmer 2 can control the conduction angle of the power source voltage of the commercial power source AC1, thereby controlling lighting of each of the light-emitting diodes 10 of each of the light source parts 1.

[0022] The current adjusting part 3 includes, as shown in Fig. 3, a rectifier DB1 including a diode bridge for full-wave rectifying the input voltage V1 and a smoothing capacitor C2 for smoothing a pulsating voltage outputted from the rectifier DB1 and outputting it. The current adjusting part 3 further includes a signal outputting part 30, a constant current switching circuit 31, a constant current circuit 32, a resistor connection control circuit 33 and a resistor connection switching circuit 34.

[0023] The signal outputting part 30 is configured by serially connecting a plurality of (three in this figure) shell-type infrared light-emitting diodes 30A to 30C. These infrared light-emitting diodes 30A to 30C each output an infrared signal according to current quantity and can transmit the infrared signal to an external device to control the external device.

[0024] The constant current switching circuit 31 is connected to output ends of the smoothing capacitor C2, and is configured by connecting a series circuit including a resistor R4 and a capacitor C3, and a series circuit formed of a resistor R5 and a switching element Q2 as an npn-type transistor to each other in parallel. A Zener diode D2 is inserted between a connection point of the resistor R4 and the capacitor C3, and a base terminal of the switching element Q2. A collector terminal of the switching element Q2 is connected to a base terminal of a switching element Q1 as an npn-type transistor. A collector terminal of the switching element Q1 is connected to a connection point of a resistor R9 and a capacitor C5 in the below-mentioned constant current circuit 32 via a resistor R8.

[0025] Here, in the constant current switching circuit 31, when an absolute value of the input voltage V1 exceeds a yield voltage of the Zener diode D2, the capacitor C3 is charged and a charging voltage is applied between a base and an emitter of the switching element Q2, thereby turning on the switching element Q2. As a result, since no voltage is applied between a base and an emitter of the switching element Q1, the switching element Q1 is

turned off. On the contrary, when the absolute value of the input voltage V1 does not exceed the yield voltage of the Zener diode D2, the switching element Q2 is turned off and a voltage is applied between the base and the emitter of the switching element Q1, thereby turning on the switching element Q1. A current level of a below-mentioned load current I2 varies based on turning-on/off of the switching element Q1.

[0026] The constant current circuit 32 is connected to the constant current switching circuit 31, and is configured by connecting a series circuit of a resistor R7 and a Zener diode D3, and a series circuit of a switching element Q3 as an npn-type transistor, the resistor R9 and the capacitor C5 to one another. A capacitor C4 for reducing a noise generated in the Zener diode D3 is connected to the Zener diode D3 in parallel. A series circuit of the signal outputting part 30 and a current control resistor R6 is connected to a collector terminal of the switching element Q3. A resistor R10 is connected to the series circuit of the resistor R9 and the capacitor C5 in parallel. Further, the resistor R8 is connected between a connection point of the resistor R9 and the capacitor C5, and a collector terminal of the switching element Q1.

[0027] In the constant current circuit 32, the Zener diode D3 acts as a constant voltage diode, so that a potential at a connection point of the resistor R7 and the Zener diode D3, that is, a base potential of the switching element Q3 becomes substantially constant. Thereby, since the Zener diode D3 operates so that an emitter potential of the switching element Q3 becomes constant, a current flowing through the resistor R10 is kept substantially constant.

[0028] Here, the current flows through only the resistor R10 when the switching element Q1 of the constant current switching circuit 31 is turned off, while the current also flows through the resistors R8, R9 when the switching element Q1 is turned on. For this reason, the "load current I2" flowing through the resistor R6 and the signal outputting part 30 becomes the current flowing through the resistor R10 at turning-off of the switching element Q1 or a combined current of the current flowing through the resistor R10 and the current flowing through the resistors R8, R9 at turning-on of the switching element Q1. Accordingly, the load current I2 increases when the switching element Q1 is turned on and decreases when the switching element Q1 is turned off. When the switching element Q1 is switched from the on state to the OFF state, the load current I2 smoothly varies according to time constants of the resistor R9 and the capacitor C5. When the switching element Q1 is switched from the off state to the ON state, the load current I2 smoothly varies according to time constants of the resistor R8 and the capacitor C5.

[0029] The resistor connection control circuit 33 is connected to the constant current circuit 32 and is configured of a series circuit formed of a resistor R11, a Zener diode D4 and a capacitor C6, and a switching element Q4 as an npn-type transistor. A base terminal of the switching

element Q4 is connected to a connection point of the Zener diode D4 and the capacitor C6, and a collector terminal is connected to a gate terminal of a switching element Q5 in the below-mentioned resistor connection switching circuit 34.

[0030] Here, in the resistor connection control circuit 33, when the absolute value of the input voltage V1 exceeds a yield voltage of the Zener diode D4, the capacitor C6 is charged and a charging voltage is applied between a base and an emitter of the switching element Q4, thereby turning on the switching element Q4. Thereby, since no voltage is applied between a gate and a source of the switching element Q5, the switching element Q5 is turned off. Connection/opening of a below-mentioned resistor R13 is controlled based on turning-on/off of the switching element Q5.

[0031] The resistor connection switching circuit 34 is connected to the resistor connection control circuit 33 and is configured by connecting a series circuit formed of a resistor R12 and a Zener diode D5, and a series circuit including the resistor R13 and the switching element Q5 as an n-channel MOSFET to each other in parallel. The switching element Q5 is biased by the resistor R12 and the Zener diode D5 controls a voltage between a gate and a source of the switching element Q5. A capacitor C7 for reducing noise generated in the Zener diode D5 is connected to the Zener diode D5 in parallel. A capacitor C8 for reducing noise generated in the switching element Q5 is connected to the switching element Q5 in parallel. In order to keep the holding current flowing through the triac TR1 to be a certain value or larger even when the absolute value of the input voltage V1 is low, a resistor having a sufficiently low resistance value is used as the resistor R13.

[0032] Here, in the resistor connection switching circuit 34, since the switching element Q5 is turned on when the switching element Q4 of the resistor connection control circuit 33 is turned off, the resistor R13 is connected and a connecting current flows. On the other hand, since the switching element Q5 is turned off when the switching element Q4 is turned on, the resistor R13 is opened and no connecting current flows.

[0033] An operation of the current adjusting part 3 in the present embodiment will be described referring to Fig. 4. First, from a time t0 to a time t1, since no trigger signal is transmitted from the dimmer 2 to the gate terminal of the triac TR1, the triac TR1 is in a non-conductive state, and therefore, all of the input voltage V1, the input current I1 and the load current I2 are almost zero.

[0034] Next, when the trigger signal is transmitted from the dimmer 2 to the gate terminal of the triac TR1 at the time t1, the triac TR1 is turned on and the input current I1 and the load current I2 increase. Then, the absolute value of the input voltage V1 exceeds the yield voltage of the Zener diode D2 and the yield voltage of the Zener diode D4. In following description, the yield voltage of the Zener diode D2 is referred to as a "first threshold voltage Vth1" and the yield voltage of the Zener diode D4 is re-

ferred to as a "second threshold voltage Vth2" ($V_{th1} > V_{th2}$).

[0035] When the absolute value of the input voltage V1 exceeds the first threshold voltage Vth1, in the constant current switching circuit 31, the switching element Q2 is turned on and the switching element Q1 is turned off. Thereby, the load current I2 is limited to a constant current flowing through the resistor R10. When the absolute value of the input voltage V1 exceeds the second threshold voltage Vth2, in the resistor connection control circuit 33, the switching element Q4 is turned on, and in the resistor connection switching circuit 34, the switching element Q5 is turned off. Thereby, since the resistor R13 is opened and no connecting current flows, the input current I1 is limited to a constant current I10 of low level.

[0036] Timing at which the switching element Q2 is turned on is slightly delayed from a rising edge of the input voltage V1 by a delay circuit formed of the resistor R4 and the capacitor C3. Thereby, it is possible to prevent a false operation due to a ringing current generated at the instant when the triac TR1 is turned on. Then, by appropriately setting time constants of the resistor R4 and the capacitor C3 according to a generation period of the ringing current, the triac TR1 can be reliably turned on.

[0037] From the time t1 to a time t2, since the absolute value of the input voltage V1 exceeds the first threshold voltage Vth1, the input current I1 is kept to be the constant current I10 of low level.

[0038] Next, when the absolute value of the input voltage V1 falls below the first threshold voltage Vth1 at the time t2, in the constant current switching circuit 31, the switching element Q2 is turned off and the switching element Q1 is turned on. Thereby, the load current I2 rises to a sum of the current flowing through the resistor R10 and the current flowing through the resistors R8, R9, and the input current I1 increases to a constant current I11 of high level.

[0039] Then, when the absolute value of the input voltage V1 falls below the second threshold voltage Vth2 at a time t3, in the resistor connection control circuit 33, the switching element Q4 is turned off, and in the resistor connection switching circuit 34, the switching element Q5 is turned on. Thereby, since the resistor R13 is connected and the connecting current flows, the input current I1 increases to I12. After that, until the power source voltage of the commercial power source AC 1 reaches zero cross (the absolute value of the input voltage V1 reaches zero cross) (time t3 to t4), both the input current I1 and the load current I2 decrease according to the power source voltage of the commercial power source AC 1 and becomes almost zero at time t4.

[0040] As described above, in the present embodiment, in a period from a time when the triac TR1 is turned on to a time when the power source voltage of the commercial power source AC1 reaches zero cross, the input current I1 inputted from the current adjusting part 3 to itself can be kept at a certain value or larger. As a result,

since the holding current flowing through the triac TR1 can be kept to be the certain value or larger in the above-mentioned period irrespective of the number of the light source parts 1, the triac TR1 is not suddenly turned off and thus, a lighting control operation that is different from the intended lighting control operation can be prevented. Further, in the present embodiment, while the power source voltage of the commercial power source AC1 exceeds the second threshold voltage V_{th2} , the resistor R13 connected to each of the light source parts 1 in parallel is opened so as not to pass the connecting current. Therefore, power loss at a time when the power source voltage of the commercial power source AC 1 is high can be reduced.

[0041] Further, in The present embodiment, by passing the load current I2 having the certain value or larger to the signal outputting part 30 in the above-mentioned period, the infrared signal can be outputted from each of the infrared light-emitting diodes 30A to 30C of the signal outputting part 30 to an external device. This infrared signal, as shown in Fig. 4, is outputted at a frequency that is twice as much as the power frequency of the commercial power source AC1 and an output period of the infrared signal is equal to a turning-on period of the triac TR1.

[0042] Accordingly, the external device receiving the infrared signal can detect the conduction angle of the power source voltage of the commercial power source AC1 based on the output period of the infrared signal. For this reason, for example, if the external device is an illumination fixture, since lighting can be controlled based on the detected conduction angle, the lighting control operation can be performed in connection with the present embodiment. Thus, since lighting of the light source part 1 connected to a power supply line to which the triac TR1 is connected as well as the external device that is not connected to the same power supply line can be controlled, convenience of the lighting control operation can be improved.

[0043] Although the infrared signal is outputted by using the infrared light-emitting diodes 30A to 30C as the signal outputting part 30 in the present embodiment, a form of the output signal is not limited to infrared ray and for example, a communication method such as wireless communication using a radio wave may be employed.

[0044] An installation example of the current adjusting part 3 in this embodiment will be described referring to figures. In following description, it is defined that vertical and horizontal directions in Fig. 5(a) are vertical and horizontal directions, a near side of the figure is a forward direction and a depth side of the figure is a rearward direction. The current adjusting part 3, as shown in Fig. 5(a), is accommodated in a box-like housing 4. A connecting part 40 caught on a wiring duct 5 arranged on a ceiling is provided on an upper surface of the housing 4 to attach the housing 4 to the wiring duct 5. A power supply line connected to the triac TR1 is arranged in the wiring duct 5. Accordingly, by attaching the connecting

part 40 of the housing 4 to the wiring duct 5, the housing 4 can be mechanically fixed to the wiring duct 5 and the current adjusting part 3 can be electrically connected to the power supply line.

[0045] As shown in Figs. 5(a) and 5(b), the infrared light-emitting diodes 30A to 30C are arranged on right and left side surfaces and a lower surface of the housing 4, respectively, so as to be exposed to an outside. Thereby, since the infrared light-emitting diodes 30A to 30C can output the infrared signal in different directions, an output range of the infrared signal can be extended. A movable part (not shown) may be provided on each of the infrared light-emitting diodes 30A to 30C so that an output orientation of the infrared signal from each of the infrared light-emitting diodes 30A to 30C may be varied.

[0046] By installing the current adjusting part 3 as described above, for example, as shown in Fig. 5(c), the infrared signal can be outputted toward an external device 100. The infrared signal has a frequency of 120 Hz that is about twice as much as the power frequency and contains information such as an on-duty ratio of 80%.

(Second embodiment)

[0047] A second embodiment of an illumination fixture according to the present invention will be described below referring to figures. However, since a basic configuration of this embodiment is the same as that of the first embodiment, description of the common structure is omitted. This embodiment, as shown in Fig. 6, uses a current adjusting part 6 including a microcomputer M1, in place of the current adjusting part 3 in the first embodiment.

[0048] The current adjusting part 6, as shown in Fig. 6, includes the rectifier DB1 including a diode bridge for full-wave rectifying the input voltage V1. The current adjusting part 6 includes a signal output part 60, an input voltage detecting circuit 61, a constant current circuit 62, a control circuit 63, a resistor connection switching circuit 64 and a resistor connection detecting circuit 65.

[0049] The signal output part 60 is configured of one shell-type infrared light-emitting diode 60A. The infrared light-emitting diode 60A outputs the infrared signal according to current quantity and can control the external device and the like by transmitting the infrared signal to the external device. A current control resistor R25 is serially connected to one end of the signal output part 60 and an output terminal P3 of the below-mentioned microcomputer M1 is connected to the other end of the signal output part 60.

[0050] The input voltage detecting circuit 61 is configured by serially connecting a parallel circuit including a resistor R15 and a capacitor C9, and a resistor R14 to one another. The input voltage detecting circuit 61 divides and detects the input voltage V1 via the rectifier DB1 by the resistor R 14 and the resistor R15 and inputs the detected voltage to an A/D input terminal AD1 of the microcomputer M1. The microcomputer M1 converts the

inputted detected voltage into a digital value, compares the digital value with digital values corresponding to the first threshold voltage Vth1 and the second threshold voltage Vth2 in the first embodiment and performs below-mentioned control based on a comparison result. The digital values corresponding to the first threshold voltage Vth1 and the second threshold voltage Vth2 are stored in a memory built in the microcomputer M1. In following description, the digital value converted from the inputted detected voltage is referred to as an "input detection value", the digital values corresponding to the first threshold voltage Vth1 and the second threshold voltage Vth2 are referred to as a "first threshold value" and a "second threshold value", respectively.

[0051] The constant current circuit 62 is connected to the input voltage detecting circuit 61 and is configured by connecting a series circuit including a resistor R16 and a Zener diode D6, and a series circuit including a switching element Q6 as an npn-type transistor and resistors R17, R18 to each other in parallel. A capacitor C10 for reducing noise generated in the Zener diode D6 is connected to the Zener diode D6 in parallel. In the constant current circuit 62, since the Zener diode D6 acts as a constant voltage diode, a potential at a connection point of the resistor R16 and the Zener diode D6, that is, a base potential of the switching element Q6 becomes substantially constant. Thereby, the switching element Q6 operates so that its emitter potential becomes constant. Here, since an emitter current of the switching element Q6 is determined by the resistor R18, a resistor R21 of a below-mentioned control circuit 63 and a switching element Q8, a constant current flowing through the resistor R17 is determined by the resistors R18, R21 and the switching element Q8.

[0052] The control circuit 63 includes a lowpass filter formed of the resistor R21 connected to the resistor R18 in parallel and a capacitor C11. The cutoff frequency of the lowpass filter needs to be higher than the frequency that is twice as much as the power frequency (in this embodiment, the cutoff frequency is set to 1 kHz). The control circuit 63 further includes the switching element Q8 as a pnp-type transistor having a collector terminal connected to an emitter terminal of the switching element Q6 via the lowpass filter. A collector terminal of a switching element Q9 as a pnp-type transistor is connected to a base terminal of the switching element Q8 via a resistor R22. A parallel circuit formed of a capacitor C12 and a Zener diode D7 is connected to the collector terminal of the switching element Q8. A base terminal of the switching element Q9 is connected to an output terminal P1 of the microcomputer M1 via a resistor R23. The output terminal P1 of the microcomputer M1 is also connected to the emitter terminal of the switching element Q8 via a resistor R24.

[0053] Here, the constant current flowing through the resistor R17 in the constant current circuit 62 is determined based on the emitter current of the switching element Q6, and the emitter current of the switching element

Q6 is controlled by turning-on/off of the switching element Q8. In the control circuit 63, a PWM signal is outputted from the output terminal P1 of the microcomputer M1, and is inputted to the base terminal of the switching element Q9 via the resistor R23, thereby turning on/off the switching element Q9. According to the turning-on/off of the switching element Q9, the switching element Q8 is turned on/off.

[0054] Accordingly, by turning on/off the switching element Q8 according to the PWM signal outputted from the microcomputer M1, the emitter current of the switching element Q6 is controlled and thus, the constant current flowing through the resistor R17 in the constant current circuit 62 can be controlled. Then, by varying an on-duty ratio of the PWM signal in the microcomputer M1, the constant current flowing through the resistor R17 in the constant current circuit 62 can be varied. A frequency of the PWM signal needs to be sufficiently higher than the cutoff frequency of the lowpass filter including the resistor R21 and the capacitor C11 (in this embodiment, the frequency of the PWM signal is set to 50 kHz).

[0055] When the switching element Q8 is turned on, the capacitor C12 is charged in a path of the resistor R17, the switching element Q6, the resistor R21 and the switching element Q8. The charging voltage of the capacitor C12 is applied to a power source terminal VC1 of the microcomputer M1 and a below-mentioned reference voltage generating circuit IC1. In other words, the capacitor C12 becomes a driving voltage source for the microcomputer M1 and the reference voltage generating circuit IC1. A voltage between both ends of the capacitor C12 is limited to a certain value by the Zener diode D7.

[0056] The reference voltage generating circuit IC1 includes a switching power source IC for outputting a constant voltage based on the voltage between both the ends of the capacitor C12, and inputs the constant voltage to an input terminal VR1 of the microcomputer M1. Thereby, a reference voltage of A/D conversion in the microcomputer M1 becomes the constant voltage, and even when the input voltage of the power source terminal VC1 of the microcomputer M1 varies to some degree, stable A/D conversion can be performed.

[0057] The resistor connection switching circuit 64 is connected between the collector and the emitter of the switching element Q6 and is configured of a series circuit including a switching element Q7 as an n-channel MOSFET and a resistor R20. An output terminal P2 of the microcomputer M1 is connected to a gate terminal of the switching element Q7 via a resistor R26. Accordingly, the switching element Q7 can be turned on/off by transmitting a driving signal from the output terminal P2 of the microcomputer M1 to the gate terminal of the switching element Q7. Thereby, when the switching element Q7 is turned off, the resistor R20 is opened and no connecting current flows, and when the switching element Q7 is turned on, the resistor R20 is connected and the connecting current flows. A resistor having a sufficiently low resistance value is used as the resistor R20 in order to

keep the holding current flowing through the triac TR1 to be the certain value or larger even when the absolute value of the input voltage V1 is low.

[0058] The resistor connection detecting circuit 65 is configured of a lowpass filter formed of a resistor R27 and a capacitor C 13. The resistor connection detecting circuit 65 is connected to a connection point of a resistor R19 connected to a gate terminal of the switching element Q7 in the resistor connection switching circuit 64 and the resistor R18, and detects a voltage between both ends of the resistor R 18 applied at turning-on of the switching element Q7. Then, the resistor connection detecting circuit 65 inputs the detected voltage to an A/D input terminal AD2 of the microcomputer M1. Thereby, the microcomputer M1 detects a connection state of each of the light source parts 1 based on the detected voltage of the resistor connection detecting circuit 65.

[0059] An operation of the current adjusting part 6 in this embodiment will be described below. First, when the commercial power source AC1 is powered on, the constant current circuit 62 operates, a current flows to the resistor R18 and a voltage is applied to both ends of the resistor R18. Here, a voltage is applied between the base and the emitter of the switching element Q9 via the resistors R21, R24 and R23, thereby turning on the switching element Q9 and the switching element Q8. As a result, the capacitor C13 is charged and the charging voltage is inputted to the power source terminal VC1 of the microcomputer M1. When the charging voltage reaches a predetermined voltage value (a few V), the microcomputer M1 is activated.

[0060] The microcomputer M1 converts an analog voltage inputted to the A/D input terminals AD1, AD2 into a digital value in a cycle that is sufficiently faster than the cycle of the commercial power source AC1. Then, when the input detection value exceeds the first threshold value, the microcomputer M1 varies the on-duty ratio of the PWM signal outputted from the output terminal P1. Thereby, as in the first embodiment, the constant current flowing through the resistor R17 is controlled so that the input current I1 becomes the constant current I10 of low level. After that, until the input detection value falls below the first threshold value, the input current I1 is kept to be the constant current I10 of low level.

[0061] Next, when the input detection value falls below the first threshold value, the microcomputer M1 varies the on-duty ratio of the PWM signal outputted from the output terminal P1. Thereby, as in the first embodiment, the constant current flowing through the resistor R17 is controlled so that the input current I1 becomes the constant current I11 of high level. In other words, the input current I1 increases from the constant current I10 of low level to the constant current I11 of high level.

[0062] Then, when the input detection value falls below the second threshold value, the microcomputer M1 transmits the driving signal of high level from the output terminal P2 to the gate terminal of the switching element Q7, thereby turning on the switching element Q7. There-

by, since the resistor R20 is connected and the connecting current flows, as in the first embodiment, the input current I1 increases to I2. After that, until the power source voltage of the commercial power source AC1 reaches zero cross (the absolute value of the input voltage V1 reaches zero cross), the input current I1 decreases according to the power source voltage of the commercial power source AC1 and when reaching zero cross, becomes almost zero.

[0063] Here, while the switching element Q7 is turned on, the resistor connection detecting circuit 65 detects the voltage between both the ends of the resistor R18 and inputs the detected voltage to the A/D input terminal AD2 of the microcomputer M1. Thereby, the microcomputer M1 can detect the connection state of each of the light source parts 1 based on the detected voltage of the resistor connection detecting circuit 65.

[0064] Further, the microcomputer M1 controls lighting-on/off of the infrared light-emitting diode 60A of the signal output part 60 based on a power cycle of the commercial power source AC1. In other words, the microcomputer M1 can alternately switch the voltage of the output terminal P3 between a high level and a low level of the commercial power source AC1, thereby controlling lighting-on/off of the infrared light-emitting diode 60A. When the output terminal P3 is at a high level, since a potential difference between both ends of the signal output part 60 is not generated, the infrared light-emitting diode 60A is not lighted, and when the output terminal P3 is at a low level, since the potential difference between both ends of the signal output part 60 is generated, the infrared light-emitting diode 60A is lighted. By lighting on/off the infrared light-emitting diode 60A in this manner, as in the first embodiment, the infrared signal can be transmitted to the external device.

[0065] In the present embodiment, since the voltage is supplied from the capacitor C12 of the control circuit 63 to the signal output part 60, even in a period when the triac TR1 is turned off, the infrared light-emitting diode 60A can be lighted on/off. Thus, in the microcomputer M1, by setting using an attached ID setting switch SW1 in the period when the triac TR1 is turned off, the infrared signal with ID information can be transmitted.

[0066] As described above, in this embodiment, as in the first embodiment, in the period from the time when the triac TR1 is turned on to the time when the power source voltage of the commercial power source AC1 reaches zero cross, the input current I1 from the current adjusting part 6 to itself can be kept to be a certain value or larger. As a result, since the holding current flowing through the triac TR1 can be kept to be the certain value or larger irrespective of the number of the light source parts 1 in the above-mentioned period, the triac TR1 does not suddenly turned off, thereby preventing a lighting control operation that is different from the intended lighting control operation. Further, in this embodiment, while the input detection value exceeds the second threshold value, the resistor R20 is opened and no connecting current

flows. Therefore, power loss at the time when the power source voltage of the commercial power source AC 1 is high can be reduced.

[0067] Further, in this embodiment, as in the first embodiment, the infrared signal can be outputted from the infrared light-emitting diode 60A of the signal output part 60 toward the external device. Accordingly, the external device receiving the infrared signal can detect the conduction angle of the power source voltage of the commercial power source AC1 based on the output period of the infrared signal. For this reason, when the external device is an illumination fixture, since lighting can be controlled based on the detected conduction angle, the lighting control operation can be performed in connection with this embodiment. Therefore, since lighting of the light source part 1 connected to the power supply line to which the triac TR1 is connected as well as the external device that is not connected to the same power supply line can be controlled, convenience of the lighting control operation can be improved.

[0068] Furthermore, in this embodiment, as described above, even in the period when the triac TR1 is turned off, the signal output part 60 can output the infrared signal. For this reason, by outputting the infrared signal with the ID information set by the ID setting switch SW1 in this period, even when a plurality of external devices are used, interference can be prevented.

[0069] The microcomputer M1 in this embodiment, as described above, can detect the connection state of each of the light source parts 1 based on the voltage detected by the resistor connection detecting circuit 65. For this reason, using the period when the triac TR1 is turned off, the infrared signal with detected information on the connection state of each of the light source parts 1 can be outputted.

[0070] Further, in this embodiment, since a driving voltage is supplied from the capacitor C12 to the microcomputer M1 at all times, power supply for the microcomputer M1 is relatively stable. For this reason, a receiving part for receiving a signal externally transmitted to the microcomputer M1 may be provided and the microcomputer M1 may perform control based on the signal received by the receiving part. For example, by separately providing an infrared light-receiving part at the microcomputer M1, bidirectional communication between the microcomputer M1 and the external device can be achieved.

[0071] Although the infrared light-emitting diode 60A used as the signal output part 60 outputs the infrared signal in this embodiment, the form of the output signal is not limited to infrared ray and for example, a communication method such as wireless communication using a radio wave may be employed.

[Description of Reference Numerals]

[0072]

1	Light source part
10	Light-emitting diode
1A	Lighting circuit
2	Dimmer
5 3	Current adjusting part
30	Signal output part
30A to 30C	Infrared light-emitting diode
AC1	Commercial power source (External power source)
10 TR1	Triac (Bidirectional switching element)

Claims

- 15 1. An illumination fixture comprising:
 - one or more light source parts each including a solid-state light-emitting element and a lighting circuit for receiving an AC voltage from an external power source and lighting the solid-state light-emitting element;
 - 20 a bidirectional switching element including a self holding function serially connected to the external power source;
 - 25 a dimmer for controlling the bidirectional switching element to make a conduction angle of the AC voltage of the external power source variable; and
 - 30 a current adjusting part for keeping a holding current flowing through the bidirectional switching element to be a certain value or larger in a conductive period of the bidirectional switching element, wherein the current adjusting part includes a resistor that is connected to each of the light source parts in parallel when a power source voltage of the external power source falls below a predetermined threshold value, and is released in connection to each of the light source parts when the power source voltage of the external power source exceeds the predetermined threshold value, and a signal output part for outputting a signal to an external device according to an input current inputted to the current adjusting part.
- 35 2. The illumination fixture according to claim 1, wherein the signal output part outputs the signal in a conductive period of the bidirectional switching element.
- 40 3. The illumination fixture according to claim 1 or 2, wherein:
 - 45 the current adjusting part includes a microcomputer, and
 - the microcomputer has a receiving part for receiving a signal externally transmitted and performs control according to the signal received by the receiving part.

4. The illumination fixture according to any one of claims 1 to 3, wherein the signal output part includes an infrared light-emitting diode.
5. The illumination fixture according to claim 4, wherein the infrared light-emitting diodes is plural in number, and arranged so that the infrared light-emitting diodes each output the infrared signal in different directions from each other.

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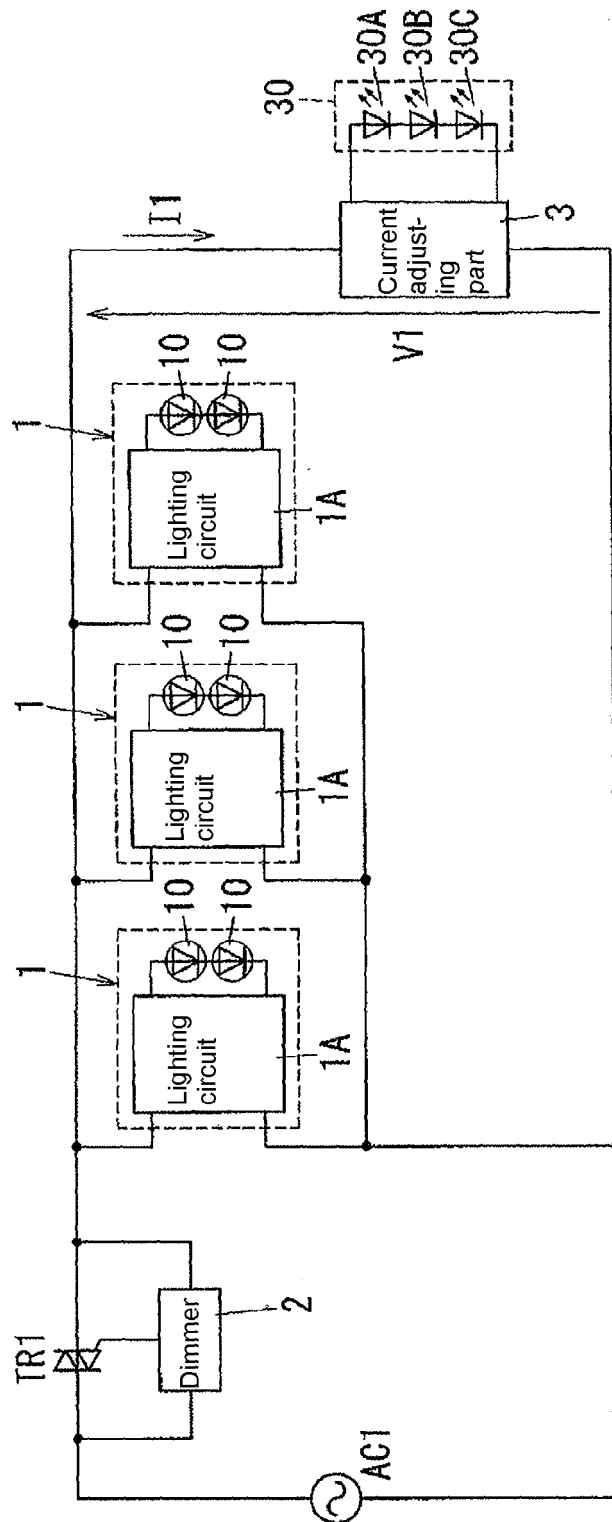
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Figure 1



- 1 Light source part
- 10 Light-emitting part
- 1A Lighting circuit
- 2 Dimmer
- 3 Current adjusting part
- 30 Signal output part
- 30A ~ 30C Infrared light-emitting diode
- AC1 Commercial power source (External power source)
- TR1 Triac (Bidirectional switching element)

Figure 2

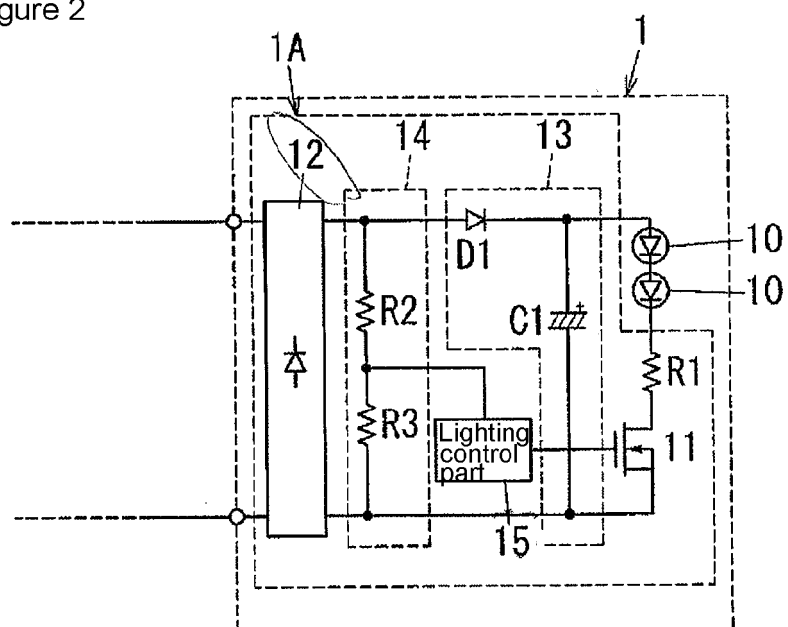


Figure 3

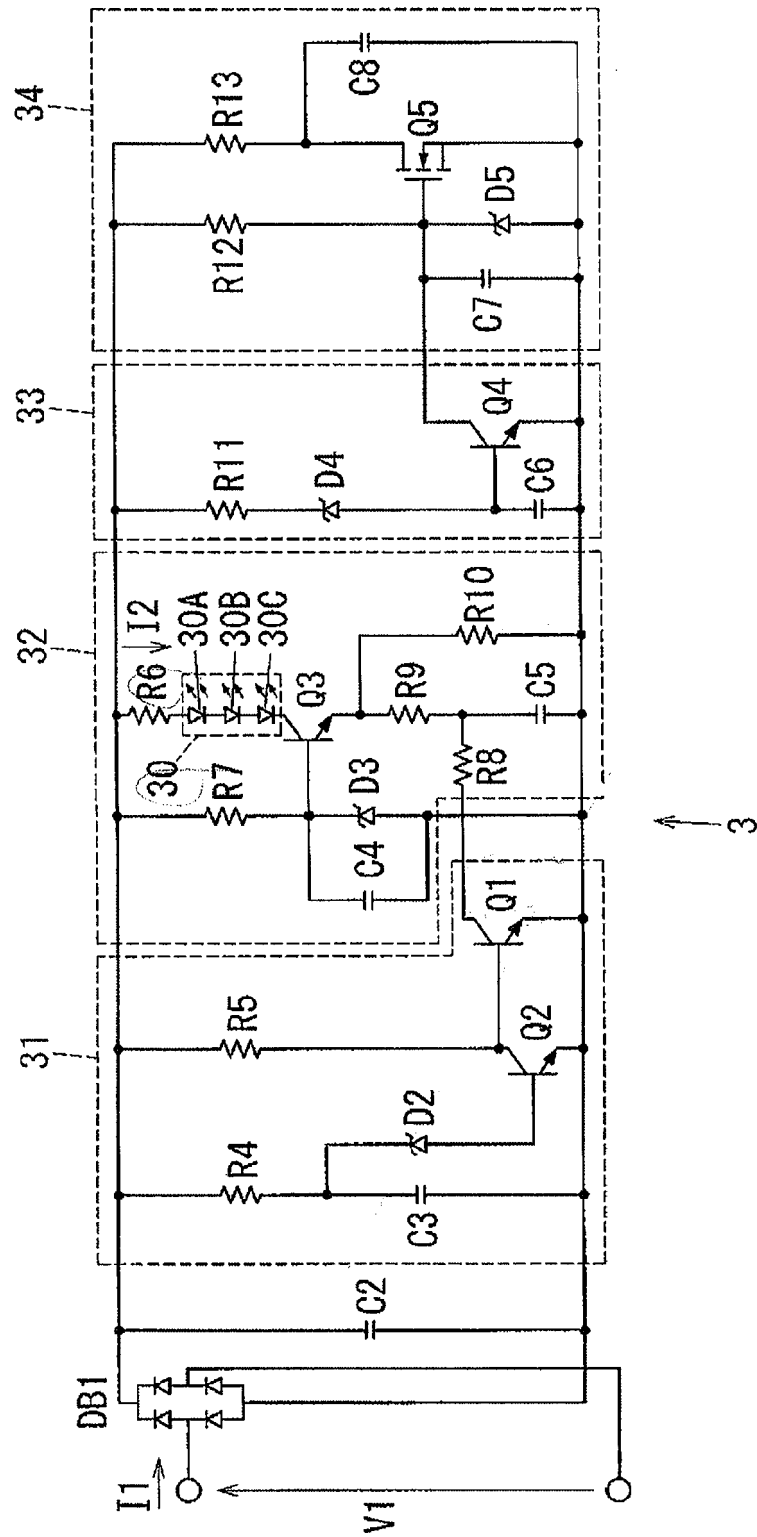


Figure 4

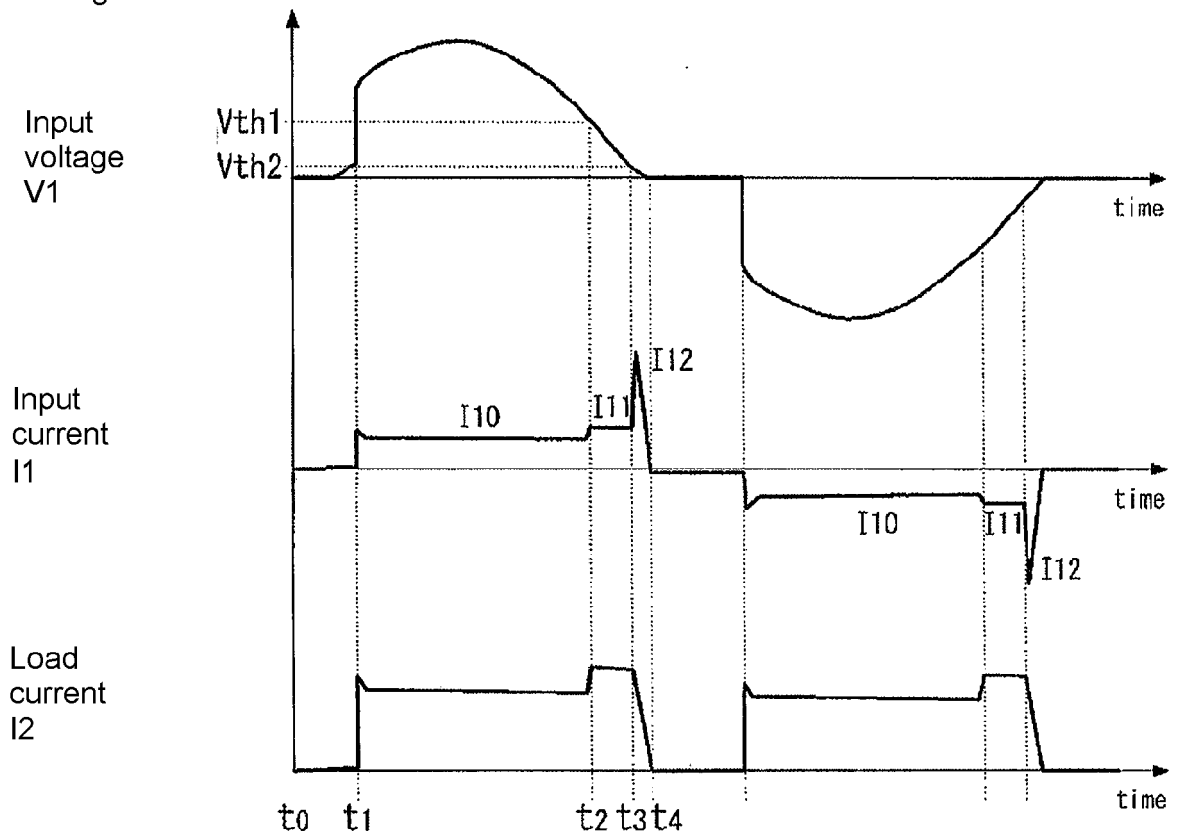


Figure 5

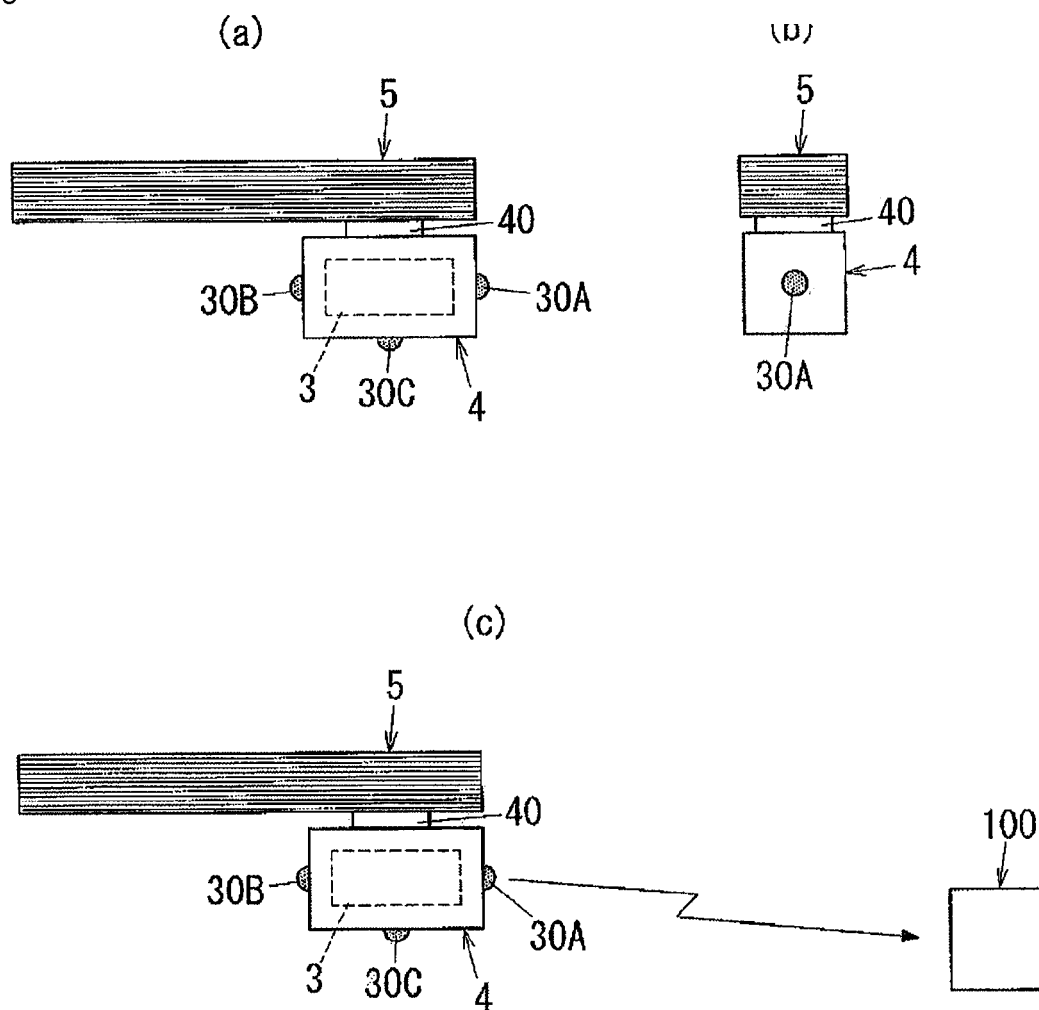
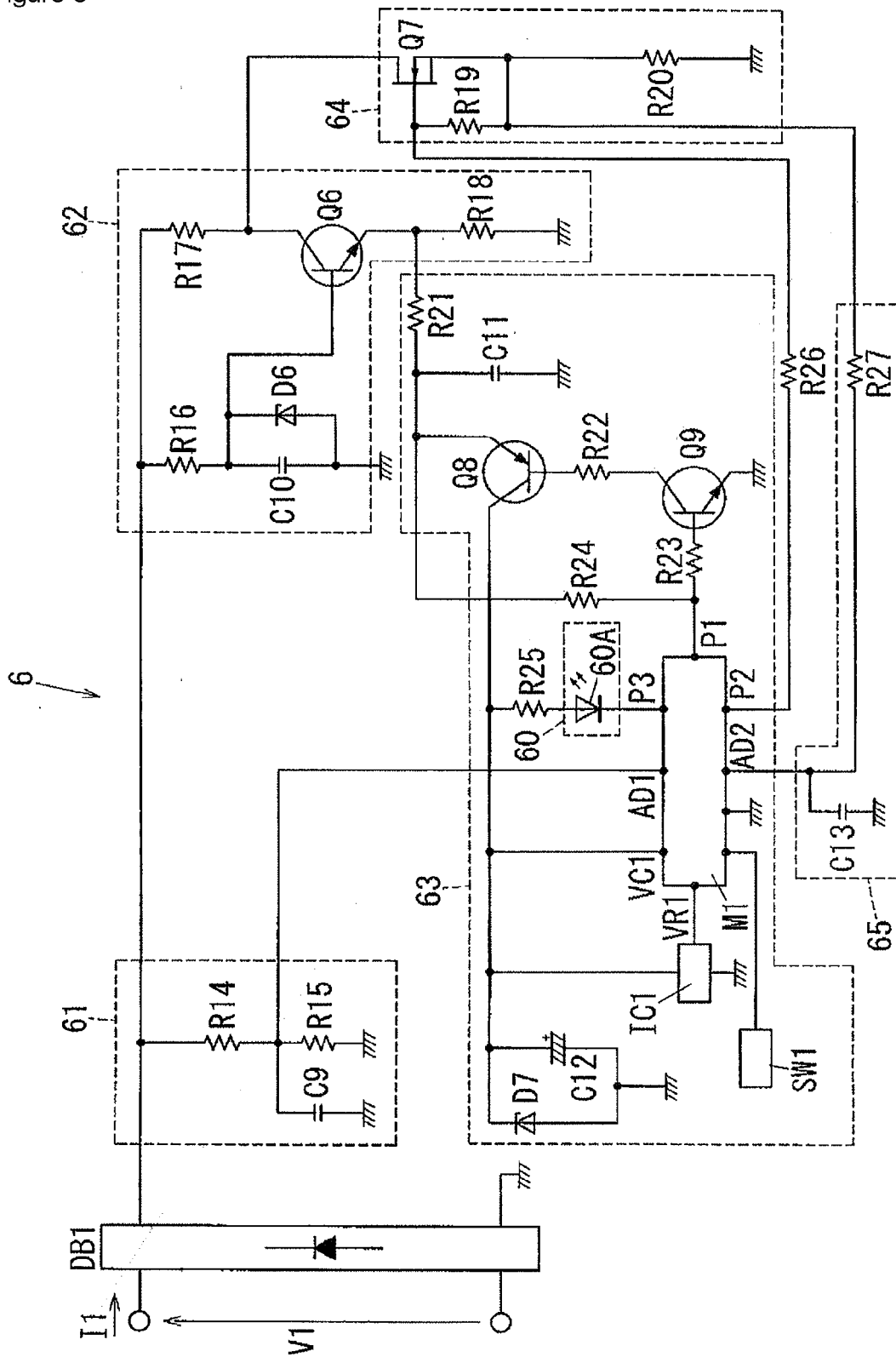


Figure 6



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP HEISEI566718 A [0003]