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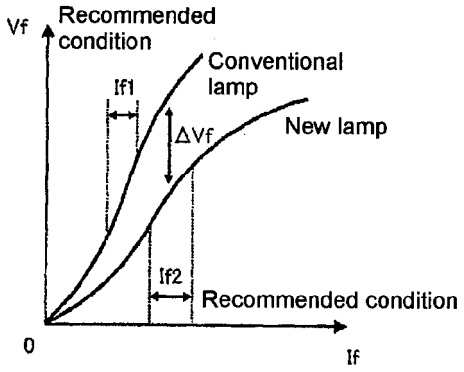
## (54) Discharge lamp lighting device and illumination fixture

(57) [Object] A plurality of lamps having compatible electrical characteristics and considerably different rated power can be lit by using a common lighting device.

[Means for Settlement] In a discharge lamp lighting device capable of lighting plural types of discharge lamps with different recommended conditions of precedent preheating for filament and determining the type of a discharge lamp by detecting a voltage at both ends of the filament within a period of precedent preheating time, a higher current value included in the recommended conditions is used for a preheating current in the detection and an output is set to be applicable to rated power of a determined discharge lamp. A preheating current in the detection is also set to generate a discharge between electrodes in the periphery of a filament within a period of precedent preheating time if a discharge lamp with lower criteria of the recommended conditions is fitted.

Fig. 1




EP 2 106 200 A2

## Description

[Field of the Invention]

**[0001]** The present invention relates to a discharge lamp lighting device for lighting a discharge lamp having a thermal cathode, and a illumination fixture using thereof.

[Background Art]

**[0002]** Discharge lamps such as fluorescent lamps are variously rated in general. Discharge lamps are different not only in a structural size, a shape and a filament structure or the like, but also in electrical characteristics such as a lamp voltage and a lamp current in normal lighting, a starting voltage at the starting time, and preheating current characteristics at the preheating time. As a result, a discharge lamp lighting device has been exclusively used for a fluorescent lamp according to a product name thereof in substantially one to one corresponding relationship. A technique progress in the lighting device in recent years has made it possible to use a lighting device commonly for fluorescent lamps of plural ratings with a similar structure and similar electrical characteristics, and mainstream discharge lamp lighting devices in, for example, a class with a straight tube length of 4 feet include a lighting device for FHF32 which is also capable of lighting other lamps such as FLR40S/36 and FL40SS/37.

**[0003]** There is also a well-known technique which enables to use a lighting device commonly for discharge lamps with considerably different ratings. For example, fluorescent lamps or so-called T5 lamps with a tube diameter of 16mm in the same shape and size with those in a class with a tube length of 4 feet are divided into two types of lamps including 54W (HO: lamp current 400mA, lamp voltage 135V) and 28W (HE: lamp current 170mA, lamp voltage 165V), and their difference is approximately double in the rating. Therefore, it is impossible to commonly use a lighting device in the same manner with treating the above FHF32, FLR40S/36 and FLR40S/36. Therefore, a type determination means adapted to determine the type of a lamp and a control means adapted to variably control an oscillation frequency of a lighting circuit and an output voltage of a DC power source circuit are provided so as to obtain the rating of individual adaptable lamps when each of the lamps is lit. More specifically, the type of a lamp is determined by a resistance value of a filament in each fluorescent lamp, a lamp voltage and a lamp current in lighting each lamp.

**[0004]** Patent document 1 proposes a configuration in which a single lighting device is commonly used for mounting fluorescent lamps with different ratings in the same shape by determining the type of lamps using a filament resistance value, a lamp voltage and a lamp current or the like and changing over a switching frequency of an inverter.

[Patent Document 1] Japanese Unexamined Patent Publication No. H11-307290

[Disclosure of the Invention]

[Problems to be solved by the Invention]

**[0005]** There has been proposed a new lamp in which an output is increased without reducing life while maintaining electrical compatibility with existing lamps. This lamp realizes both extension of life and a high output by optimizing coil design and an emitter coating amount in a filament, and a phosphor in an internal surface of a glass bulb or the like with almost no changes made in the gas which is sealed inside a glass bulb of the lamp. It is made possible to realize a flow of a lamp current which is substantially doubled to that of conventional lamps at the time of lighting, whereas a lamp voltage similar to that of conventional lamps is maintained, so that light outputted from almost two of conventional lamps can be obtained by a single lamp, which is favorably received particularly in the renewal market.

**[0006]** However, this new lamp which maintains electrical compatibility with the conventional lamp has a lamp voltage substantially equivalent to that of the conventional lamp, so that it is impossible to determine the type of the lamp by a lamp voltage at the time of lighting. A slight difference in the filament resistance also makes it difficult to determine the type of the lamps by a filament resistance value obtained before lighting the lamps in a cold state. Accordingly, it is extremely difficult to determine the difference between the conventional lamp and the new lamp even if the technique as disclosed in Patent Document 1 is used.

**[0007]** Moreover, if such two types of lamps are lit by a lighting device which can be commonly used to light a similar lamp as disclosed by the technique in Patent Document 1, following problems arise. If a new lamp is connected to a lighting device for use in the conventional lamp, only about half of a light output originally aimed for the new lamp can be obtained. In contrast, if the conventional lamp is connected to a lighting device for use in the new lamp, power which is about double the lamp rating of the conventional lamp is applied and causes early deterioration of the lamp. In either case, these lamps go beyond the category of "similar lamp" to be seen from the lighting device because a difference is approximately double in the rated power of the lamp, preventing the lamps from exhibiting original performances thereof.

**[0008]** The present invention has achieved by taking the above problems into consideration and an object thereof is to light a plurality of lamps with compatible electrical characteristics and considerably different rated power by using a common lighting device.

[Means adapted to solve the Problems]

**[0009]** A first aspect of the present invention is to provide a discharge lamp lighting device capable of lighting plural types of discharge lamps with different recommended conditions of precedent preheating for filament and determining the type of a discharge lamp by detecting a voltage at both ends of a filament within a period of precedent preheating time, wherein a higher current value included in the recommended conditions is used for a preheating current in the detection, and an output is set to be applicable to rated power of a determined discharge lamp, in order to solve the above problems as shown in Figs. 1 to 3.

**[0010]** A second aspect of the present invention is to provide a discharge lamp lighting device capable of lighting plural types of discharge lamps with different recommended conditions of precedent preheating for filament and determining the type of a discharge lamp by detecting a voltage at both ends of a filament within a period of precedent preheating time, wherein a preheating current used in the detection has a current value to cause a discharge between electrodes in the vicinity of the filament within the period of the precedent preheating time if a discharge lamp with low criteria of the recommended conditions is mounted, and an output is set to be applicable to rated power of a determined discharge lamp, in order to solve the above problems as shown in Figs. 3 to 5.

**[0011]** A third aspect of the present invention is based on the discharge lamp lighting device according to any one of the first and second aspects of the present invention, wherein the type of a mounted discharge lamp is determined only at the initial precedent preheating time, an output thereafter is set to be applicable to the initially determined discharge lamp, and determination information of the discharge lamp is reset when the discharge lamp is removed.

**[0012]** A fourth aspect of the present invention is based on the discharge lamp lighting device according to any one of the first to third aspects of the present invention, wherein the plurality of the discharge lamps has a difference of 1.5 times or more in the amount of emitter coated on a filament.

**[0013]** A fifth aspect of the present invention is to provide a illumination fixture including the discharge lamp lighting device according to any one of the first to fourth aspects of the present invention, a fixture main body 31 for mounting the discharge lamp lighting device, and a socket 32 arranged in the fixture main body 31 so as to attachably/detachably mount a discharge 21 and electrically connect the discharge lamp lighting device and the discharge lamp 21.

[Effect of the Invention]

**[0014]** The present invention makes it possible to light a plurality of lamps with compatible electrical characteristics and considerably different rated power by using a common lighting device.

**[0015]** According to the first aspect of the present invention, the type of a plurality of lamps with different recommended conditions of precedent preheating for filament can be easily determined by causing a higher current included in the recommended conditions to flow in a filament to detect a voltage at both ends of the filament. It is also made possible to light a plurality of lamps with considerably different rated power in a common lighting device by setting the lighting device to have an output applicable to rated power of a connected lamp. It is further possible to realize the determination within a short period of time because a lamp can be determined within a period of precedent preheating time.

**[0016]** According to the second aspect of the present invention, the type of a plurality of lamps with different recommended conditions of precedent preheating for filament can be easily determined by applying a voltage, which causes a discharge between electrodes of a filament, to a filament if a discharge lamp with lower criteria of the recommended conditions is mounted.

**[0017]** According to the third aspect of the present invention, a mounted discharge lamp is determined only at the initial precedent preheating time and an output thereafter in a lighting device is set to be applicable to the initially determined lamp, whereby preventing deterioration of the lamp due to repetition of the determination process. Determination information on a lamp is also reset when the lamp is removed, which makes it possible to realize precedent preheating under recommended conditions constantly even if the lamp is exchanged while being used.

**[0018]** According to the fourth aspect of the present invention, if a plurality of discharge lamps has a difference of 1.5 times or more in an amount of emitter coated on the filament, a remarkable difference will appear in the voltage at both ends of the filament with respect to a preheating current, whereby realizing the determination with higher accuracy.

**[0019]** According to the fifth aspect of the present invention, an illumination fixture capable of lighting a plurality of lamps with considerably different rated power by using a common lighting device can be provided with the discharge lamp lighting device having a lamp determination function as stated above.

[Best Mode for Carrying Out the Invention]

(First embodiment)

**[0020]** A lighting device for a fluorescent lamp generally employs "precedent preheating" to heat a filament prior to apply a starting voltage to a lamp so that the time for the lamp to reach an end of life can be extended as long as possible by suppressing consumption of an emitter (i.e. thermal electron emitting substance) which is coated on the filament. The present embodiment exem-

plifies how to determine a discharge lamp by detecting a voltage at both ends of the filament within this precedent preheating time.

**[0021]** In the case of the aforementioned new lamp which is enhanced to have an about double light output by causing a flow of a lamp current which is approximately double the lamp current of a conventional lamp, a heat capacity of a filament is made larger than that of a conventional lamp by optimizing a coil design in order to allow the filament to bear the increased lamp current. However, a filament resistance in a cold state is equivalent to or slightly lower than that of the conventional lamp, and using this difference is extremely difficult to determine the type of lamps.

**[0022]** A recommended condition for a precedent preheating current which is applied to the filament are fixed according to product names of lamps, and a parameter which considerably affects the recommended condition include a heat capacity of the filament. Even if the same preheating current is made to flow in a coil, a large heat capacity of a filament prevents a sufficient temperature rise in the coil, resulting in an insufficient preheating state. That is, the new lamp has a recommended preheating condition with a higher current than that of the conventional lamp.

**[0023]** Relationship as shown in Fig. 1 is established between a preheating current If and a voltage Vf at both ends of the filament. Although, the voltage at both ends of the filament rises as the preheating current is increased, a new lamp with a larger filament preheating capacity has a more gradual rise in the voltage Vf at both ends of the filament with respect to a rise of the preheating current If. It is because a lamp with a larger heat capacity is allowed to further suppress a rise in the resistivity of the filament.

**[0024]** Filament has a configuration as shown in Fig. 2. 10 represents a coil, 11 represents a glass bulb, 12 represents a lead wire, and 13 represents a glass stem. The filament has a heat capacity which is determined by factors such as the number, a wire diameter and winding of the coil 10, the length and a wire diameter of the lead wire 12, and a size of the glass stem 13. Such characteristics of the filament are used to detect a voltage at both ends of the filament within precedent preheating time during which the preheating current is made to flow, so as to easily determine the type of lamps even if only a slight difference is observed in the resistance of the filament in a cold state. Then, a preheating current which is made to flow at that time is set to have a value corresponding to a lamp with a higher preheating current in the recommended conditions in order to further increase a difference in the filament voltage V, which can be therefore a more preferable method. In Fig. 1, If1 shows a recommended preheating current for the conventional lamp, and If2 shows a recommended preheating current for the new lamp.

**[0025]** Once the type of a lamp is determined by such a method, a lighting device which determined the lamp is set to have an output applicable to rated power of the lamp to be connected in order to light the lamp, whereby a plurality of lamps with considerably different rated power can be lit by using a common lighting device.

**[0026]** Moreover, a lamp is generally being attached to a illumination fixture in a normal usage state until the lamp reaches the end of life, in which the type of the lamp does not need to be determined every time in the precedent preheating and the determination may be executed only at the initial precedent preheating time after mounting the discharge lamp. Information on the determination results is written into a storage element such as, for example, a micro computer and a nonvolatile memory, and the information is read in lighting a lamp. Stored determination information is reset when a lamp is removed, which enables precedent preheating under recommended conditions constantly except for the initial precedent preheating time even if the type of a lamp is changed while being used. Particularly because precedent preheating applied to a mounted conventional lamp for determination of the lamp deviates from recommended conditions thereof, it is desirable to set the frequency of the type determination as low as possible so that deterioration of the lamp can also be suppressed. This also applies to another embodiment to be explained later.

**[0027]** Fig. 3 shows a general configuration of the discharge lamp lighting device according to the present embodiment. An AC voltage of a commercial AC power source 1 is subjected to full-wave rectification by a full-wave rectifier circuit 2, converted into a smooth DC voltage by a chopper circuit 3, converted into high frequency AC power by an inverter circuit 4, and supplied to a discharge lamp load circuit 5.

**[0028]** The inverter circuit 4 includes a switching element to be switched by a high frequency, and a resonance circuit which is made of a resonance inductor and a resonance capacitor to be excited by a switched high frequency, having a structure to start/light a discharge lamp by supplying high frequency power generated in the resonance circuit to the discharge lamp load circuit 5. An inverter control circuit 8 has a function to control a switching frequency of the switching element so as to shift to a stable lighting mode through a preheating mode for causing a current to flow in the filament in a level without lighting the discharge lamp prior to start the discharge lamp, and a starting mode for applying a high voltage required to start the discharge lamp.

**[0029]** The discharge lamp load circuit 5 includes a fluorescent lamp and a preheating circuit for the fluorescent lamp. The preheating circuit may be configured in a capacitor preheating method and/or a winding preheating method. The capacitor preheating method generally provides a configuration in which a preheating capacitor is connected between respective one ends of a pair of filaments of a fluorescent lamp so as to supply high frequency AC power of the inverter circuit 4 to a point between the other respective ends of the pair of the filaments. The winging preheating method generally pro-

vides a configuration in which a preheating transformer is connected to an output of the inverter circuit 4 via a capacitor so as to supply a preheating current to a pair of filaments of a fluorescent lamp via a preheating capacitor from a pair of secondary windings arranged in the preheating transformer respectively. In another configuration example by the winding preheating method, a pair of secondary windings for preheating may be arranged in an inductor (e.g. resonance inductor) of the inverter circuit 4 so as to supply a preheating current to a pair of filaments of a fluorescent lamp via a preheating capacitor from the pair of the secondary windings respectively. In either case, a configuration may be provided so as to selectively realize a combination of a lamp current applicable to the conventional lamp and a filament current and a combination of a lamp current applicable to the new lamp and a filament current.

**[0030]** The type of a fluorescent lamp connected to the discharge lamp load circuit 5 is detected by a lamp type detection circuit 6 at the initial precedent preheating time and stored in a storage part of a lamp type correction circuit 7. That is, it is controlled so that the lamp type detection circuit 6 detects the type of the lamp by preheating the new lamp at a recommended preheating current at the initial precedent preheating time, and a recommended preheating current of the conventional lamp or the new lamp is used to preheat the lamp at the next preheating time and thereafter in accordance with the type of a lamp held in the lamp type correction circuit 7. More specifically, corrections are made in the characteristics of the resonance circuit of the inverter 4 in accordance with the type of the lamp held in the lamp type correction circuit 7, an oscillation frequency of the inverter circuit 4 is corrected by the inverter control circuit 8, and an output voltage of the chopper circuit 3 is corrected by a chopper control circuit 9. It is therefore possible to supply an appropriate preheating current and an appropriate lamp current to any one of the conventional lamp and the new lamp to be connected.

**[0031]** Explanation will be made here for an advantage of a lamp having an emitter coating amount which is 1.5 times more than a normal amount. If lamps to be determined have a difference of 1.5 times or more in the emitter coating amount, it is of course possible to prevent error detection owing to a sufficient difference observed in the remaining emitter amount, wherein a distinctive difference has been discovered in the life of a lamp with respect to a lamp output. The life of the lamp is generally shortened by an increased lamp current which increases a surface temperature of the filament and accelerates emitter consumption. However, a lamp coated with emitter whose amount is 1.5 times more than that of a normal lamp (G-Hf fluorescent lamp: FHF63) has been sold by Matsushita Electric Industrial Co., Ltd, and the lamp allows a life of a rated lamp to be multiplied by 1.5 even if a lamp current approximately double the current of a conventional lamp such as FHF32 is made to flow (or even in about double brightness). A lamp output can be thus increased by coating emitter 1.5 times more than a normal amount while securing life of the lamp. The discharge lamp lighting device according to the present embodiment makes it possible to supply an appropriate preheating current and an appropriate lamp current even in connecting a conventional lamp such as FHF21 and a new lamp such as a G-Hf fluorescent lamp.

(Second embodiment)

**[0032]** The first embodiment exemplified a discharge lamp lighting device in which the type of lamps with different recommended conditions of precedent preheating is determined by causing a preheating current If 2, being a higher current in the conditions, to flow in the lamps and detecting the voltage Vf at both ends of the filament, whereas the present embodiment shows an example of causing a much higher preheating current If3 to flow. A general configuration in the discharge lamp lighting device may remain the same as that of Fig. 3.

**[0033]** According to the explanation made for the relationship between the current If flowing through the filament and the voltage Vf at both ends of the filament as shown in Fig. 1 in the first embodiment, a voltage applied to a filament needs to be further increased in order to cause a much higher current to flow. The filament is fixed by lead wires 12 arranged on the glass stem 13 as explained in Fig. 2, wherein a distance of only several to ten and several milliliters is allowed between the lead wires so as to be contained in the glass bulb 11 with a narrow tube diameter, and a shortest distance therebetween is generally in the vicinity of the glass stem 13. If a voltage applied to the filament is increased here, dielectric breakdown occurs between the lead wires and a discharge is observed between the electrodes as shown in Fig. 5. This phenomenon is used to determine the type of lamps.

**[0034]** As explained in Fig. 1 in the first embodiment, lamps with different recommended conditions of precedent preheating have different characteristics in the voltage Vf at both ends of a filament with respect to the preheating current If, wherein the lamp with lower criteria of the recommended conditions has a larger increase in the filament voltage Vf. When a voltage applied to the filament is increased here, a large current is made to flow in the coil 10 whose temperature becomes extremely high, and a lamp with lower criteria of the recommended conditions tends to have a higher temperature in the coil 10. Heat generated in the coil 10 is conducted to the glass stem 13 via the lead wires 12, so that a high temperature is also observed in the vicinity of the glass stem 13. Since the glass is characterized with a tendency in such that an insulation resistance decreases as approaching a melting temperature, the glass stem 13 behaves like a conductor when discharge is generated between electrodes as shown in Fig. 5, exhibiting a sharp decrease in the voltage Vf at both ends of a filament as shown in Fig. 4.

**[0035]** In contrast, a lamp with higher criteria of the

recommended conditions of precedent preheating is originally based on a design which allows the lamp to bear a high preheating current, whereby a discharge between electrodes is hard to occur and a temperature in the glass stem 13 can be suppressed to low. That is, a high preheating current for causing the conventional lamp to have a decrease in the voltage Vf at both ends of the filament as shown in If3 of Fig. 4 is made to flow (i.e. high voltage is applied to the filament) so as to easily determine the type of lamps.

**[0036]** Both the first and second embodiments make it possible to determine the type of lamps with different recommended conditions of precedent preheating, and lamps having a difference of 1.5 times or more in the amount of the emitter coated on the coil of the filament exhibit a more remarkable difference in the voltage at both ends of the filament with respect to the preheating current and can be determined with higher accuracy, which is particularly effective.

**[0037]** Fig. 6 shows an appearance of the illumination fixture to which the discharge lamp lighting device according to the first and second embodiments is mounted. Both the first and second embodiments are provided with a fixture main body 31 for integrating the discharge lamp lighting device having a determination function as stated above and fitting the discharge lamp lighting device, and a socket 32 arranged in the fixture main body so as to attachably/detachably mount the discharge lamp 21 and electrically connect the discharge lamp lighting device and the discharge lamp, whereby it is made possible to provide a illumination fixture 30 in which a plurality of lamps with considerably different rated power can be lit by using a common lighting device.

[Brief Description of the Drawings]

**[0038]**

[Fig. 1] Fig. 1 is an operation explanatory diagram according to a first embodiment of the present invention.

[Fig. 2] Fig. 2 is a main component diagram of a fluorescent lamp according to the first embodiment of the present invention.

[Fig. 3] Fig. 3 is a block diagram showing a configuration example of a discharge lamp lighting device according to the first and second embodiments of the present invention.

[Fig. 4] Fig. 4 is an operation explanatory diagram according to the second embodiment of the present invention.

[Fig. 5] Fig. 5 is a main component diagram of a fluorescent lamp according to the second embodiment of the present invention.

[Fig. 6] Fig. 6 is a perspective view showing an appearance of an illumination fixture for mounting the discharge lamp lighting device according to the first and second embodiments of the present invention.

[Description of Reference Numerals]

**[0039]**

| | |
|---|---|
| 4 | Inverter circuit |
| 5 | Discharge lamp load circuit |
| 6 | Lamp type detection circuit |
| 7 | Lamp type correction circuit |
| If | Filament preheating current |
| Vf | Voltage at both ends of a filament |

## Claims

1. A discharge lamp lighting device capable of lighting plural types of discharge lamps with different recommended conditions of precedent preheating for filament and determining the type of a discharge lamp by detecting a voltage at both ends of the filament within a period of precedent preheating time, wherein:

   a higher current value included in the recommended conditions is used for a preheating current in the detection; and
   an output is set to be applicable to rated power of a determined discharge lamp.

2. A discharge lamp lighting device capable of lighting plural types of discharge lamps with different recommended conditions of precedent preheating for filament and determining the type of a discharge lamp by detecting a voltage at both ends of the filament within a period of precedent preheating time, wherein:

   a current value to cause a discharge between electrodes in the vicinity of the filament within a period of the precedent preheating time is used for a preheating current in the detection of a mounted discharge lamp with low criteria of the recommended conditions and an output is set to be applicable to rated power of a determined discharge lamp.

3. The discharge lamp lighting device according to any one of claims 1 and 2, wherein a mounted discharge lamp is determined only at initial precedent preheating time, an output thereafter being set to be applicable to the initially determined discharge lamp, and determination information of the discharge lamp being reset upon removal of the discharge lamp.

4. The discharge lamp lighting device according to any one of claims 1 to 3, wherein the plurality of the discharge lamps has a difference of 1.5 times or more in the amount of emitter coated on the filament.

**5.** An illumination fixture comprising: the discharge lamp lighting device according to any one of claims 1 to 4; a fixture main body for fitting the discharge lamp lighting device; and a socket arranged in the fixture main body so as to attachably/detachably mount the discharge lamp and electrically connect the discharge lamp lighting device and the discharge lamp.

Fig. 1

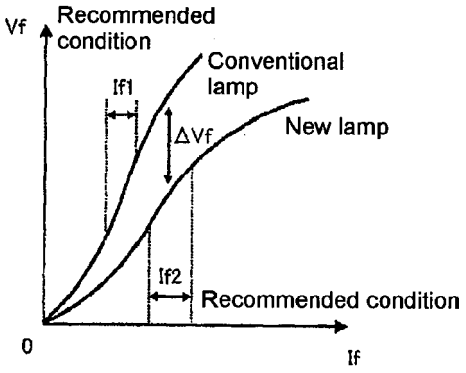

Vf
Recommended condition
Conventional lamp
If1
ΔVf
New lamp
If2
Recommended condition
0
If

Fig. 2

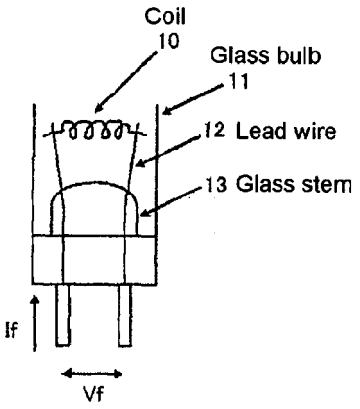

Coil
10
Glass bulb
11
12 Lead wire
13 Glass stem
If
Vf

Fig. 3

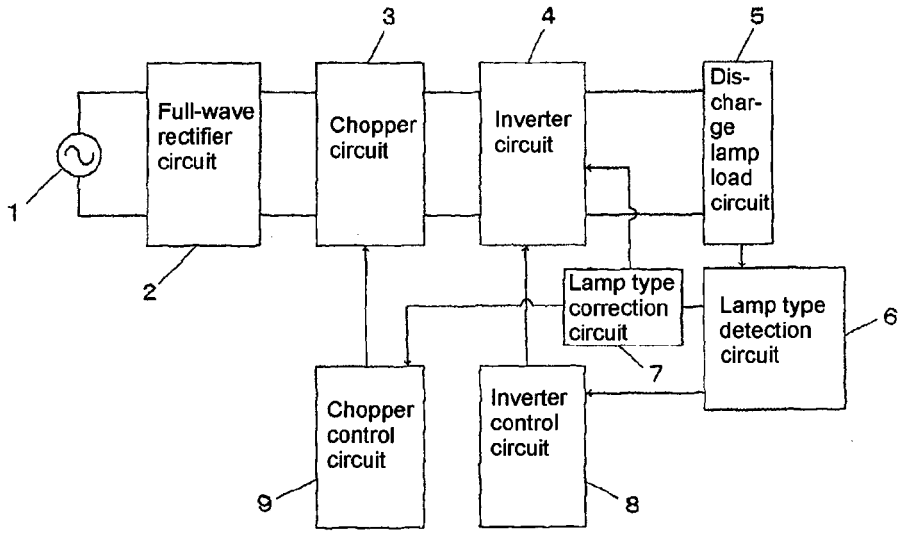

3
4
5
Full-wave rectifier circuit
Chopper circuit
Inverter circuit
Dis-char-ge lamp load circuit
1
2
Lamp type correction circuit
Lamp type detection circuit
6
7
Chopper control circuit
Inverter control circuit
9
8

Fig. 4

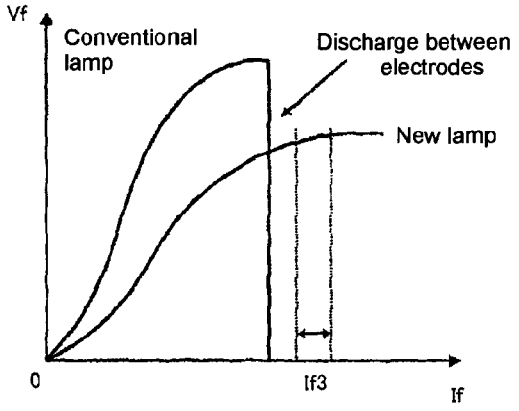

Vf
Conventional lamp
Discharge between electrodes
New lamp
0
If3
If

Fig. 5

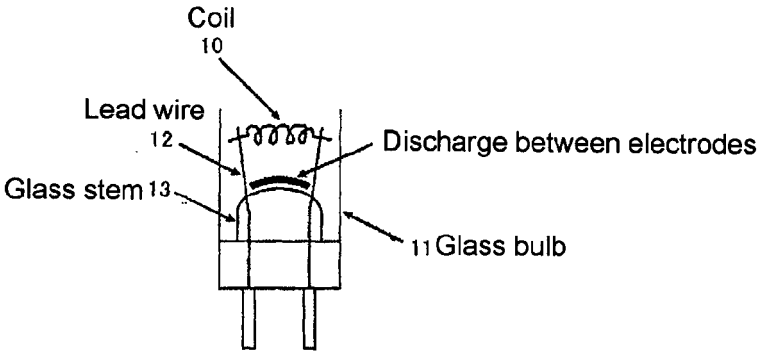
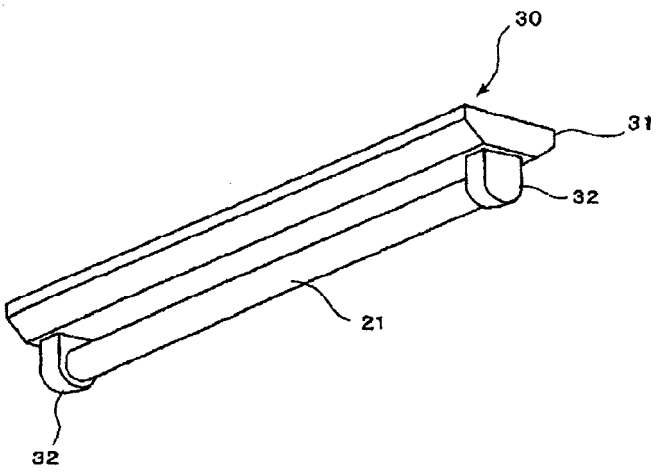

Coil
10
Lead wire
12
Discharge between electrodes
Glass stem 13
11 Glass bulb

Fig. 6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## REFERENCES CITED IN THE DESCRIPTION

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