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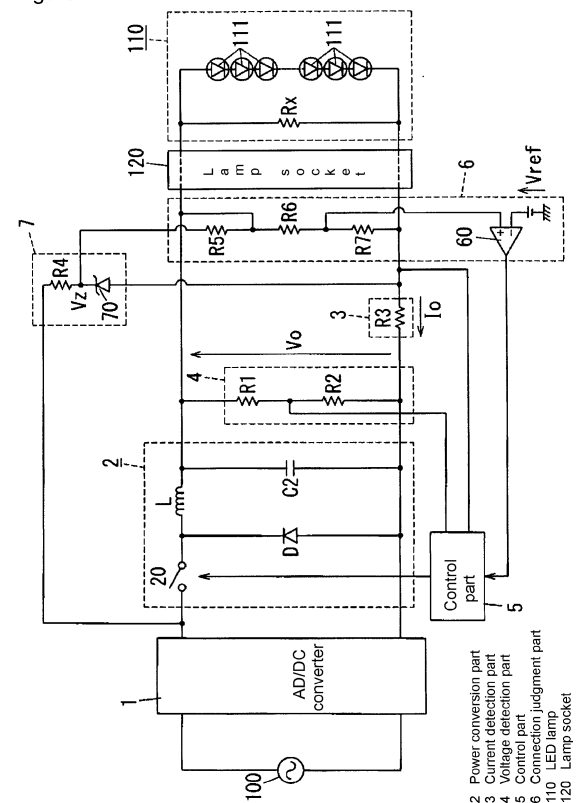
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(54) **LED lighting device and illumination fixture using the same**

(57) [Object] To prevent a breakdown of an LED lamp by suppressing a current flowing when the LED lamp is attached to a lamp socket.

[Means for Settlement] In the case where a voltage equal to or more than a rated voltage of an LED lamp 110 is outputted from a power conversion part 2 under an unloaded state, there is a possibility that an over current exceeding the rated value flows immediately after the LED lamp 110 is connected to the lamp socket 120. However, in an LED lighting device according to the present embodiment, a control part 5 stops the operation of the power conversion part 2 until the connection judgment part 6 judges whether or not the LED lamp 110 is connected. And, the control part 5 starts the operation of the power conversion part 2 after the connection judgment part 6 judges the connection is done (the loaded state). Accordingly, a voltage equal to or more than the rated voltage is not applied to the LED lamp 110, the current flowing when the LED lamp 110 is attached to the lamp socket 120 is suppressed, and thus the LED lamp 110 can be prevented from breaking down.

Figure 1



Description

[Field of the Invention]

[0001] The present invention relates to an LED lighting device for lighting an LED (a light-emitting diode) and to an illumination fixture using the same.

[Background Art]

[0002] In these years, an LED has been increasingly used as a light source for lighting instead of a fluorescent lamp. For example, in Patent Literature 1, an LED lamp having a similar shape to that of a conventional straight tube fluorescent lamp is disclosed. The LED includes: a light source block configured by mounting many LEDs on a mounting substrate formed in a band plate shape: a glass tube formed to be a straight tube for internally housing the light source block; a base for closing both ends of the glass tube; and a terminal pin for supplying electric power to the light source block, the terminal pin projecting from a side surface of the base. The above-mentioned LED lamp is detachably attached to a lamp socket provided to a dedicated illumination fixture, and is turned on when the electric power (direct-current power) is supplied via the lamp socket from the LED lighting device mounted on the illumination fixture.

[0003] In addition, Patent literature 2 describes the LED lighting device as a conventional example. In the conventional example described in Patent Document 2, control (constant current control) to detect a voltage (an output voltage) applied to the LED lamp (a lamp socket) and a current (an output current) flowing in the LED lamp, and to adjust an output voltage so that the output current can coincide with a target value (for example, a rated current of the LED lamp) is carried out.

[Conventional Technique Literature]

[Patent Literature]

[0004]

[Patent literature 1] JP 2009-43447A

[Patent literature 2] JP 2006-210271A

[Disclosure of the Invention]

[Problems to be solved by the Invention]

[0005] However, in the case of replacing the LED lamp and the like, under a state where an LED lighting device keeps operating, the LED lamp was detached from the lamp socket, and then the LED lamp is sometimes attached to the lamp socket again. In this case, there is a possibility that an excessive current over a rated value flows in the LED lamp immediately after the LED lamp has been attached to the lamp socket. And, when the

excessive current has flown, there is a possibility that a light-emitting diode of the LED lamp is broken down.

[0006] The present invention is achieved in consideration of the above-mentioned problems, and intends to prevent an LED lamp from breaking down by suppressing an electric current flowing when the LED lamp is attached to a lamp socket.

[Means adapted to solve the Problems]

[0007] An LED lighting device according to the present invention includes: a power conversion part able to vary an output voltage; a current detection part for detecting an output current supplied via a lamp socket from the power conversion part to the LED lamp; a voltage detection part for detecting the output voltage applied via the lamp socket to the LED lamp; a control part for increasing and decreasing the output voltage by controlling the power conversion part so that the output current detected by the current detection part can coincide with a target value; and a connection judgment part for judging whether or not the lamp socket is connected to the LED lamp, wherein the control part limits the output voltage to a predetermined minimum value or less by controlling the power conversion part in the case where a judgment result of the connection judgment part shows no connection and does not limit the output voltage to the predetermined minimum value or less in the case where the judgment result of the connection judgment part shows connection.

[0008] In the LED lighting device, it is preferred that the LED lighting device includes: a constant voltage source for applying a constant voltage via the lamp socket; and a detection resistance connected via the lamp socket in parallel to a resistance connected in parallel with a light-emitting diode in the LED lamp, wherein the connection judgment part determines the connection is done when a voltage drop in the detection resistance is less than a predetermined threshold value and determines the connection is not done when the voltage drop is the predetermined threshold value or more.

[0009] In the LED lighting device, it is preferred that the control part limits the output voltage to the minimum value or less by controlling the power conversion part in the case where the output voltage detected by the voltage detection part falls below a predetermined threshold voltage when the judgment result of the connection judgment part shows the connection is done.

[0010] An illumination fixture according to the present invention comprises: the LED lighting device according to any one of claims 1 to 3; the lamp socket; and a fixture body for holding the LED lighting device and the lamp socket.

[Effect of the Invention]

[0011] An LED lighting device and an illumination fixture according to the present invention has an effect of preventing an LED lamp from breaking down by sup-

pressing an electric current flowing when the LED lamp is attached to a lamp socket.

[Brief Description of the Drawings]

[0012]

[Fig. 1] Fig. 1 is a circuit block diagram showing an embodiment of an LED lighting device according to the present invention.

[Fig. 2] Fig. 2] is a perspective view showing an embodiment of an illumination fixture according to the present invention.

[Best Mode for Carrying Out the Invention]

[0013] Referring to drawings, an embodiment of the present invention will be explained in detail below referring to drawings.

[0014] Fig. 1 is a circuit block diagram showing the embodiment of an LED lighting device according to the present invention.

[0015] An LED lamp 110 lighted by the LED lighting device according to the embodiment has a similar configuration to the LED lamp described in Patent Document 1. Specifically, the LED lamp 110 includes a series circuit of many light-emitting diodes 111, a resistance Rx connected in parallel with the series circuit, a glass tube of a straight tube type (refer to Fig. 2), and bases (not shown in the drawings) for closing both ends of the glass tube. Meanwhile, a pair of terminal pins (not shown in the drawings) connected via a lamp socket 120 to an output terminal of the LED lighting device is provided to the base to be projected. Then, a direct current (an output current Io) is supplied via the terminal pin from the lamp socket 120 to the light-emitting diode 111.

[0016] The LED lighting device according to the embodiment includes an AC/DC converter 1, a power conversion part 2, a current detection part 3, a voltage detection part 4, a control part 5, a connection judgment part 6, and a constant voltage source 7. The AC/DC converter 1 converts an alternating voltage supplied from a commercial alternating power source 100 into a desired direct voltage, and, for example, includes a conventionally-known step-up chopper circuit (a power factor improvement circuit).

[0017] The power conversion part 2 includes a conventionally-known step-down chopper circuit including: a semiconductor switching element (hereinafter, abbreviated to a switching element) 20 such as a bipolar transistor and a field-effect transistor; an inductor L; a diode D; and a capacitor C2.

[0018] The voltage detection part 4 includes a series circuit of voltage-dividing resistances R1 and R2 connected between the output terminals of the power conversion part 2 (between both ends of the capacitor C2). Then, detected voltages (voltages proportional to an output voltage Vo) divided by the voltage-dividing resistances

es R1 and R2 are outputted from the voltage detection part 4 to the control part 5. In addition, the current detection part 3 includes a detection resistance R3 inserted between the output terminal on a negative voltage side of the power conversion part 2 and a negative electrode side of the lamp socket 120. Then, the voltage stepping-down of the detection resistance R3 due to the output current Io is outputted as the detected voltage from the current detection part 3 to the control part 5.

[0019] The control part 5 is configured by a controlling integrated circuit or a microcontroller and a memory, and controls the power conversion part 2 so that the output current Io detected by the current detection part 3 can coincide with a target value, thereby increasing and decreasing the output voltage Vo. In the case where the control part 5 is configured by the microcontroller and the memory, data of a rated current value of the LED lamp 110 is preliminarily stored in the memory. Then, the microcontroller (the controller 5) converts the detected voltage received from the current detection part 3 into a magnitude of the output current Io (a current value), and adjusts an on-duty ratio of the switching element 20 so that the current value can coincide with the rated current value (the target value) stored in the memory, thereby increasing and decreasing the output voltage Vo. That is, the control part 5 carries out constant current control to pass a constant current (a rated current) through the LED lamp 110.

[0020] Here, the rated voltage of the LED lamp 110 is a value obtained by multiplying a forward voltage Vf of the used light-emitting diode 111 by the number n of the light-emitting diodes 111 ($= V_f \times n$). For example, when the forward voltage Vf is 3.5 V and the number n of the light-emitting diodes 111 is 20, the rated voltage is $3.5 \times 20 = 70$ V, and when the number n of the light-emitting diodes 111 is 10, the rated voltage is $3.5 \times 10 = 35$ V. In addition, the control part 5, for example, may carry out the constant current control within at least a range between 35V and 70V so that a plurality of the LED lamps having various rated voltage can be used.

[0021] The constant voltage source 7 includes: a resistance R4 connected at one end to the output terminal on a higher potential side of the AC/DC converter 1; and a Zener diode 70 connected at the cathode to the other end of the resistance R4 and connected at the anode to a lower potential side of the lamp socket 120. Then, a constant voltage (a Zener voltage Vz) generated between both ends (between the cathode and anode) of the Zener diode 70 is applied via a resistance R5 to the lamp socket 120 and the connection judgment part 6, respectively. Meanwhile, the constant voltage (the Zener voltage) applied from the constant voltage source 7 is required to be lower than the rated voltage of the LED lamp 110. In the case of the configuration where the plurality of LED lamps having various rated voltage can be used, the constant voltage (the Zener voltage) can be set so as to be lower than the rated voltage referring to the LED lamp having a lower rated voltage as a criterion.

Moreover, in the case where the rated voltage of the LED lamp exceeds a dangerous voltage and the voltages divided by the resistances R5, R6, and R7 exceed the dangerous voltage, the constant voltage (the Zener voltage) applied from the constant voltage source 7 has to be a lower voltage than the dangerous voltage. The voltage value of the dangerous voltage slightly varies depending on the specification, but generally is a voltage exceeding 50V in the direct current.

[0022] The connection judgment part 6 includes: a series circuit of three resistances R5, R6, and R7 connected between the cathode of the Zener diode 70 and the lower potential side of the lamp socket 120; and a comparator 60 for comparing the voltage stepping-down in the resistance (detection resistance) R7 with a threshold voltage Vref. Meanwhile, the connection point of two resistances R5 and R6 is connected to the higher potential side of the lamp socket 120. In a state where the LED lamp 110 is not connected to the lamp socket 120 (an unloaded state), the voltage obtained by dividing the Zener voltage Vz with the resistances R5, R6, and R7 (the voltage stepping-down in the resistance R7) is inputted to a positive terminal of the comparator 60. Meanwhile, in a state where the LED lamp 110 is connected to the lamp socket 120 (a loaded state), the resistance Rx of the LED lamp 110 is connected in parallel to two resistances R6 and R7. Accordingly, the voltage stepping-down in the resistance R7 under the loaded state is lower than that under the unloaded state. Here, the threshold voltage Vref inputted to a negative terminal of the comparator 60 is set to be a value between the voltage stepping-down in the resistance R7 under the loaded state and the voltage stepping-down in the resistance R7 under the unloaded state. Hence, the output of the comparator 60 becomes an H level under the unloaded state and becomes an L level under the loaded state. In addition, the output of the comparator 60 (the judgment result of the connection judgment part 6) is inputted to the control part 5, and in accordance with the output of the comparator 60, the control part 5 makes the power conversion part 2 be operating or non-operating.

[0023] Next, an operation of the LED lighting device according to the embodiment will be explained. Firstly, when a power source switch is turned on to start the power source supply from the commercial alternating power source 100, the AC/DC converter 1 operates to output the direct voltage. When the direct voltage is outputted from the AC/DC converter 1, the constant voltage (the Zener voltage Vz) is applied from the constant voltage source 7 to the connection judgment part 6 and the lamp socket 120. Then, the connection judgment part 6 carries out the judgment, the loaded state or the unloaded state. When the judgment result of the connection judgment part 6 is the loaded state, the control part 5 makes the power conversion part 2 operate to start the constant current control. Meanwhile, in the case where the judgment result of the connection judgment part 6 is the unloaded state, the control part 5 does not make the power

conversion part 5 operate.

[0024] Here, in the case where a voltage equal to or more than the rated voltage of the LED lamp 110 is outputted from the power conversion part 2 under the unloaded state, there is a possibility that an over current exceeding the rated value flows immediately after the LED lamp 110 is connected to the lamp socket 120. However, in the LED lighting device according to the present embodiment, the control part 5 stops the operation of the power conversion part 2 until the connection judgment part 6 judges whether or not the LED lamp 110 is connected. And, since the control part 5 starts the operation of the power conversion part 2 after the connection judgment part 6 judges the connection is done (the loaded state), a voltage equal to or more than the rated voltage is not applied to the LED lamp 110. As the result, the current flowing when the LED lamp 110 is attached to the lamp socket 120 is suppressed, and accordingly the LED lamp 110 can be prevented from breaking down.

[0025] Subsequently, the case where the LED lamp 110 is detached from the lamp socket 120 under a condition where the power conversion part 2 is operating will be explained. When the LED lamp 110 is detached from the lamp socket 120, the output current Io does not flow; however, the output voltage Vo of the power conversion part 2 is increased because the control part 5 continues the constant current control. And, when the output voltage Vo detected by the voltage detection part 4 exceeds a predetermined maximum value (> the rated voltage), the control part 5 cancels the constant current control to stop the power conversion part 2. Accordingly, when the LED lamp 110 is connected to the lamp socket 110 next time, the connection judgment by the connection judgment part 6 is carried out under the state the output of the power conversion part 2 stops as described above. Moreover, immediately after the LED lamp 110 is detached from the lamp socket 120 to stop the power conversion part 2, a high voltage (= the predetermined maximum value) is generated in the lamp socket 120. However, when the resistance value of the resistance R5 is set to be relatively small, the current passes the resistance R5 and the Zener diode 70, and thus the voltage applied to the lamp socket 120 can be rapidly decreased.

[0026] Finally, the case where the LED lamp 110 is broken down under the condition where the power conversion part 2 is operating will be explained. However, in the case of breaking-down caused when a line in the LED lamp 110 is broken (opened), the case is substantially similar to the case where the LED lamp 110 is detached from the lamp socket 120 as described above, and accordingly the explanation is omitted.

[0027] In the case of breaking-down caused when the line in the LED lamp 110 shorts, the number of the light-emitting diodes 111 is substantially reduced, and thus the output voltage Vo of the power conversion part 2 is reduced when the control part 5 carries out the constant current control. Then, when the output voltage detected by the voltage detection part 4 falls below the predeter-

mined value (<the rated voltage), the control part 5 cancels the constant current control to stop the power conversion part 2.

[0028] As described above, in the case where the breaking down such as the breaking of wire and the short-circuit is caused in the LED lamp 110, the control part 5 stops the operation of the power conversion part 2, and thus the broken LED lamp 110 can be prevented from being continuously used.

[0029] Meanwhile, in the present embodiment, the control part 5 stops the power conversion part 2 in the unloaded state and in the breaking-down; however, the stopping is not necessarily required. For example, in the unloaded state and in the breaking-down, the control part 5 controls the power conversion part 2 to limit the output voltage V_o to be the minimum value sufficiently lower than the rated voltage of the LED lamp 110 or less. In addition, the LED lighting device according to the present embodiment lights one LED lamp 10; however, it is needless to say that the plurality of LED lamps 110 connected in series can be lighted at the same time. In addition, after the power source supply from the commercial alternating power source 100 is started, the connection judgment part 6 judges the loaded state and the unloaded state, and when the judgment result shows the loaded state, the control part 5 may operate the AC/DC converter 1 and the power conversion part 2.

[0030] Meanwhile, the LED lighting device according to the embodiment, for example, is mounted on the illumination fixture shown in Fig. 2. The illumination fixture includes: a fixture body 130 directly fixed to a ceiling; and a pair of lamp sockets 120 provided to the fixture body 130.

[0031] The fixture body 130 is formed in a long angulated cylindrical shape whose side surface shape seen from the longitudinal direction is a trapezoidal shape, and internally houses the LED lighting device. And, the lamp sockets 120 and 120 are arranged on both end parts in the longitudinal direction on a lower surface of the fixture body 130, respectively. The lamp sockets 120 and 120 have the same structure as that of a conventionally-known lamp socket for a straight tube fluorescent lamp. Here, in the case where a direct current is supplied from any one of two lamp sockets 120 and 120 to the LED lamp 110, there is a possibility that the direct current is supplied to the filament part when the fluorescent lamp is attached to the lamp sockets 120 and 120 by mistake. However, since the power conversion part 2 is stopped when the output voltage detected by the voltage detection part 4 falls below a predetermined value (< the rated voltage) as described above, there is not a possibility that an unsafe phenomenon and the breaking-down of the lighting device are caused even in the case where the fluorescent lamp is attached by mistake. However, when attaching the fluorescent lamp by mistake, a user cannot distinguish whether it is safe or not. Hence, in order to prevent the mistake attachment, an electrode shape of the base of the LED lamp 110 may be formed to be a

different shape from that of the fluorescent lamp, and the lamp sockets 120 and 120 may have a structure conforming to the base of the LED lamp 110.

5 [Description of Reference Numerals]

[0032]

- 2 Power conversion part
- 10 3 Current detection part
- 4 Voltage detection part
- 5 Control part
- 6 Connection judgment part
- 110 LED lamp
- 15 120 Lamp socket

Claims

- 20 1. An LED lighting device comprising: a power conversion part able to vary an output voltage; a current detection part for detecting an output current supplied via a lamp socket from the power conversion part to the LED lamp; a voltage detection part for detecting the output voltage applied via the lamp socket to the LED lamp; a control part for increasing and decreasing the output voltage by controlling the power conversion part so that the output current detected by the current detection part can coincide with a target value; and a connection judgment part for judging whether or not the lamp socket is connected to the LED lamp, wherein
 - 25 the control part limits the output voltage to a predetermined minimum value or less by controlling the power conversion part in the case where a judgment result of the connection judgment part shows a no connection and does not limit the output voltage to the predetermined minimum value or less in the case where the judgment result of the connection judgment part shows connection.
- 30 2. The LED lighting device according to claim 1, comprising: a constant voltage source for applying a constant voltage via the lamp socket; and a detection resistance connected via the lamp socket in parallel to a resistance connected in parallel with a light-emitting diode in the LED lamp, wherein
 - 35 the connection judgment part determines the connection is done when a voltage drop in the detection resistance is less than a predetermined threshold value and determines the connection is not done when the voltage drop is the predetermined threshold value or more.
- 40 3. The LED lighting device according to claim 1 or 2, wherein
 - 45 the control part limits the output voltage to the minimum value or less by controlling the power conversion part

sion part in the case where the output voltage detected by the voltage detection part falls below a predetermined threshold voltage when the judgment result of the connection judgment part shows the connection is done.

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4. An illumination fixture comprising: the LED lighting device according to any one of claims 1 to 3; the lamp socket; and a fixture body for supporting the LED lighting device and the lamp socket.

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Figure 1

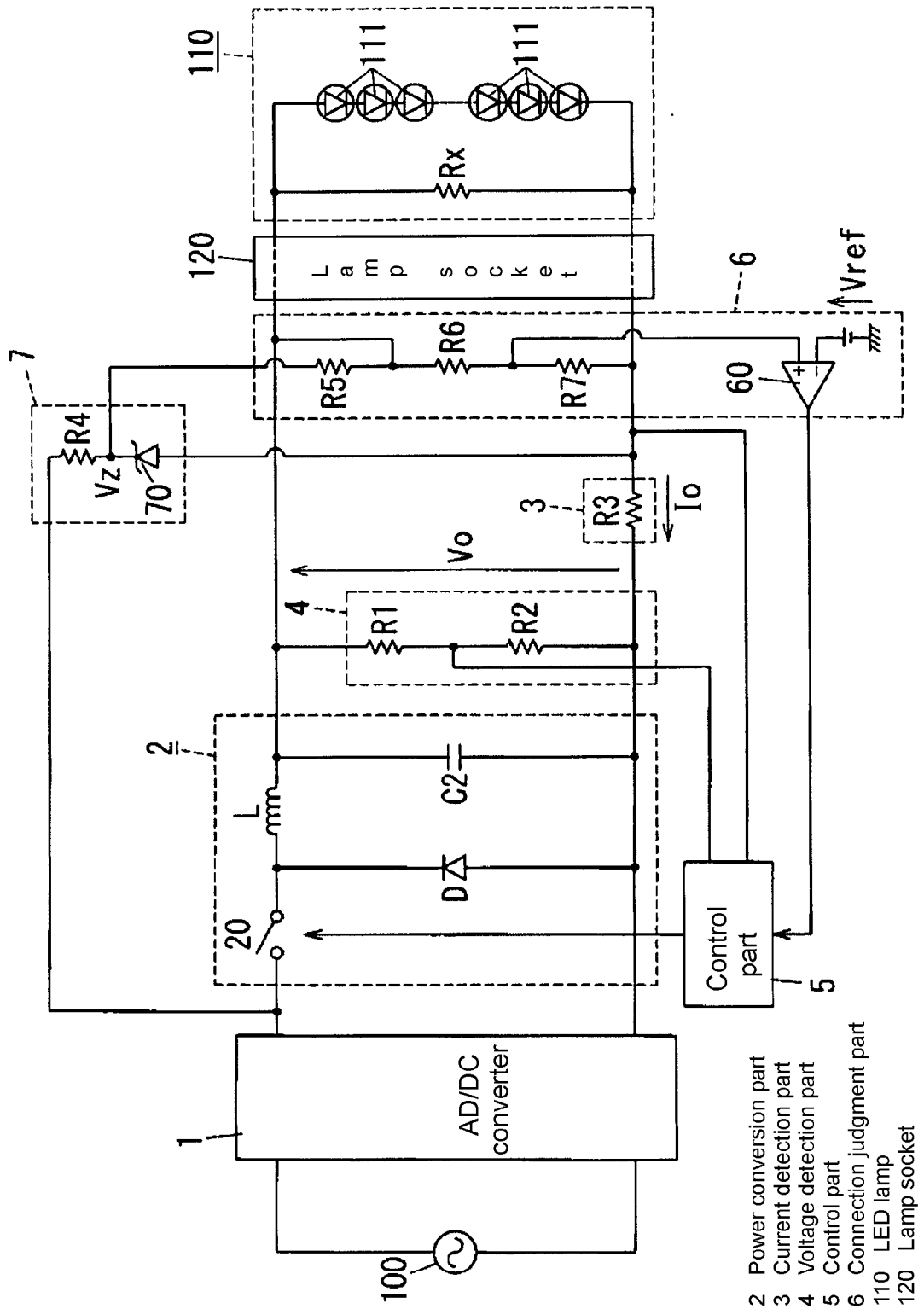
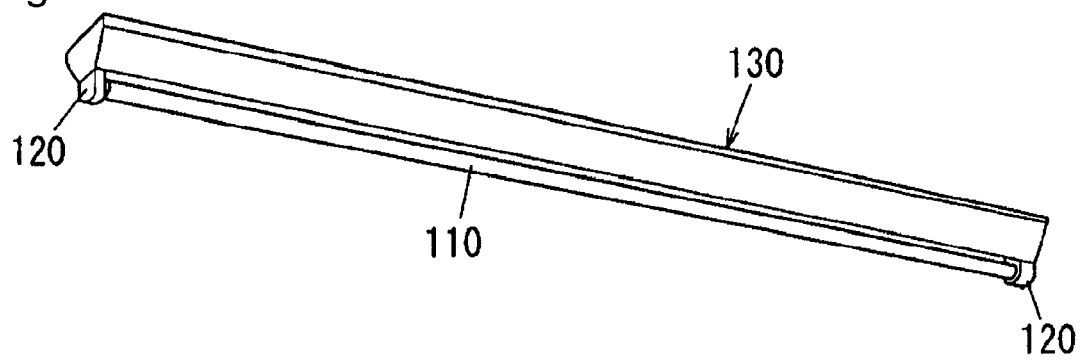


Figure 2





EUROPEAN SEARCH REPORT

Application Number
EP 11 17 2730

DOCUMENTS CONSIDERED TO BE RELEVANT				
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)	
X	US 2008/284346 A1 (LEE SANG YUN [KR]) 20 November 2008 (2008-11-20)	1,3,4	INV. H05B33/08	
A	* pages 3-5; figure 1 * -----	2		
X	US 7 391 335 B2 (MUBASLAT SAED M [US] ET AL) 24 June 2008 (2008-06-24)	1,3,4		
A	* columns 11, 12; figure 2 * -----	2		
X	US 2008/197786 A1 (SCHAIBLE UWE D [CA] ET AL) 21 August 2008 (2008-08-21)	1,3,4		
A	* pages 2, 3; figure 1 * -----	2		
The present search report has been drawn up for all claims				TECHNICAL FIELDS SEARCHED (IPC)
				H05B
Place of search		Date of completion of the search	Examiner	
Munich		8 November 2011	Morrish, Ian	
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 17 2730

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08-11-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2008284346 A1	20-11-2008	JP 4782164 B2	28-09-2011
		JP 2008288207 A	27-11-2008
		KR 100867551 B1	10-11-2008
		TW 200847120 A	01-12-2008
		US 2011043134 A1	24-02-2011
US 7391335 B2	24-06-2008	EP 1915630 A2	30-04-2008
		US 2007040696 A1	22-02-2007
		WO 2007022409 A2	22-02-2007
US 2008197786 A1	21-08-2008	CA 2621909 A1	19-08-2008

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2009043447 A [0004]
- JP 2006210271 A [0004]