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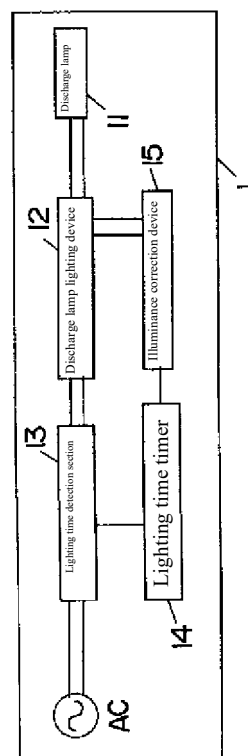
(54)[Title of invention] Lighting device

(57) [Summary]

[Problem] To provide a lighting device that suppresses a decrease in illuminance associated with elapsed usage time, and that is easy to install and has a relatively low cost even in the case when there is a small number of units.

[Means for solving] The discharge lamp lighting device 12 can illuminate the discharge lamp 11 and control the supply power to the discharge lamp 11. The power supply time to the discharge lamp lighting device 12 is measured by the lighting time timer 14 as the lighting time of the discharge lamp 11. In the illuminance correction device 15, the power supply to the discharge lamp 11 is instructed to the discharge lamp lighting device 12 according to the lighting time measured by the lighting time timer 14 so as to suppress the decrease in luminous flux as the lighting time of the discharge lamp 11 passes. The discharge lamp 11, the discharge lamp lighting device 12, the lighting time timer 14, and the illuminance correction device 15 are provided in one lighting fixture 1.

[Means for solving]



[Scope of Patent Claims]

[Claim 1] A lighting device characterized by comprising, in one fixture, a discharge lamp, a discharge lamp lighting device capable of lighting the discharge lamp and controlling the power supplied to the discharge lamp, a lighting time timer that measures the time that power is supplied to the discharge lamp lighting device as the lighting time of the discharge lamp, and an illuminance correction device that instructs the discharge lamp lighting device to adjust the power to be supplied to the discharge lamp in accordance with the lighting time measured by the lighting time timer so as to suppress a decrease in luminous flux over the course of the lighting time of the discharge lamp.

[Claim 2] The lighting device according to Claim 1, characterized in that a circuit board on which the lighting time timer and the illuminance correction device are mounted is provided separately from a circuit board on which the discharge lamp lighting device is mounted.

[Claim 3] The lighting device according to Claim 1, characterized in that a circuit board on which the lighting time timer and the illuminance correction device are mounted is provided integrally with a circuit board that implements the discharge lamp lighting device.

[Claim 4] The lighting device according to any one of Claim 1 to Claim 3, characterized in that the discharge lamp lighting device is an inverter circuit.

[Claim 5] The lighting device according to any one of Claims 1 to Claim 4, characterized in that the illuminance correction device determines the power to be supplied to the discharge lamp by comparing the dimming ratio and the lighting time instructed from the outside with a correction table.

[Claim 6] The lighting device according to any one of Claim 1 to Claim 4, characterized in that the illuminance correction device determines the power to be supplied to the discharge lamp by correcting the power to be supplied to the discharge lamp, which is calculated from the luminous flux maintenance ratio of the discharge lamp according to the lighting time, with the dimming ratio instructed from the outside.

[Claim 7] A lighting device according to any one of Claim 1 to Claim 4, characterized in that it comprises a means for detecting an emitter-less state of the discharge lamp, and a reset control section for resetting the lighting time timer when the emitter-less state is detected.

[Claim 8] A lighting device according to any one of Claim 1 to Claim 4, characterized in that it comprises a means for detecting a no-load state of the discharge lamp, and a reset control section for resetting the lighting time timer when the no-load state is detected.

[Claim 9] A lighting device according to any one of Claim 1 to Claim 4, characterized in that it comprises means for detecting a no-load state of the discharge lamp during a period when the power supply is not turned on, and a reset control section for resetting the lighting time timer when the no-load state is detected.

[Claim 10] A lighting device according to any one of Claim 1 to Claim 4, characterized in that it is provided with a reset switch for resetting the lighting time timer.

[Claim 11] The lighting device according to any one of Claim 1 to 4, characterized in that it comprises a power switch for turning the power on and off, and a reset control section for resetting a lighting time timer when the power is turned on and off in a specified sequence.

[Claim 12] The lighting device according to any one of Claim 1 to Claim 4, characterized in that a temperature detection means is provided for detecting a temperature corresponding to the coldest point temperature of the discharge lamp, wherein the illuminance correction section determines the power to be supplied to the discharge lamp based on the difference between the measured temperature obtained by the temperature detection means and the optimal coldest point temperature determined according to the lighting time.

[Claim 13] A lighting device according to Claim 12, characterized in that the temperature detection means is provided in the fixture.

[Detailed Description of the Invention]

[0001]

[Technical field to which the invention belongs] The present invention relates to lighting devices.

[0002]

[Prior art] In general, the luminous flux of lamps used for lighting decreases over time. That is, the illumination decreases over the course of the lamp's usage time. A known technology for suppressing the decrease in illuminance over time as a lamp is used is that adopted in a lighting system in which an on/off control terminal 31 and a dimming control terminal 32 are connected to a main operation panel 30 via a signal line 33, and the on/off control terminal 31 and the dimming control terminal 32 control a dimming lighting fixture 34 that can dim the lamp, as shown in FIG. 36 (Japanese Unexamined Patent Application Publication No. S64-89287). In this illumination system, dimming lighting fixture 34 has the function of dimming the lamp in response to dimming signals from dimming control terminal 32, and the on-off control terminal 31 indicates that the lamp is on or off. In other words, when the lamp is illuminated by the on-off control terminal 31 in the dimming lighting fixture 34, the light output of the lamp can be adjusted in response to dimming signals from the dimming control terminal 32. When the wall switch 35 connected to the signal line 33 is operated, the on-off control terminal 31 and the dimming control terminal 32 control the light on/off of the lamp and the dimming amount of the lamp in accordance with the command transmitted from the main operation panel 30 via the signal line 33. In addition, multiple dimming lighting fixtures 34 are connected to the on-off control terminal 31 and dimming control terminal 32. That is, multiple dimming lighting fixtures 34 are controlled collectively by a common on-off control terminal 31 and dimming control terminal 32. Here, the on-off control terminal 31 is connected to lighting power 36 that provides a power supply for lighting the lamp relative to the dimming lighting fixture 34.

[0003] Now, in the illumination system described above, in order to suppress the change in the luminous flux of the lamp regardless of the time of use of the lamp, the illumination correction value calculation device 37 is connected to the dimming control terminal 32 as shown in FIG. 37. The illuminance correction value calculation device 37 comprises a clock means 38 for measuring time, a memory 39 for storing the luminous flux reduction characteristics of the lamp, a memory 40 for storing the luminous flux reduction characteristics due to dirt, and a calculation means 41 for adding and outputting correction values read from the memories 39 and 40 according to the time measured by the clock means 38. The output of this calculation means 41 is provided to an illuminance correction section 42 provided in

the dimming control terminal device 32, and the output of the dimming control signal generation section 43, which generates a dimming signal for the dimming amount specified through the signal line 33 from the main control panel 30, is corrected by the illuminance correction section 42. By providing such a corrected dimming signal to dimming lighting fixture 34, the decrease in illumination over time is suppressed.

[0004]

[Problem to be Solved by the Invention] However, the lighting system described above requires at least the main control panel 30, dimming control terminal 32, dimming light fixture 34, and illuminance correction calculation device 37. Moreover, since it is necessary to wire signal line 33, the initial investment is extremely large as well as labor-intensive.

[0005] In addition, in the configuration described above, multiple dimming lighting fixtures 34 are connected to one dimming control terminal 32, so in any of these dimming lighting fixtures 34, if the lamp is replaced early due to cracking of the lamp or variations in the characteristics of the lamp, the usage time will be different from that of other lamps, and there will be a difference in illumination from dimming fixtures 34 using other lamps. To prevent such a difference in illumination, the lamps of dimming lighting fixtures 34 controlled by the same dimming control terminal 32 must be replaced simultaneously, increasing the cost of lamp replacement.

[0006] In addition, the lighting system described above is intended for use in offices and stores, and it is believed that multiple dimming lighting fixtures 34 are connected to one dimming control terminal 32, and the lamp is not only lit when necessary, but is continuously lit at a specific time of day each day. Therefore, it is difficult to adopt it in places where the number of lamps is small (hot water rooms, stairs, restrooms, small offices, etc.) because the cost increases and the wiring of signal line 33 is troublesome. Furthermore, since the lamp is continuously lit, the clock means 38 is continuously measured regardless of whether or not the lamp is used, and in the above-mentioned location where the lamp is lit for a relatively short period of time, the time measured by the timing means 38 does not correctly reflect the usage time of the lamp.

[0007] The present invention was made in consideration of the above reasons, and the purpose is to provide lighting devices that are easy to install, have relatively low costs, and do not cause differences in illuminance even when the lamp is replaced alone when adopted in locations with a small number of lamps, while suppressing the decrease in illuminance over time.

[0008]

[Means for solving the problem] The invention of claim 1 comprises, in one fixture, a discharge lamp, a discharge lamp lighting device that lights the discharge lamp and can control the power supplied to the discharge lamp, a lighting time timer that measures the time that power is supplied to the discharge lamp lighting device as the lighting time of the discharge lamp, and an illuminance correction device that instructs the discharge lamp lighting device to supply power to the discharge lamp according to the lighting time measured by the lighting time timer so as to suppress a decrease in luminous flux over the passage of the lighting time of the discharge lamp.

[0009] The invention of Claim 2 is the lighting device

according to Claim 1, where a circuit board on which the lighting time timer and the illuminance correction device are mounted is provided separately from a circuit board on which the discharge lamp lighting device is mounted.

[0010] The invention of Claim 3 is the invention of Claim 1, in which a circuit board on which the lighting time timer and the illuminance correction device are mounted is provided integrally with a circuit board implementing the discharge lamp lighting device.

[0011] The invention of Claim 4 is the invention of Claims 1 through 3, wherein the discharge lamp lighting device is made from an inverter circuit.

[0012] The invention of Claim 5, in the invention of Claims 1 through 4, the illumination correction device determines the supply power to the discharge lamp by comparing the dimming ratio and lighting time indicated by the outside to the correction table.

[0013] The invention of Claim 6, in the invention of Claims 1 through 4, the illuminance correction device determines the supply power to the discharge lamp by correcting the supply power to the discharge lamp obtained from the luminous flux maintenance ratio of the discharge lamp according to the lighting time with the dimming ratio indicated by the outside.

[0014] The invention of Claim 7, in the invention of Claims 1 through 4, comprises a means for detecting an emitter-less state of a discharge lamp, and a reset control section for resetting a lighting time timer when an emitter-less state is detected.

[0015] The invention of Claim 8 is the invention of Claims 1 through 4, including a means for detecting a no load state of discharge lamp, and a reset control section that resets a lighting time timer when a no load state is detected.

[0016] The invention of Claim 9, in the inventions of Claims 1 to 4, further comprises a means for detecting a no-load state of the discharge lamp during a period when the power is not turned on, and a reset control section for resetting the lighting time timer when the no-load state is detected.

[0017] The invention of Claim 10 is the invention of Claims 1 through 4, wherein a reset switch is provided to reset the lighting time timer.

[0018] The invention of Claim 11 includes a power switch that turns the power supply on and off, and a reset control section that resets the lighting time timer when turning the power supply on and off is a prescribed procedure.

[0019] The invention of Claim 12, in the invention of Claims 1 to 4, comprises a temperature detection means for detecting a temperature corresponding to the coldest point temperature of the discharge lamp, and the illuminance correction section determines the supply power to the discharge lamp based on the difference between the measured temperature determined by the temperature detection means and the optimal coldest point temperature specified according to the lighting time.

[0020] The invention of Claim 13 is the invention of Claim 12, wherein the aforementioned temperature detection means are provided in the aforementioned fixture.

[0021]

[Embodiments of the invention] (First embodiment) The lighting device 1 in this embodiment comprises a discharge lamp 11 as a lamp, and the discharge lamp 11 is illuminated by an output of the discharge lamp lighting device 12 capable of dimming control, as shown in FIG. 1. A lighting time detection section 13 is provided between a power source AC such as a commercial power source and the discharge lamp lighting device 12, which detects whether or not electricity is being applied to the discharge lamp lighting device 12, and the power application period detected by the lighting time detection section 13 is timed by a lighting time timer 14. In other words, the duration of energization is regarded as the duration of use of the discharge lamp 11, and the duration of use of the discharge lamp 11 is measured by the lighting time timer 14.

[0022] Now, as shown in FIG. 2(a), the luminous flux of the lamp decreases with the usage time, and in addition the light quantity decreases with the light fixture that is equipped with the lamp or the lamp becoming dirty over time, so the lighting device 1 is provided with an illuminance correction device 15 to suppress the decrease in light quantity over time. Here, the decrease in the luminous flux of the discharge lamp 11 is caused by the deterioration of the phosphor, etc., if it is a fluorescent light. The illuminance correction device 15 is basically configured to compensate for the decrease in the luminous flux over the passage of the usage time of the discharge lamp 11. As shown in FIG. 2(b), immediately after replacing the discharge lamp 11, the discharge lamp 11 is dimmed, and the power supplied to the discharge lamp 11 is controlled via the discharge lamp lighting device 12 so that the discharge lamp 11 approaches full lighting (rated lighting) as the time of use of the discharge lamp 11 passes. That is, the output of the discharge lamp lighting device 12 increases over the course of the use time of the discharge lamp 11. Thus, by increasing the supply power to the discharge lamp 11 over time, while the luminous flux of the discharge lamp 11 decreases over time, the light output of the discharge lamp 11 can be kept generally constant as in FIG. 2(c).

[0023] As described above, in this embodiment, the discharge lamp 11, the discharge lamp lighting device 12, the lighting time timer 14, and the illumination correction device 15 are integrated into the lighting device 1 provided in the form of, for example, a lighting fixture, so it is possible to compensate for the decrease in the luminous flux over the course of the usage time of the discharge lamp 11 by simply performing wiring installation connected to the power supply AC, and to handle wiring installation similarly to conventional lighting fixtures. Furthermore, a lighting time detection section 13 is inserted between the discharge lamp lighting device 12 and the power supply AC, and the lighting time timer 14 measures only the period during which the lighting time detection section 13 determines that the discharge lamp 11 is lit. Therefore, the lighting time timer 14 detects a time that almost corresponds to the usage time of the discharge lamp 11, and the usage time of the discharge lamp 11 can be accurately measured even in a usage mode in which the discharge lamp 11 is repeatedly turned on and off in a relatively short period of time.

[0024] The operation of this embodiment is summarized as

in FIG. 3. Here, the lighting time timer 14 has the function of writing the measured time into nonvolatile memory, and immediately after power-on (S1), an initial setting process (S2) of the lighting time timer 14 is carried out and the lighting time (i.e., usage time) written in the nonvolatile memory is read out to the lighting time timer 14. When the lighting time timer 14 is thus set, the illuminance correction device 15 reads the lighting time from the lighting time timer 14 (S3). The dimming ratio is determined so that a predetermined light output is obtained from the discharge lamp 11 based on the read-out usage time (S4), and the dimming signal is output according to the dimming ratio (S5). In accordance with this dimming signal, the discharge lamp lighting device 12 determines the power supplied to the discharge lamp 11. Next, the lighting time timer 14 measures the lighting time (i.e., usage time) (S6) and stores the lighting time after the timing in nonvolatile memory (S7). Subsequently, it is repeated to read the lighting time from nonvolatile memory, to control dimming, and to write the lighting time to nonvolatile memory.

[0025] FIG. 4 shows the specific configuration. Inverter circuits are used for discharge lamp lighting device 12. That is, a rectifier DB1 comprising a diode bridge that rectifies the power supply AC in full waves, and a switching element Q3 comprising MOSFET is connected between the DC output ends of the rectifier DB1 via inductor L1. In addition, a series circuit of diode D1 and smooth capacitor C1 is connected between both ends of switching element Q3, and the inverter circuit is driven using this smooth capacitor C1 as a power source. The inverter circuit comprises a series circuit of a pair of switching elements Q1, Q2 consisting of MOSFETs connected between both ends of the smooth capacitor C1, and between both ends of one switching element Q2, the series circuit of capacitor C2 for DC cutting and the inductor L2 for resonance and the discharge lamp 11 is connected. Also, between the non-power side ends of both filaments of the discharge lamp 11, capacitor C3, which together with inductor L2 constitutes a resonant circuit, is connected. Switching elements Q1 to Q3 are turned on and off at high frequencies by the inverter control section CN1, and switching elements Q1 and Q2 are turned on and off alternately. In addition, dimming signals from the illuminance correction device 15 are input to the inverter control section CN1, and by controlling the on and off period (i.e., operating frequency) of switching elements Q1 and Q2, the power supplied to the discharge lamp 11 is adjusted.

[0026] The operation of the inverter circuit shown in FIG. 4 is well known, and the output voltage from the rectifier DB1 is boosted by a boost chopper circuit composed of inductor L1, switching element Q3, diode D1, and smooth capacitor C1, and alternately turning on and off switching elements Q1 and Q2 causes alternating currents to flow to the discharge lamp 11. Here, since the power supply path to the discharge lamp 11 has an inductor L2 and a capacitor C3, the supply energy to the discharge lamp 11 can be adjusted based on the relationship between the on and off cycle (operating frequency) of the switching element Q1, Q2 and the resonant frequency by the inductor L2 and the capacitor C3, etc.

[0027] The lighting time detection section 13 consists of a series circuit of resistors R1 and R2 that divide the voltage of the power supply AC, a rectifier DB2 consisting of a diode bridge that rectifies the voltage across the entire wave of resistor R2, and a smooth capacitor C4 that smooths the output voltage of the rectifier DB2. In other words, the lighting time timer 14 measures the period during which the extremity voltage of the smooth capacitor C4 is greater than or equal to the specified voltage.

[0028] The illuminance correction device 15 is configured by a microcontroller along with the lighting time timer 14. The microcontroller is provided with a nonvolatile memory 17, which is an EEPROM that stores a correction table used in the illuminance correction device 15, upon reading and writing the time measurement time by the lighting time timer 14. The correction table is a table that corresponds to the usage time of the discharge lamp 11 and the dimming ratio for the correction, and by reading the dimming ratio from the nonvolatile memory 17 using the usage time measured by the lighting time timer 14 at the dimming ratio setting section 18 provided in the illuminance correction device 15, the dimming ratio for keeping the light output of the discharge lamp 11 generally constant can be determined. The dimming ratio determined by the dimming ratio setting section 18 is given to the dimming signal generation section 19 to generate the dimming signal imparted to the inverter control section CN1. Here, the power supply of the lighting time timer 14, dimming ratio setting section 18, and dimming signal generation section 19 is supplied by a three-terminal regulator RG1 that constant voltages the extremity voltage of the smooth capacitor C4.

[0029] On the other hand, when the power supply AC is applied and the voltage across the smooth capacitor C4 reaches the specified voltage, the lighting time timer 14 performs the initial settings process described above to read the usage time of the previous discharge lamp 11 from the nonvolatile memory 17, and then gives this usage time to the dimming ratio setting section 18. The dimming ratio setting section 18 collates the usage time with the correction table stored in the nonvolatile memory 17, and reads the dimming ratio corresponding to the usage time. The dimming ratio read in this way is given to dimming signal generation section 19 to control the output of the inverter circuit. In addition, the lighting time timer 14 measures the usage time and stores the time after the measurement time in the nonvolatile memory 17. Subsequently, the operation until the usage time is read from the nonvolatile memory 17 and the new usage time is written to the nonvolatile memory 17 is repeated during the period in which the power supply AC is supplied, and the supply power to the discharge lamp 11 is adjusted according to the usage time.

[0030] A variety of forms can be adopted for dimming signals from dimming signal generation section 19 to inverter control section CN1. In this embodiment, it is assumed that a signal representing dimming ratio is used based on the duty ratio of a rectangular wave signal with a frequency of 1 kHz and an amplitude of 5 V. However, dimming signals can be used, for example, to provide dimming ratio at a DC voltage of 0 to 10 V. In the dimming signal in this embodiment, the luminous flux ratio of the discharge lamp 11 to the duty ratio (the ratio of the luminous flux when the luminous flux is 100% when the rated power is given) is set as in FIG. 5. In other words, the shorter the

dimming signal ON period, the larger the output of the discharge lamp lighting device 12.

[0031] A specific example setting of the correction table in this embodiment is shown here. Fluorescent lamps commonly used for lighting as discharge lamps 11 are known to reduce the luminous flux at the end of life by about 70% if the luminous flux at the beginning of life (immediately after lamp replacement) is 100%. In other words, if the output of the discharge lamp lighting device 12 is set to about 70% of the rated output at the beginning of life, and the output is increased to 100% at the end of life, it is considered possible to maintain the light output of the discharge lamp 11 at a generally constant level regardless of the usage time. In addition, if such a control is performed, it is not necessary to increase the output of the discharge lamp lighting device 12 to 110% or more of the rated output, and in the early lifespan, the consumption power can be suppressed, resulting in energy saving.

[0032] However, if the output of the discharge lamp lighting device 12 is used as 70% of the rated output, and the transition is shown with the elapsed time of the luminous flux of the discharge lamp 11, it becomes FIG. 6(a), and the luminous flux at 12,000 hours is approximately 60%, which is about 9.8% decrease from the early life. Thus, if the output of the discharge lamp lighting device 12 is increased by a decrease in the luminous flux over time, as shown in FIG. 6(b), the luminous flux of the discharge lamp 11 is kept generally constant regardless of the elapsed time (i.e., usage time). Here, in order to control the output of the discharge lamp lighting device 12 as shown in FIG. 6(b), the duty ratio corresponding to the luminous flux ratio at each time in FIG. 6(b) may be determined by the relationship shown in FIG. 5, and the dimming ratio corresponding to the duty ratio obtained at each time may be stored in the nonvolatile memory 17 as a correction table.

[0033] In the illustrated example, the luminous flux ratio, luminous flux reduction rate, output ratio of discharge lamp lighting device 12, and dimming signal duty ratio at each time when the lighting time is 0 hours, 4000 hours, 8000 hours, 12000 hours, and 16000 hours are as shown in Table 1.

[0034]

[Table 1]

Lighting time (hours)	0	4000	8000	12000	16000
Luminous flux ratio (%)	70	63.7	60.9	60.2	59.5
Decrease rate (%)	0	6.3	9.1	9.8	10.5
Output ratio (%)	70	76.3	79.1	79.8	80.5
Duty (%)	60	47.4	41.8	40.4	39

[0035] By storing the relationship between the lighting time and the duty ratio shown in Table 1 as a correction table in nonvolatile memory 17 and reading the duty ratio according to the lighting time measured by the lighting time timer 14 and giving it to the discharge lamp lighting device 11, the light output can be kept generally constant (approximately 70% of the rated output) regardless of the lighting time, as shown in FIG. 7.

[0036] It should be noted that, in the present embodiment, lighting device 1 is used as a single lighting fixture, and unit U1 (see FIG. 4) comprising discharge lamp lighting device 12 and unit U2 comprising lighting time detection section 13, lighting time timer 14, and illuminance correction device 15 are divided into two circuit boards and incorporated into lighting device 1, but both may be combined into one unit. When combined into a single unit, it is possible to mount on a circuit board, eliminating the need for a connection wire that connects dimming signal generation section 19 and inverter control section CN1. In addition, when two units U1 and U2 are provided, the number of circuit boards is reduced, making it possible to save space for lighting devices (light fixtures) 1, and also making it possible to reduce costs and ease assembly by reducing parts (boards and housings). An example of the above-described configuration of the discharge lamp lighting device 12 is an example, and other configurations may be used if the configuration allows dimming control.

[0037] (Second embodiment) This embodiment adds dimming functionality to the configuration of the first embodiment as shown in FIG. 8. That is, it is possible to give instructions to the dimming ratio setting section 18 in response to the dimming signal from the outside through the dimming signal detection section 21. Differences from the configuration shown in FIG. 4 are described.

[0038] In this embodiment, a non-polarization circuit DB3 comprising a diode bridge into which an external dimming signal (external dimming signal) is input is provided, and the output of the non-polarization circuit DB3 is isolated by the optocoupler PC1 and input to the dimming signal detection section 21 through a filter consisting of resistance R4, R5 and capacitor C5. The external dimming signal is a

rectangular wave signal with a frequency of 1 kHz and an amplitude of 5 V, similar to the dimming signal generated at dimming signal generation section 19, and is used to represent the dimming ratio by duty ratio. Therefore, the dimming signal detection section 21 is input with a voltage corresponding to the dimming ratio. Since the dimming ratio setting section 18 needs to determine the dimming ratio for the combination of the light time read from the nonvolatile memory 17 and the dimming ratio based on the external dimming signal input through the dimming signal detection section 21, as shown in FIG. 9, after the light time is read from the nonvolatile memory 17 in the lighting time timer 14 (S3), the dimming signal given through the dimming signal detection section 21 is read (S4), and the dimming ratio is determined by reading the correction table of the nonvolatile memory 17 (S5). Other procedures are similar to those shown in FIG. 3. Also, the dashed area in FIG. 8 shows the area mounted on a circuit board.

[0039] The change in the luminous flux of the discharge lamp 11 over time when the output of the discharge lamp lighting device 12 is set to 85%, 80%, and 70% of the rated output is shown in FIG. 10(a). In contrast, changing the duty ratio of dimming signal to discharge lamp lighting device 12 as shown in FIG. 10(b) allows for a generally constant light output for each dimming ratio indicated by the external dimming signal regardless of the lighting time. That is, the luminous flux ratio, the output ratio of the discharge lamp lighting device 12, and the duty ratio of the dimming signal at each time when the lighting time is 0 hours, 4000 hours, 8000 hours, 12000 hours, and 16000 hours are as shown in Table 2. The values in parentheses in Table 2 show the dimming ratio indicated by the external dimming signal.

[0040]

[Table 2]

Lighting time (Time)	0	4000	8000	12000	16000
Luminous flux ratio [85%] (%)	85	78	74	73	73
Luminous flux ratio [80%] (%)	80	72	69	68	68
Luminous flux ratio [70%] (%)	70	64	61	61	60
Output ratio [85%] (%)	85	92	96	97	97
Output ratio [80%] (%)	80	88	91	92	92
Output ratio [70%] (%)	70	76	79	79	80
Duty [85%] (%)	30	16	8	6	6
Duty [80%] (%)	40	24	18	16	16
Duty [70%] (%)	60	48	42	42	40

[0041] Accordingly, by storing the relationship between the lighting time shown in Table 2 and the dimming ratio and the duty ratio indicated by the external dimming signal in the nonvolatile memory 17 as a correction table, and reading the duty ratio according to the lighting time measured by the lighting time timer 14 and the external dimming signal to the discharge lamp lighting device 11, the light output relative to the dimming ratio provided by the external dimming signal can be kept generally constant regardless of the lighting time. Other configurations and operations are similar to the first embodiment.

[0042] (Third embodiment) In the second embodiment, the duty ratio is read from nonvolatile memory 17 and provided to dimming signal generating section 19. In this embodiment,

the luminous flux maintenance ratio is read from nonvolatile memory 17, and the dimming ratio is calculated in dimming ratio setting section 18. However, the present embodiment also employs a configuration that controls the light output by means of an external dimming signal.

[0043] In this embodiment, the relationship between the lighting time and the luminous flux maintenance ratio in Table 3 is stored as a correction table in nonvolatile memory 17, and the dimming ratio setting section 18 reads the

lighting maintenance ratio from nonvolatile memory 17 according to the lighting time obtained by the lighting time timer 14.

[0044]

[Table 3]

Lighting time (Time)	0	4000	8000	12000	16000
Luminous flux ratio [100%] (%)	100	91	87	86	85
Luminous flux maintenance ratio	0	0.91	0.87	0.86	0.85
Output ratio [85%] (%)	85	92.65	96.05	96.9	97.75
Output ratio [80%] (%)	80	87.2	90.4	91.2	92
Output ratio [70%] (%)	70	76.3	79.1	79.8	80.5
Duty [85%] (%)	30	14.7	7.9	6.2	4.5
Duty [80%] (%)	40	25.6	19.2	17.6	16
Duty [70%] (%)	60	47.4	41.8	40.4	39

[0045] Here, the luminous flux maintenance ratio is the residual ratio of luminous flux after a predetermined time when the luminous flux at the time of the rated lighting of discharge lamp 11 at the beginning of its life is 100%, and the luminous flux ratio is expressed as a ratio rather than a percentage. That is, the luminous flux ratio after 4000 hours have passed since the replacement of the discharge lamp 11 is 91%, so the luminous flux maintenance ratio is 0.91. Now, if the dimming ratio of the external dimming signal is turned on as 80% after 4000 hours, the actual dimming ratio after 4000 hours is the dimming ratio of the external signal plus the increase in dimming ratio after 4000 hours due to illuminance correction. Here, the amount of increase in dimming ratio due to illuminance correction after 4000 hours is calculated by multiplying the corrected amount of dimming ratio to the dimming maintenance ratio after 4000 hours by the dimming ratio due to the external dimming signal, which is $(1-0.91) \times 80\% = 7.2\%$. That is, the dimming ratio is $80\% + 7.2\% = 87.2\%$ (see Table 3). Thus, if the dimming ratio due to the external dimming signal is 80% when the lighting time is 4000 hours, the dimming ratio given to the discharge lamp lighting device 12 is 87.2%. If the dimming ratio is given by the duty ratio, as in other embodiments described above, the duty ratio is 25.6% by using the relationship shown in FIG. 5.

[0046] As described above, in the present embodiment, the dimming ratio setting section 18 reads the luminous flux maintenance ratio from the nonvolatile memory 17, performs the above operations by using it in conjunction with the dimming ratio provided by the external dimming signal, calculates the dimming ratio, and converts the dimming ratio to a duty ratio to give the dimming signal generation section 19. Here, by storing the duty ratio corresponding to the dimming ratio in the nonvolatile memory 17, conversion from the dimming ratio to the duty ratio can be performed by matching with the table.

[0047] The operation of this embodiment is summarized as in FIG. 11. In other words, after the power supply is turned on (S1) and the initial settings process of the lighting time timer 14 is performed (S2), the lighting time is read from the lighting time timer 14 at the dimming ratio setting section 18 (S3). Subsequently, the luminous flux maintenance rate according to the lighting time is read from the nonvolatile memory 17 (S4), and the dimming ratio due to the external

dimming signal is also read into the dimming ratio setting section 18 (S5). Thus, the operations described above are performed based on the luminous flux maintenance rate and the dimming ratio by the external dimming signal, and the dimming ratio is determined (S6). After determining the dimming ratio, the dimming ratio is converted to a duty ratio, and the dimming signal corresponding to the dimming ratio is output from the dimming signal generation section 19 (S7). In accordance with this dimming signal, the discharge lamp lighting device 12 determines the power supplied to the discharge lamp 11. Next, the lighting time timer 14 measures the lighting time (S8) and stores the lighting time after the timing in nonvolatile memory (S9). Subsequently, it is repeated to read the lighting time from nonvolatile memory, to control dimming, and to write the lighting time to nonvolatile memory.

[0048] FIG. 12(a) shows the changes in the output over the course of the lighting time of the discharge lamp lighting device 12 for each dimming ratio provided by the external dimming signal as the output ratio (the output of the discharge lamp lighting device 12 relative to the rated lighting at the beginning of life is 100%), and FIG. 12(b) shows the changes in dimming ratio of the dimming signal provided to the discharge lamp lighting device 12. Other configurations and operations are similar to the first embodiment.

[0049] (Fourth embodiment) In this embodiment, a technique is described to detect the replacement time point of the discharge lamp 11 and automatically reset the lighting time. That is, since the lighting time set to the lighting time timer 14 and the lighting time stored in the nonvolatile memory 17 need to be reset to 0 upon replacement of the discharge lamp 11, it is necessary to detect the replacement time point of the discharge lamp 11 in some way to automate the reset of the lighting time.

[0050] In this embodiment, the replacement time of discharge lamp 11 is considered to be the life time of discharge lamp 11, and the life time of discharge lamp 11 is determined by detecting the emitter-less state. Here, it is known that the emitter-less state refers to the state in which the discharge lamp 11 is turned on only half a cycle (half wave) due to evaporation of the electron emission material provided in the filament of the discharge lamp 11, and that when the emitter-less state occurs, the extremity voltage of

the discharge lamp 11 is higher than when it is on a steady state. Thus, as shown in FIG. 13, the series circuits of resistances R3 and R4 are connected in parallel to the discharge lamp 11, and the emitter-less state is detected by monitoring the change in the potential at the connection point of resistances R3 and R4. In other words, the extremity voltage of the discharge lamp 11 is detected as the extremity voltage of the capacitor C6 by the extremity voltage of the resistor R4 being completely rectified by the rectifier DB4, which is comprised of a diode bridge, and smoothed by the capacitor C6. The extremity voltage of capacitor C6 is input to reset control section 22 and compared to the reference value. This reference value is set to detect the extremity voltage of the capacitor C6 when the discharge lamp 11 is in the emitter-less state, and when the emitter-less state is detected due to the relationship between the extremity voltage of the capacitor C6 and the reference value, the reset control section 22 resets the lighting time timer 14 and the lighting time in the nonvolatile memory 17.

[0051] In this embodiment, the connection point potentials of resistances R3 and R4 are also input to the inverter control section CN1, and when an emitter-less state is detected in the inverter control section CN1, the switching elements Q1 and Q2 are configured to be turned on and off and then operated to restart the discharge lamp 11. Therefore, when the emitter-less state is reached, the emitter-less detection → operation stop → start → light up → emitter-less detection is repeated, and the emitter-less state is reported by flashing the discharge lamp 11, and the stress of the discharge lamp lighting device 12 is reduced by the persistence of the emitter-less state. It should be noted that when an emitter-less state is detected in the inverter control section CN1, the output of the discharge lamp lighting device 12 may be reduced to a level that does not cause stress, or the operation of the discharge lamp lighting device 12 may be stopped.

[0052] The operation of this embodiment is summarized as in FIG. 14. That is, after the initial settings process (S2), the presence or absence of the emitter-less state is detected (S3), and when the emitter-less state is not detected, the operation is similar to the first embodiment. On the other hand, when an emitter-less state is detected, the process is performed to reset the lighting time as a replacement for the discharge lamp 11 (S9). In other words, until the discharge lamp 11 is replaced, the lighting time is reset by detecting the emitter-less state, and if the discharge lamp 11 is replaced and turned on normally, the lighting time measurement time is started. In this way, the reset of the lighting time occurs automatically with the replacement of the discharge lamp 11, eliminating the need to reset the lighting time. Other configurations and operations are similar to the first embodiment. The configuration of the present embodiment can also be applied in a second embodiment and in a third embodiment.

[0053] (Fifth embodiment) In the fourth embodiment, the lighting time was reset when the emitter-less state was detected, so the lighting time was repeated until the emitter-less state was resolved. In contrast, the present embodiment allows only one reset of the lighting time when an emitter-less state is detected. In the present embodiment, the operation of the reset control section 22 differs from the fourth embodiment, but the configuration is similar to that shown in FIG. 13.

[0054] In other words, as shown in FIG. 15, a function (S10) to write the emitter-less state to the nonvolatile memory 17

as "Yes" when the emitter-less state is detected (S3) is provided in reset control section 22, and the emitter-less history continues to be "Yes." During the period when the emitter-less state is detected, the process of reading the emitter-less history written to the nonvolatile memory 17 (S4) is not performed, and the detection of the emitter-less state and control over the emitter-less state are repeated. Here, if the discharge lamp 11, which is in the emitter-less state, is replaced, the emitter-less state will no longer be detected in step S3, so the emitter-less history is read from the nonvolatile memory 17 (S4), and if the emitter-less state continued before the discharge lamp 11 was replaced, the emitter-less history is "Yes," so the lighting time and the emitter-less history are reset (S11). Thus, in the present embodiment, while the emitter-less state continues, only the emitter-less history is written to the nonvolatile memory 17, and the lighting time is not reset, so that the lighting time is reset after replacing the discharge lamp 11. Other configurations and operations are similar to the first embodiment.

[0055] (6th embodiment) In the fourth embodiment and the fifth embodiment, a reset of the lighting time was performed by detecting the emitter-less state, but this embodiment resets the lighting time based on the no load state of the discharge lamp 11. That is, as shown in FIG. 16, in addition to the configuration of the first embodiment shown in FIG. 4, a transformer T1 with a primary winding inserted between the discharge lamp 11 and the switching element Q2 is provided, and by smoothing the secondary output of the transformer T1 with the capacitor C6 after rectifying with the rectifier DB4, the voltage proportional to the current flowing to the discharge lamp 11 is detectable as the extremity voltage of the capacitor C6. In other words, since the secondary output of transformer T1 cannot be obtained with no load, the extremity voltage of capacitor C6 is lower than when the load is normal. If such a change in the extremity voltage of the capacitor C6 is detected, a no load state can be detected.

[0056] Therefore, the extremity voltage of capacitor C6 is input to inverter control section CN1 and reset control section 22. In inverter control section CN1, when it is determined that there is no load due to a decrease in the extremity voltage of capacitor C6, operation of discharge lamp lighting device 12 is stopped. In addition, in the reset control section 22, when the extremity voltage of the capacitor C6 falls below the reference value, the lighting time of the lighting time timer 14 and the lighting time stored in the nonvolatile memory 17 are reset. Therefore, if the discharge lamp 11 is replaced while the power is turned on, when the discharge lamp 11 is removed, the lighting time is reset in a no load state. In this configuration, the lighting time can be reset by replacing the discharge lamp 11 regardless of whether it is in the emitter-less state, so it is possible to automatically reset the discharge lamp 11 when replacing the discharge lamp 11, such as when a crack occurs in the discharge lamp 11.

[0057] The operation of this embodiment is basically the same as that when the emitter-less state is detected as shown in FIG. 14, except that a no-load state is detected instead of the emitter-less state. In other words, as shown in FIG. 17, the presence or absence of a no load state is detected (S3), and the lighting time is reset when a no load state is detected (S9). Here, if the discharge lamp 11 is removed and the no load state continues, the no load determination is made in step S3 and the lighting time is reset, so the lighting time is repeated. Once the normal discharge lamp 11 is installed, the no load state is removed, so the dimming ratio can be set and the discharge lamp 11 turned on by transitioning from step S3 to step S4. Here, the inverter control section CN1 has the function of illuminating the discharge lamp 11 when a normal discharge lamp 11 is installed. In the present embodiment, since the lighting time is automatically reset by attaching and detaching the discharge lamp 11, there is no forgetting to reset and the hassle of operating the reset can be eliminated. Other configurations and operations are similar to the first embodiment.

[0058] (7th embodiment) In the sixth embodiment, the lighting time reset was repeated until the no load state was resolved because the lighting time reset was performed when no load state was detected. In contrast, the present embodiment only resets the lighting time once when a no load state is detected. In the present embodiment, the operation of the reset control section 22 is different from the sixth embodiment, but the configuration is similar to that shown in FIG. 16.

[0059] In other words, as shown in FIG. 18, the function (S10) to write the no load history to the nonvolatile memory 17 as "Yes" when the load-free condition is detected (S3) is provided in reset control section 22, and the no load state continues to be "Yes" while the no load state continues. During the period when the no load state is detected, the process of reading the no load history written to the nonvolatile memory 17 (S4) is not performed, and the detection of the no load state and control over the no load state are repeated. Here, if the discharge lamp 11, which is in the unloaded state, is replaced, the unloaded state will not be detected in step S3, so the no load history will be read from the nonvolatile memory 17 (S4), and if the no load state continued before the installation of the discharge lamp 11, the no load history will be "Yes," so the lighting time and unloaded background will be reset(S11) Thus, in the present embodiment, while the no load state continues, the no load history is only written to the nonvolatile memory 17, and the lighting time is not reset, and the lighting time is reset after the normal discharge lamp 11 is installed. It should be noted that the reset of the lighting time by detecting the no load state may be performed only after 12,000 hours in the case of the current discharge lamp 11. This will only reset the lighting device when replacing the discharge lamp 11 due to its lifespan. Other configurations and operations are similar to the sixth embodiment.

[0060](Eighth embodiment) In the sixth embodiment, the lighting time is reset when a no load state of the discharge lamp 11 is detected while the power supply AC is turned on. In the present embodiment, however, the lighting time is also reset when the discharge lamp 11 is disconnected while the power supply AC is not turned on. In order to detect the attachment and detachment of the discharge lamp 11 during the period when the power supply AC is not applied, in

addition to the configuration of the sixth embodiment shown in FIG. 19, in this embodiment, the first winding of the transformer T1 is connected to a series circuit between resistance R6, R7, and switch element SW1 and DC power supply E1 at both ends of the filament connected in the discharge lamp 11, and further connected to a series circuit between diode D2 and DC power supply E2 at the output end of the three-terminal regulator RG1, and powered from this DC power supply E2 via a microcomputer (a dashed portion in FIG. 19). It is preferable to use a secondary battery for DC power supplies E1 and E2, charge the DC power supply E1 and E2 while not using the power, and use one that can be used without charging for about 10 days. Other configurations are similar to the sixth embodiment shown in FIG. 16.

[0061] The switch elements SW1 and SW2 are controlled by the inverter control section CN1, and are controlled so that both switch elements SW1 and SW2 are turned on when power AC is not applied. In other words, when the power supply AC is not turned on, a current flows from the DC power supply E1 to the filament of the discharge lamp 11 via resistors R6 and R7, and the potential at the connection point between the resistor R7 and the filament is input to the reset control section 22 and the inverter control section CN1. In addition, the MCU, including the lighting time timer 14, dimming ratio setting section 18, dimming signal generation section 19, and reset control section 22, is operated even during the period when the DC power supply E2 supplies the power supply AC. Here, diode D2 is for reflux prevention.

[0062] According to the above configuration, if the discharge lamp 11 is connected even when the power supply AC is not applied, a voltage higher than the reference value is applied to the reset control section 22 by the DC power supply E1, and the connection status of the discharge lamp 11 can be monitored by the reset control section 22 by the power supply from the DC power supply E2. Here, when the discharge lamp 11 is removed, the resistors R6, R7 cease to flow current from the DC power supply E1 and the input voltage to the reset control section 22 decreases. Therefore, the reset control section 22 will reset the lighting time.

[0063] However, as shown in FIG. 20 in this embodiment, when the input voltage to the reset control section 22 is informed that it is in a no load state (S3), the lighting time is reset regardless of whether the power supply AC is applied or not (S10). In addition, when a no load state is detected, the power supply AC is determined to be on (S4), and if the power supply AC is on, the process is performed in the same manner as in the sixth embodiment, and if the power supply AC is not on, only the monitoring of the no load state is performed without processing the determination of the dimming ratio according to the lighting time and the lighting time. In this embodiment, replacing the discharge lamp 11 when the power supply AC is not turned on only prevents the reset of the lighting time by the reset control section 22, and does not illuminate the discharge lamp 11, but if the power supply AC is turned on after replacing the discharge lamp 11 with a normal one, no no load state in step S3 is detected and the discharge lamp 11 can be turned on normally. In the present embodiment, as in the sixth embodiment, since the lighting time is automatically reset by the removal and replacement of the discharge lamp 11, there is no forgetting to reset and the hassle of operating the reset can be eliminated. Other configurations and operations are similar to the first embodiment.

[0064] (Ninth embodiment) This embodiment resets the lighting time by a mechanically operated reset switch SW3 as shown in FIG. 21. In other words, reset switch SW3 is connected to reset control section 22, and it is possible to reset the lighting time regardless of whether there is an emitter-less state or no load state. A voltage of 5 V is applied to both ends of the reset switch SW3 by the reset control section 22, for example (a resistor not shown in the drawings is connected in series to the reset switch SW3.), and when the reset switch SW3 is turned on, the input voltage to the reset control section 22 is reduced in the same manner as when the no load state is detected, and the lighting time of the lighting time timer 14 and the nonvolatile memory 17 is reset. This reset switch SW3 may be manually operated or also operated in conjunction with disengagement of the discharge lamp 11.

[0065] On the other hand, as shown in FIG. 22, when the reset signal from operation of reset switch SW3 is input to reset control section 22 (S3), the lighting time timer 14 and the lighting time in nonvolatile memory 17 are reset (S9). In the configuration of this embodiment, the lighting time can optionally be reset by operation of the reset switch SW3. Furthermore, it is possible to reset the lighting time in a simple configuration by simply providing a reset switch SW3 in addition to the reset control section 22. The other configurations and operations are similar to those of the first embodiment.

[0066] (Tenth embodiment) This embodiment enables the lighting time timer 14 and the lighting time in the nonvolatile memory 17 to be reset using the power switch SW in the first embodiment shown in FIG. That is, as shown in FIG. 23, the power switch SW inserted between the power supply AC and the rectifier DB1 is configured to reset the lighting time when operated in a particular manner.

[0067] Specifically, the output voltage of the rectifier DB1 is divided by resistances R8 and R9, and the extremity voltage of resistance R9 is input to reset control section 22 using resistances R10, R11 and transistor Q4, and the number of square wave signals is counted at reset control

section 22, and it is determined whether or not to reset the lighting time based on the numerical values. That is, as shown in FIG. 24, the reset control section 22 determines whether to reset the lighting time at power on, so this process is referred to as the power reset process (S1). If the power switch SW is used in this way as a reset of the lighting time, it is possible to reset the lighting time without providing a separate reset switch SW3 as in the ninth embodiment.

[0068] The following describes the power reset process in more detail. The power supply AC is a commercial power supply, where the output frequency of the rectifier DB1 is 120 Hz in the region where the power supply AC frequency is 60 Hz, and the output frequency of the rectifier DB1 is 100 Hz in the region where the power supply AC frequency is 50 Hz. Therefore, reset control section 22 will be populated with 120 or 100 rectangular wave signals per second. In other words, if the power switch SW is turned on and off in a short period of time, the power switch SW on and off period can be determined by the number of square wave signals. Thus, in the present embodiment, upon power on, as shown in FIG. 25, the reset control section 22 is configured to reset the lighting time timer 14 and the nonvolatile memory 17 after determining that a lighting time reset is indicated when turned on after 2 seconds on, 2 seconds off, 2 seconds on, and 2 seconds off. FIG. 25(a) shows the power on/off by operation of the power switch SW, and FIG. 25(b) shows the rectangular wave signal input to the reset control section 22.

[0069] In the power reset process, as shown in FIG. 26, the counter N is reset (S2) to count the number of times the power switch SW is turned on and off at power on (S1), and the number of rectangular wave signals is counted for 3 seconds (S3). If the power switch SW does not turn off after 3 seconds (S4), it is determined that the power switch SW has been turned on continuously, and the lighting time readout (S2) in FIG. 24 is shifted. The operation to command a reset here is 2 seconds from power on, but the power switch SW is set to 3 seconds to allow for the operation by a person. In this way, the time judgment is set taking into account the error caused by human operation. If the power is turned off at 3 seconds after power is turned on (S4), the number of rectangular wave signals entering reset control section 22 from this point is considered to be off at 2 seconds if it is in the range of 180 to 300 (S5). However, it shall be used in regions where the power supply AC frequency is 60 Hz. If the power switch SW OFF period is not within the range set in step S5, the operation indicating reset is disabled.

After step S5, the timer of the reset control section 22 starts to count (S6), and it is determined whether the power switch SW is on or not (S7). If the power switch SW is not turned on, the operation indicating reset is disabled. If the power switch SW is ON, the counter N is incremented when the count value by the timer is in the range of 1.8 to 2.2 seconds (S8). That is, it is determined whether or not it is on 2 seconds, and if it is on 2 seconds, it is determined that the first reset operation (on 2 seconds, off 2 seconds, on 2 seconds) was successful. After that, the power switch SW is turned off for 3 seconds, and the determination of whether the power switch SW is turned on for 1.8 to 2.2 seconds is repeated again, and when counter N is set to 2 (S9), the lighting time timer 14 and the lighting time in the nonvolatile memory 17 are reset (S10). In addition, at this time, the counter N, the timer that measures the OFF time of the power switch SW, and the number of square wave signals are also reset at the same time to 0.

[0070] As described above, since the lighting time can be reset by turning the power switch SW on and off, it is not necessary to set the reset switch SW3 for resetting the lighting time, making configuration easier. Especially, in the case of a large number of discharge lamps 11, a large number of reset switches SW3 are also required, but in the configuration of this embodiment, it is easy to configure because the wire switch SW is also used for reset. Other configurations and operations are similar to the first embodiment.

[0071] (Eleventh embodiment) As shown in FIG. 27, this embodiment combines a configuration that resets the lighting time upon detection of the emitter-less state shown in FIG. 13 and a configuration that resets the lighting time by means of the reset switch SW3 shown in FIG. 21. In this case, when detecting the emitter-less state, the emitter-less history is remembered, and the lighting time is reset when the emitter-less state is resolved.

[0072] As shown in FIG. 28, the lighting time and the emitter-less history are reset (S12) when the reset switch SW3 is operated (S3) or when the emitter-less state is not detected (S4) and the emitter-less history is "Yes" (S5). By adopting this configuration, if the discharge lamp 11 is replaced after the discharge lamp 11 has reached the emitter-

less state at the end of its life, the lighting time can be automatically reset, and if the discharge lamp 11 is replaced before the end of its life due to a cracking of the discharge lamp 11 or an initial failure of the discharge lamp 11, the reset switch SW3 can be operated to force the lighting time to reset, making it more convenient. Other configurations and operations are similar to the first embodiment.

[0073] It should be noted that, in each of the embodiments described above, the time to replace the discharge lamp 11 often comes after the current lighting time of the discharge lamp 11 exceeds 12,000 hours, so it is desirable to set a monitor lamp that lights up when the lighting time reaches 12,000 hours, and use it as a reference for replacing the discharge lamp 11.

[0074] (Twelfth embodiment) In each of the embodiments described above, a configuration that inhibits the reduction of the luminous flux over the course of the lighting time of the discharge lamp 11 is described, but it is known that the luminous flux of the discharge lamp 11 also varies depending on the ambient temperature. As shown in FIG. 32, the luminous flux is greater than the rated value at ambient temperatures around 20-35°C, while the luminous flux is lower than the rated value at other temperature ranges. On the other hand, the optimal coldest point temperature when the discharge lamp 11 is dimmed is in the relationship shown in FIG. 33. That is, as in each of the embodiments described above, when the dimming ratio increases with the passage of the lighting time of the discharge lamp 11, the coldest point temperature of the discharge lamp 11 increases with the passage of the lighting time. The relationship between ambient temperature and luminous flux ratio and coldest point temperature is shown in Table 4, and an example of the relationship between dimming ratio and coldest point temperature to lighting time is shown in Table 5. Here, when the dimming ratio is controlled with the passage of the lighting time, the luminous flux is kept constant regardless of the lighting time if the coldest point temperature of the discharge lamp 11 at each dimming ratio is the temperature shown in Table 5.

[0075]

[Table 4]

Ambient temperature (°C)	0	5	10	15	20	25	30	35	40	45
Luminous flux ratio (%)	47	60	75	90	100	104	103	100	93	85
Coldest point temperature (°C)	28	32	38	42	48	53	58	63	68	73

[0076]

[Table 5]

Lighting time (hours)	0	4000	16000	22000
Dimming ratio (%)	70	75	80	85
Coldest point temperature (°C)	42	44	45	47

[0077] However, as the ambient temperature changes, the coldest point temperature relative to the desired dimming ratio changes, as shown in FIG. 34 at point A and point B. Point A indicates that the coldest point temperature to the desired dimming ratio is lower than the desired temperature, and point B indicates that it is conversely higher. In the case of point A, the coldest point temperature can be increased if the dimming ratio is high, and in the case of point B, the coldest point temperature can be decreased if the dimming ratio is low.

[0078] This embodiment is based on the above knowledge, and in addition to the configuration of the first embodiment shown in FIG. 4 as shown in FIG. 29, provides a temperature sensor 23 for detecting ambient temperature, and provides an output of the temperature sensor 23 to the temperature correction signal determination section 24 through a filter consisting of resistance R12, R13 and capacitor C7. At the temperature correction signal determination section 24, a temperature correction signal corresponding to the ambient temperature detected by the temperature sensor 23 is output and supplied to the dimming ratio setting section 18.

[0079] The temperature sensor 23 can be attached to the discharge lamp 11 so as to detect the coldest point temperature of the discharge lamp 11 as shown in FIG. 31(a), disposed behind the reflector 1a provided in the light fixture 1 as shown in FIG. 31(b), to detect the temperature of the reflector, and to the discharge lamp lighting device 12 as shown in FIG. 31(c). The temperature of the fixture body of the light fixture 1, the stabilizer, the ambient temperature of the light fixture 1, etc. may also be detected. In any case, any temperature at the site where it is possible to know the relationship with the coldest point temperature of the discharge lamp 11 can be used. For reference, FIG. 35 shows the relationship between the ambient temperature and the coldest point temperature, the fixture temperature, and the temperature of the case of the discharge lamp lighting device 12.

[0080] In nonvolatile memory 17, the dimming ratio with the passage of the lighting time and the optimal coldest point temperature of discharge lamp 11 at the dimming ratio are stored as a correction table, and the dimming ratio and optimal coldest point temperature are read from the correction table based on the lighting time measured by the lighting time timer 14. Here, at the dimming ratio setting section 18, the coldest point temperature output from the temperature correction signal determination section 24 is input. That is, at the temperature correction signal determination section 24, the coldest point temperature of the discharge lamp 11 is determined based on the temperature detected by the temperature sensor 23. The coldest point temperature obtained thus is used as the measurement temperature, and the dimming ratio setting section 18 calculates the difference between the optimal coldest point temperature read from the nonvolatile memory 17 and the measurement temperature, and corrects the dimming ratio by this difference. The corrected amount of the dimming ratio (duty ratio) for the difference between the optimal coldest point temperature and the measured temperature is as shown in Table 6.

[0081]
[Table 6]

Correct temperature - detection temperature (°C)	15	10	5	0	-15	-20
Duty amount (%)	-10	-5	-1	0	1	5
Output increase or decrease	Increase			Decrease		

[0082] In other words, when the measured temperature based on the ambient temperature detected by the temperature sensor 23 is lower than the optimal coldest point temperature stored in the nonvolatile memory 17, the dimming ratio read from the nonvolatile memory 17 is increased, and when the temperature is higher, the dimming ratio read from the nonvolatile memory 17 is corrected to decrease. Such a process is repeated until the optimal coldest point temperature is obtained. Here, in Table 6, the greater the difference between the optimal coldest point temperature and the measured temperature, the greater the change in the corrected amount. If this is set, even if the temperature difference is large, the dimming ratio can be converged in a short time.

[0083] The operation of this embodiment is shown in FIG. 30. In other words, the dimming ratio setting section 18 reads the lighting time from the lighting time timer 14 (S3), the temperature correction signal determination section 24 determines whether to perform temperature correction (S4), and when performing correction, determines the temperature correction value (S5). Since the dimming ratio can be determined when the temperature correction value is determined (S6), the discharge lamp 11 is then dimmed with the dimming ratio determined in the same manner as the first embodiment. The dimming ratio for the difference between the measured temperature and the optimal coldest point temperature is shown for each lighting time as shown in Table 7. In Table 7, the numbers in the next parentheses of the duty represent the difference between the measured temperature and the optimum coldest point temperature. That is, if the duty [-15] is used, the measured temperature is 15 degrees below the optimal coldest point temperature.

[0084]
[Table 7]

Lighting time (Time)	0	4000	16000	22000
Duty [0] (%)	60	50	40	30
Duty [-15] (%)	50	40	30	20
Duty [-10] (%)	55	45	35	25
Duty [15] (%)	61	51	41	31

[0085] It should be noted that, in each of the embodiments described above, the period from the readout of the lighting time to the memory of the lighting time is not specifically explained, but this period can be set as appropriate. This period is good enough to compensate for the decrease in the luminous flux over the course of the lighting time of the discharge lamp 11, so it is good to have a relatively long period, for example one hour. However, this cycle must also be shortened in places where the interval between the lights on and off of the discharge lamp 11 is short, and conversely, if the discharge lamp 11 is continuously lit, it is possible to set the cycle to 100 hours, etc.

[0086]
[Effects of the Invention] The invention of Claim 1 includes an electric discharge lamp, an electric discharge lamp lighting device capable of lighting the electric discharge lamp and controlling the supply power to the electric discharge lamp, a lighting time timer that measures the

supply time to the electric discharge lamp lighting device as the lighting time of the electric discharge lamp, and an illumination correction device that indicates the supply power to the electric discharge lamp to the electric discharge lamp lighting device according to the lighting time measured by the lighting time timer so as to suppress the decrease in the luminous flux due to the passage of the lighting time of the electric discharge lamp, and it is possible to significantly reduce initial investment when compared to conventional configurations without requiring a large wiring system with the main control board and terminal devices. In other words, even in places where there are few lighting fixtures or in customers who use only a small number of lighting fixtures, it becomes possible to use the function of suppressing the decrease in luminous flux that occurs over the lighting time that a discharge lamp is turned on. Furthermore, since the lighting time is calculated based on the power supply time to the discharge lamp lighting device, it is possible to accurately calculate the lighting time for each individual discharge lamp, and it is possible to accurately correct the luminous flux. Moreover, even if one of the plurality of discharge lamps is replaced, the light output of the discharge lamp is at a generally constant value controlled by the illuminance correction device, so there is no change in the amount of light.

[0087] The invention of Claim 2, in the invention of Claim 1, has a circuit board that implements a lighting time timer and an illumination correction device separately from the circuit board that implements a discharge lamp lighting device, and the design is made easier by mounting an electric discharge lamp lighting device that is a power system and a lighting time timer and illumination correction device that are a signal system on another circuit board.

[0088] The invention of Claim 3 is the invention of Claim 1, in which the circuit board on which the lighting time timer and the illuminance correction device are mounted is integrally provided with the circuit board on which the discharge lamp lighting device is implemented. Since the lighting time timer, the illuminance correction device, and the discharge lamp lighting device can be treated as a single component, the installation work into the fixture is easy and there is a possibility that the mounting area can be reduced to make the device more compact.

[0089] The invention of Claim 4, in the invention of Claims 1 through 3, is that the discharge lamp lighting device is more than an inverter circuit, and it is easy to control the supply power to the discharge lamp, and it is possible to increase the brightness of the supply power.

[0090] In the invention of Claims 1 through 4, the illumination correction device determines the supply power to the discharge lamp by comparing the external indicated dimming ratio and the lighting time to the correction table, and while suppressing the decrease in the luminous flux of the discharge lamp over the course of the lighting time, dimming can be performed by external instructions.

[0091] The invention of Claim 6, in the invention of Claims 1 through 4, is a illuminance correction device that determines the supply power to the discharge lamp by compensating the supply power to the discharge lamp obtained from the luminous flux maintenance ratio of the discharge lamp according to the lighting time with the dimming ratio indicated externally, and it is of course possible to dim the discharge lamp according to the external instructions while suppressing the decrease in the luminous

flux of the discharge lamp light over the course of the lighting time. If the luminous flux maintenance ratio according to the time is set as the data, it is possible to calculate the supply power to the discharge lamp using the dimming ratio according to the external instructions, making the creation of the data easier, and the capacity to store the data is also reduced.

[0092] The invention of Claim 7 includes a means for detecting the emitter-less state of an discharge lamp and a reset control section that resets the lighting time timer when the emitter-less state is detected, and it is possible to automatically reset the lighting time timer by detecting the emitter-less state at the end of the life of the discharge lamp, and to prevent forgetting to reset.

[0093] The invention of Claim 8 includes a means for detecting a no load state of an discharge lamp and a reset control section that resets a lighting time timer when a no load state is detected, and it is possible to automatically reset a lighting time timer by detecting a no load state associated with the replacement of an discharge lamp, etc., and to prevent forgetting to reset.

[0094] In the invention of Claims 1 to 4, the invention of Claim 9 includes a means for detecting a no load state of a discharge lamp during a period when the power is not applied, and a reset control section that resets the lighting time timer when the no load state is detected, and it is possible to detect the unloaded state associated with the replacement of the discharge lamp, etc., and to automatically reset the lighting time timer, so it is possible to prevent the reset from being forgotten, but there is no risk of electric shock because it detects a no load state when the power is not applied.

[0095] The invention of Claim 10, in the invention of Claims 1 to 4, provides a reset switch that resets the lighting time timer, and allows the lighting time timer to be optionally reset even when the discharge lamp is replaced for the convenience of the user.

[0096] The invention of Claim 11 includes a power switch that turns the power on and off, and a reset control section that resets the light time timer when the power on and off is a prescribed procedure. In addition to the fact that the light time timer can be reset arbitrarily, since the power switch is also used for resetting, the target to be operated does not increase and configuration is easy.

[0097] The invention of Claim 12 includes a temperature detection means for detecting a temperature corresponding to the coldest point temperature of the discharge lamp in the invention of Claims 1 to 4, and the illumination correction section determines the supply power to the discharge lamp based on the difference between the measured temperature determined by the temperature detection means and the optimal coldest point temperature specified according to the lighting time, and can suppress not only the luminous flux changes over the course of the lighting time, but also the luminous flux changes due to the temperature characteristics of the discharge lamp.

[0098] The invention of Claim 13, in the invention of Claim 12, is a temperature detection means provided in a fixture, and can be constructed as a single instrument, making it easy to handle.

[Brief Description of the Drawings]

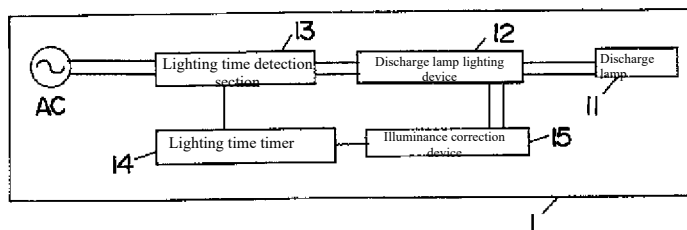
[FIG. 1] A block diagram illustrating the first embodiment of the present invention.
[FIG. 2] An illustration of the same operation.
[FIG. 3] An illustration of the same operation.
[FIG. 4] A circuit diagram showing a specific circuit above.
[FIG. 5] An illustration of the same operation.
[FIG. 6] An illustration of the same operation.
[FIG. 7] An illustration of the same operation.
[FIG. 8] A circuit diagram illustrating a second embodiment of the present invention.
[FIG. 9] An illustration of the same operation.
[FIG. 10] An illustration of the same operation.
[FIG. 11] A motion illustration showing the third embodiment of the present invention.
[FIG. 12] An illustration of the same operation.
[FIG. 13] A circuit diagram illustrating the fourth embodiment of the present invention.
[FIG. 14] An illustration of the same operation.
[FIG. 15] An operation illustration showing the fifth embodiment of the present invention.
[FIG. 16] A circuit diagram illustrating a sixth embodiment of the present invention.
[FIG. 17] An illustration of the same operation.
[FIG. 18] An operation illustration showing the seventh embodiment of the present invention.
[FIG. 19] A circuit diagram illustrating the eighth embodiment of the present invention.
[FIG. 20] An illustration of the same operation.
[FIG. 21] A schematic diagram illustrating the ninth embodiment of the present invention.

[FIG. 22] An illustration of the same operation.
[FIG. 23] A schematic diagram illustrating the embodiment of the tenth embodiment of the present invention.
[FIG. 24] An illustration of the same operation.
[FIG. 25] An illustration of the same operation.
[FIG. 26] An illustration of the same operation.
[FIG. 27] A schematic diagram illustrating the eleventh embodiment of the present invention.
[FIG. 28] An illustration of the same operation.
[FIG. 29] A schematic diagram showing the twelfth embodiment of the present invention.
[FIG. 30] An illustration of the same operation.
[FIG. 31] A schematic configuration diagram showing the above example implementation.
[FIG. 32] An illustration of the same principle.
[FIG. 33] An illustration of the same principle.
[FIG. 34] An illustration of the same principle.
[FIG. 35] A diagram showing the relationship between the ambient temperature and the temperature of each part.
[FIG. 36] A block diagram showing a conventional example.
[FIG. 37] A key block diagram of a conventional example.

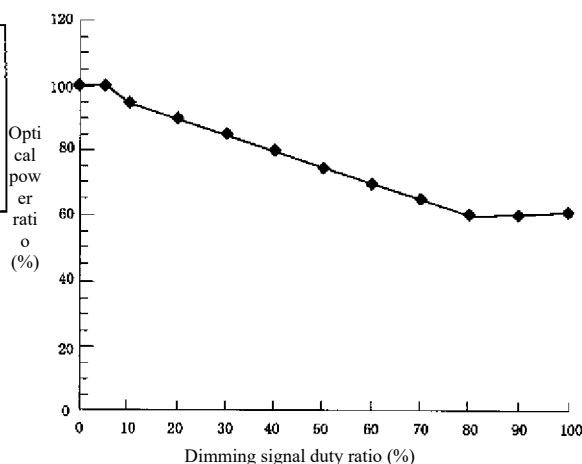
[Explanation of References]

1 Lighting device (lighting fixture)
11 Discharge lamp
12 Discharge lamp lighting device
14 Lighting time timer
15 Illuminance correction device
22 Reset control section
23 Temperature sensor
SW Power switch
SW3 Reset switch

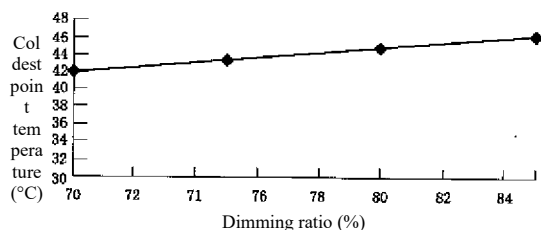
[FIG. 1]



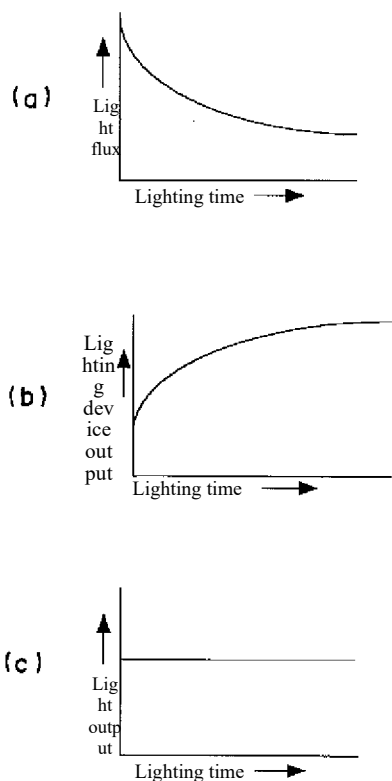
[FIG. 5]



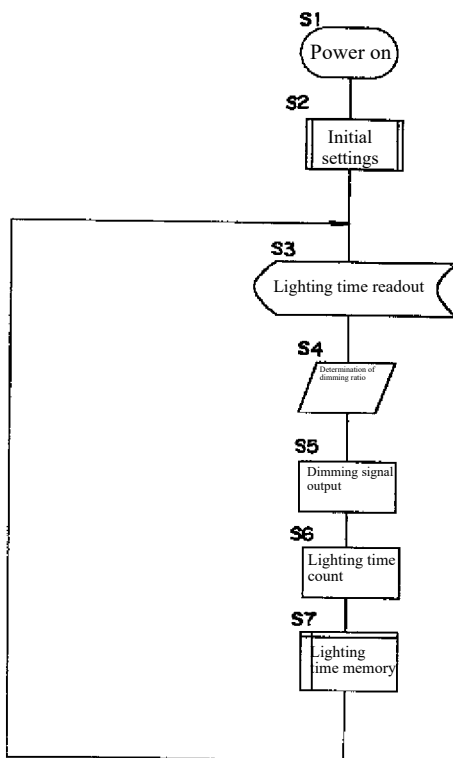
[FIG. 33]



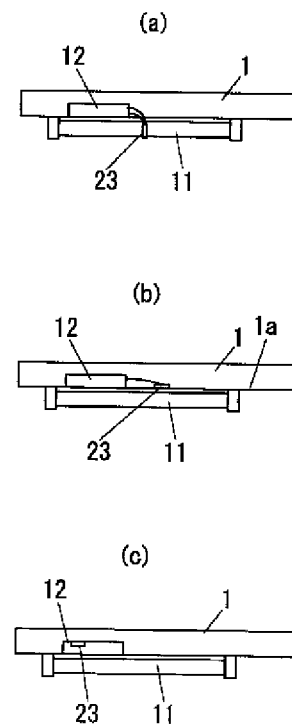
[FIG. 2]



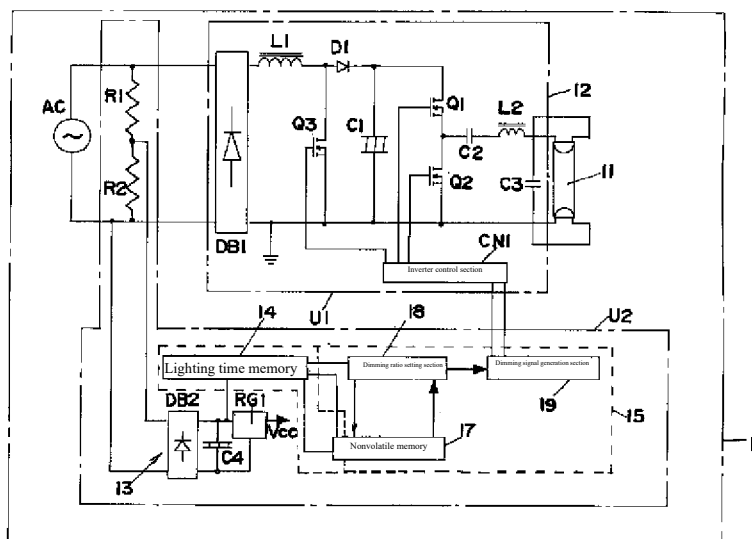
[FIG. 3]



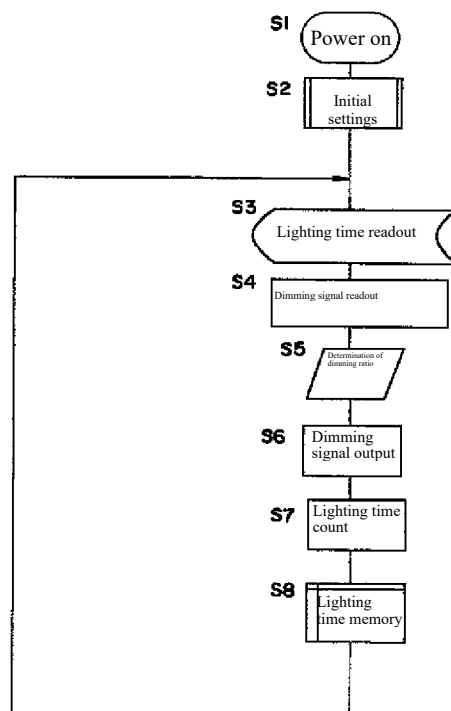
[FIG. 31]



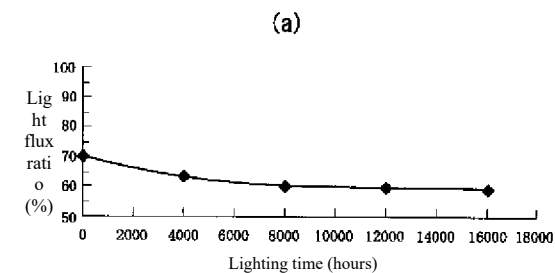
[FIG. 4]



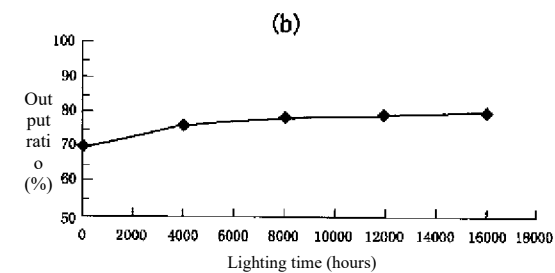
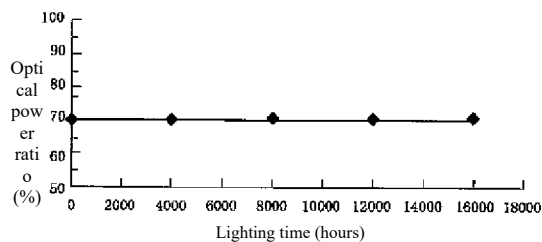
[FIG. 9]



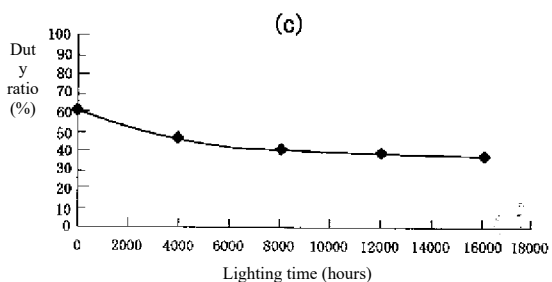
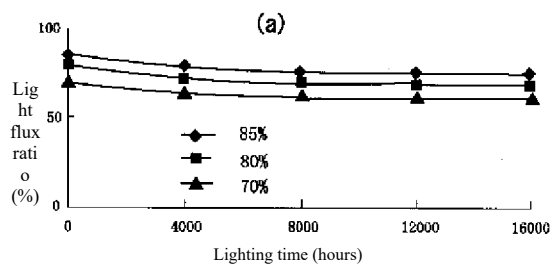
[FIG. 6]



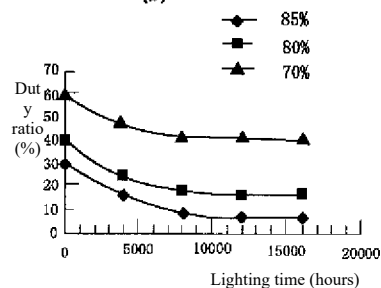
[FIG. 7]



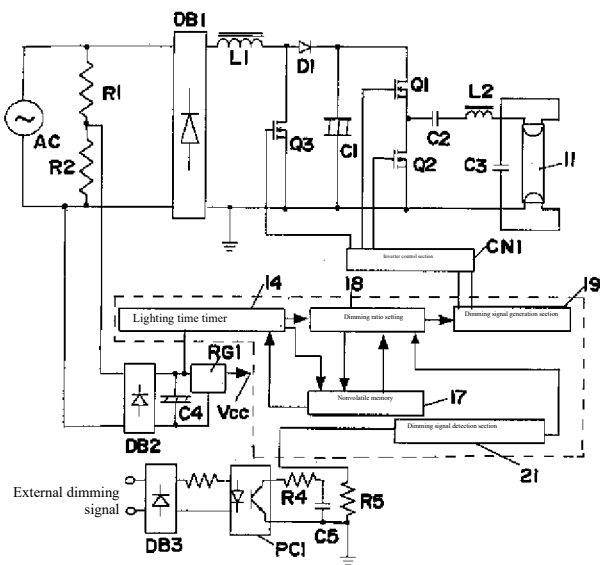
[FIG. 10]



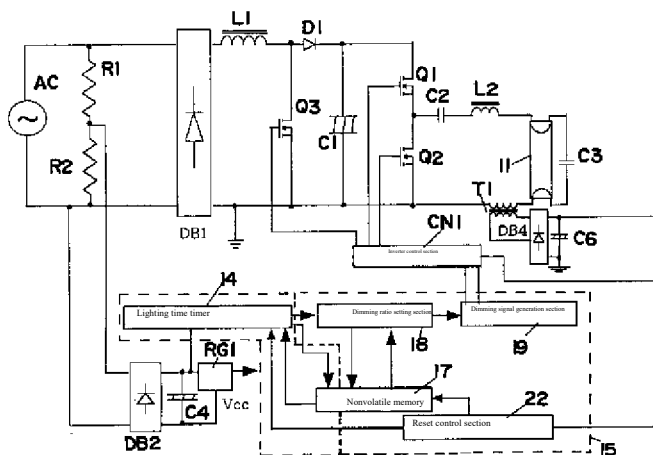
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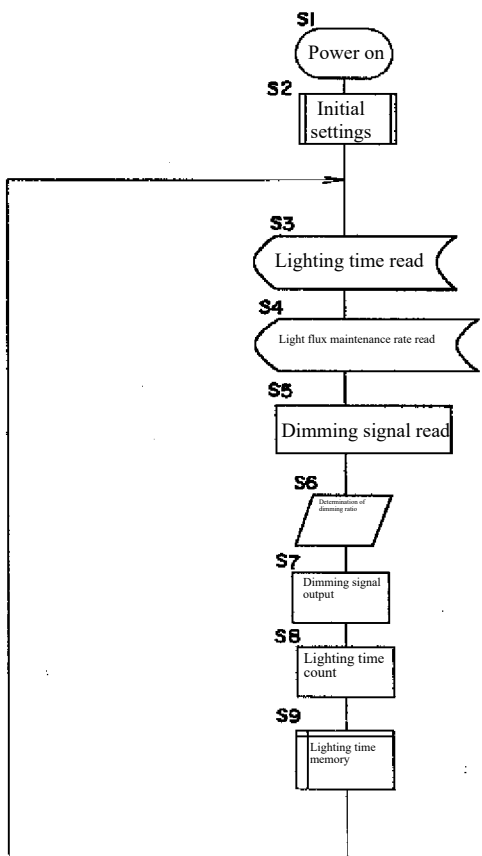
[FIG. 8]



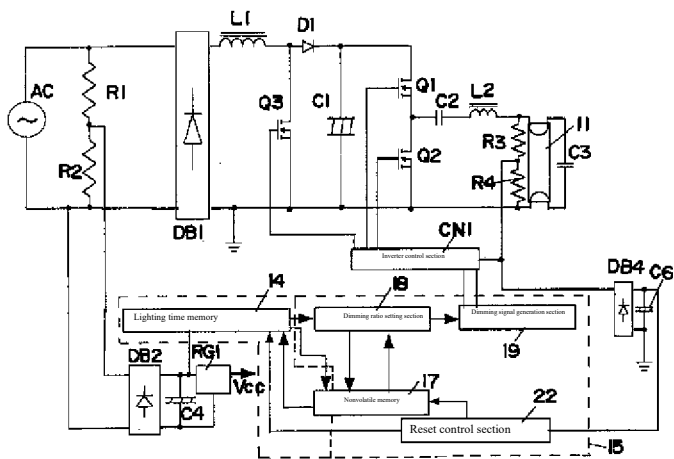
[FIG. 16]



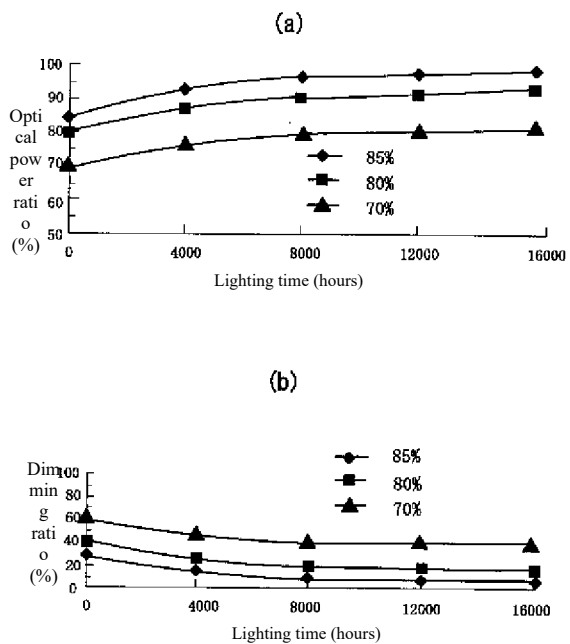
[FIG. 11]



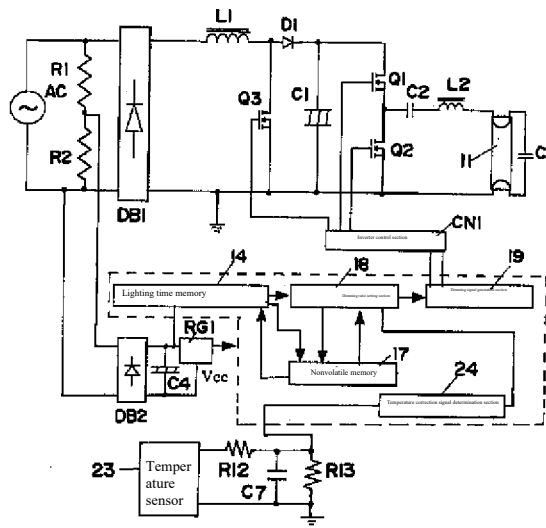
[FIG. 13]



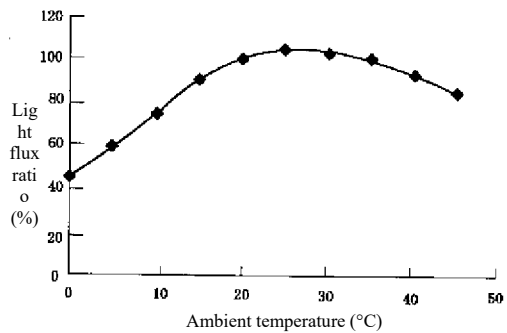
[FIG. 12]



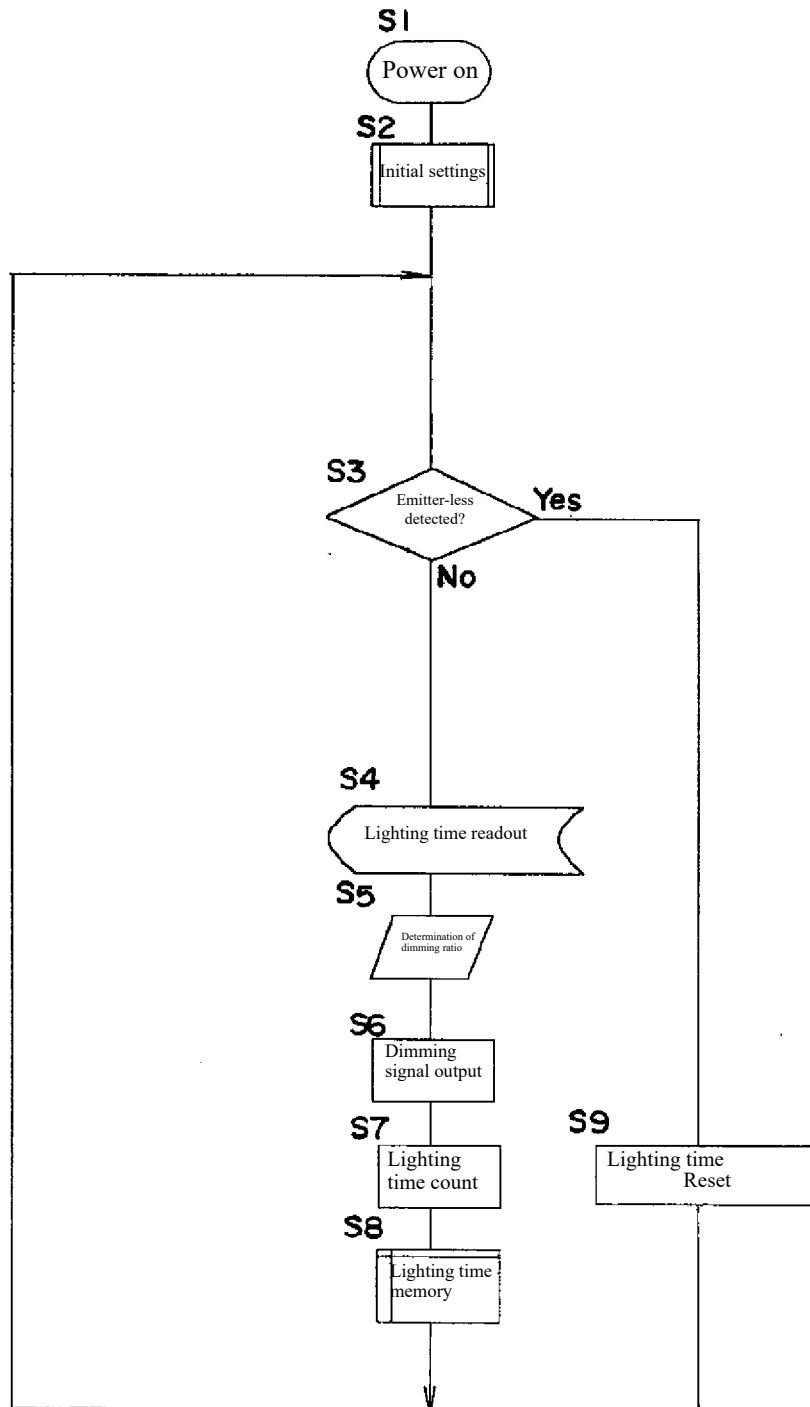
[FIG. 29]



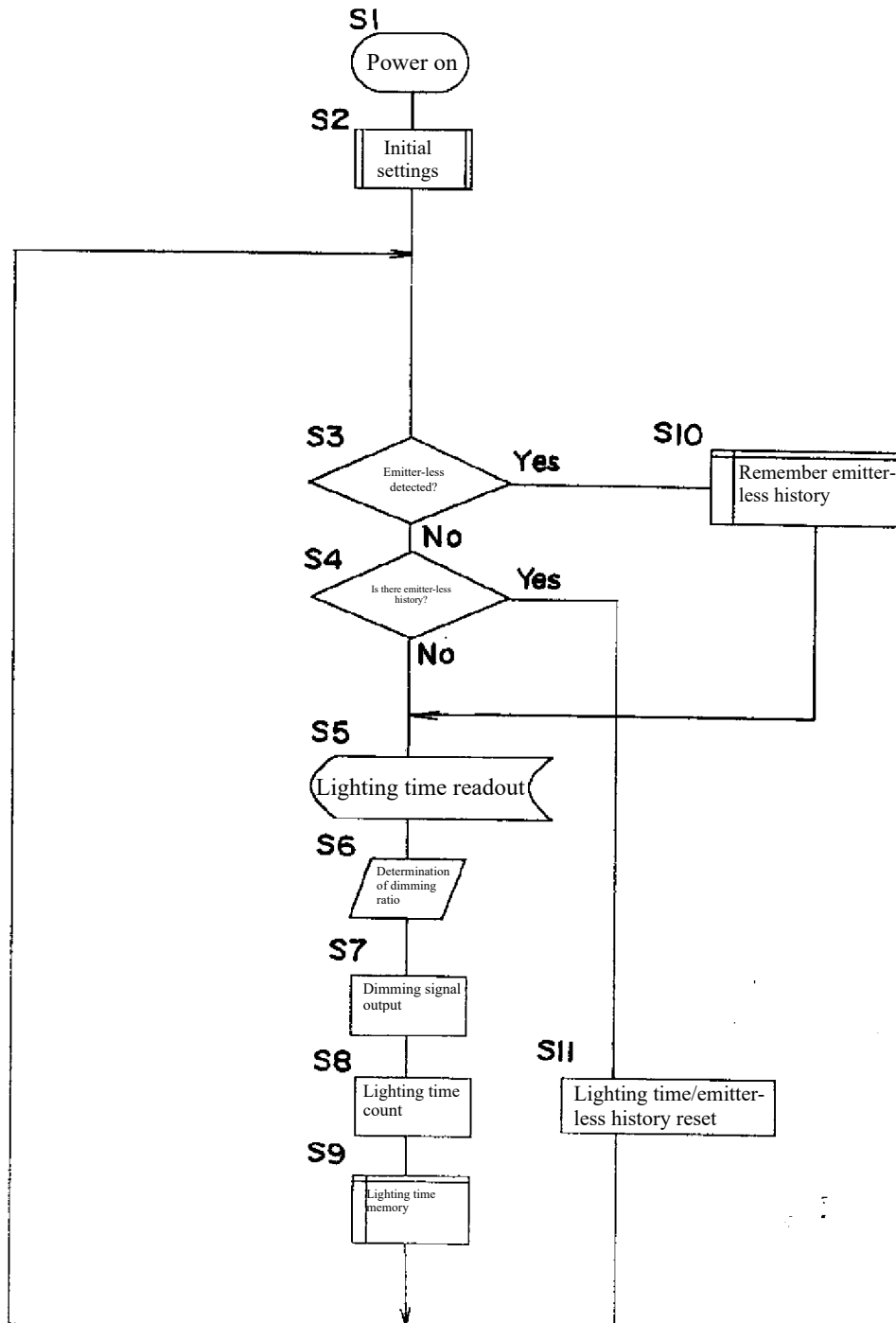
[FIG. 32]



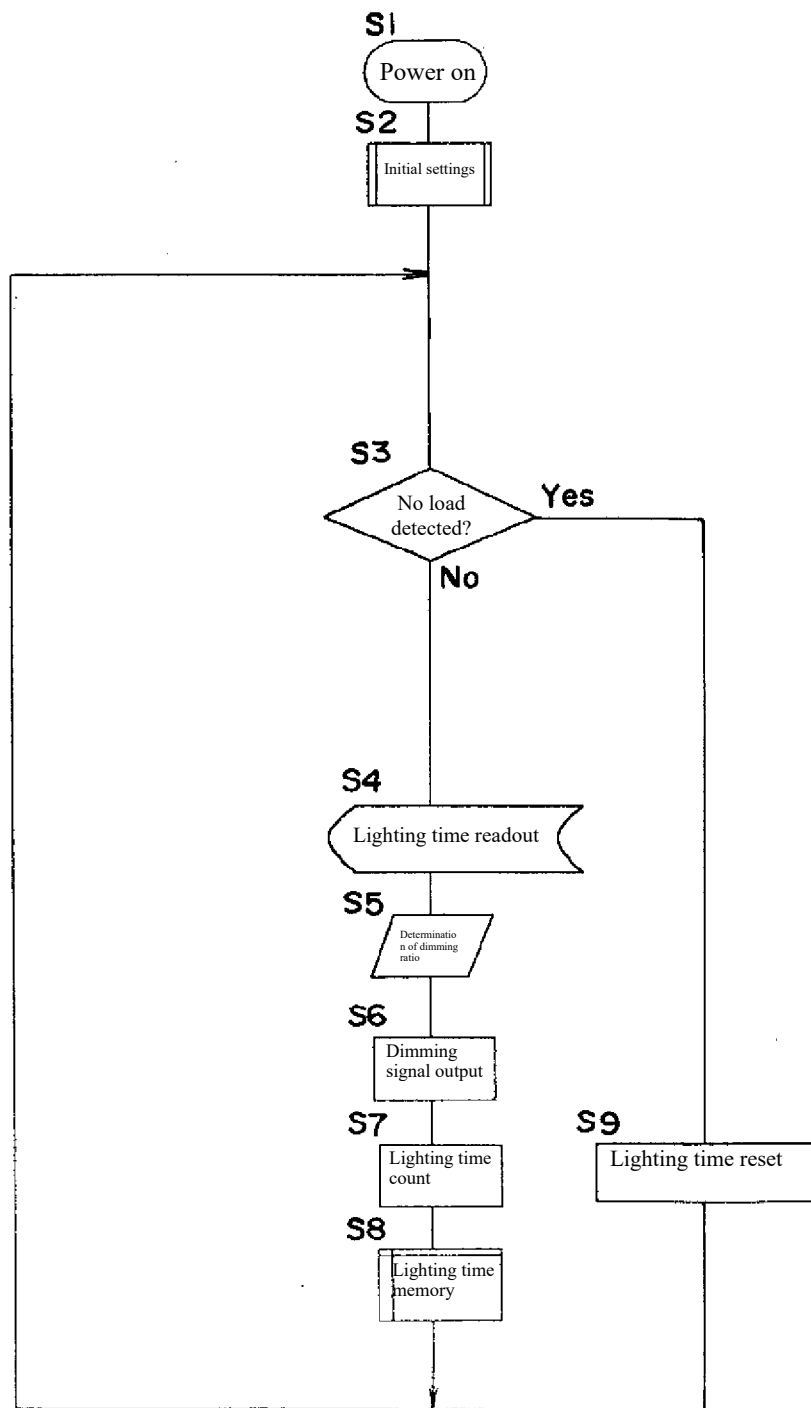
[FIG. 14]



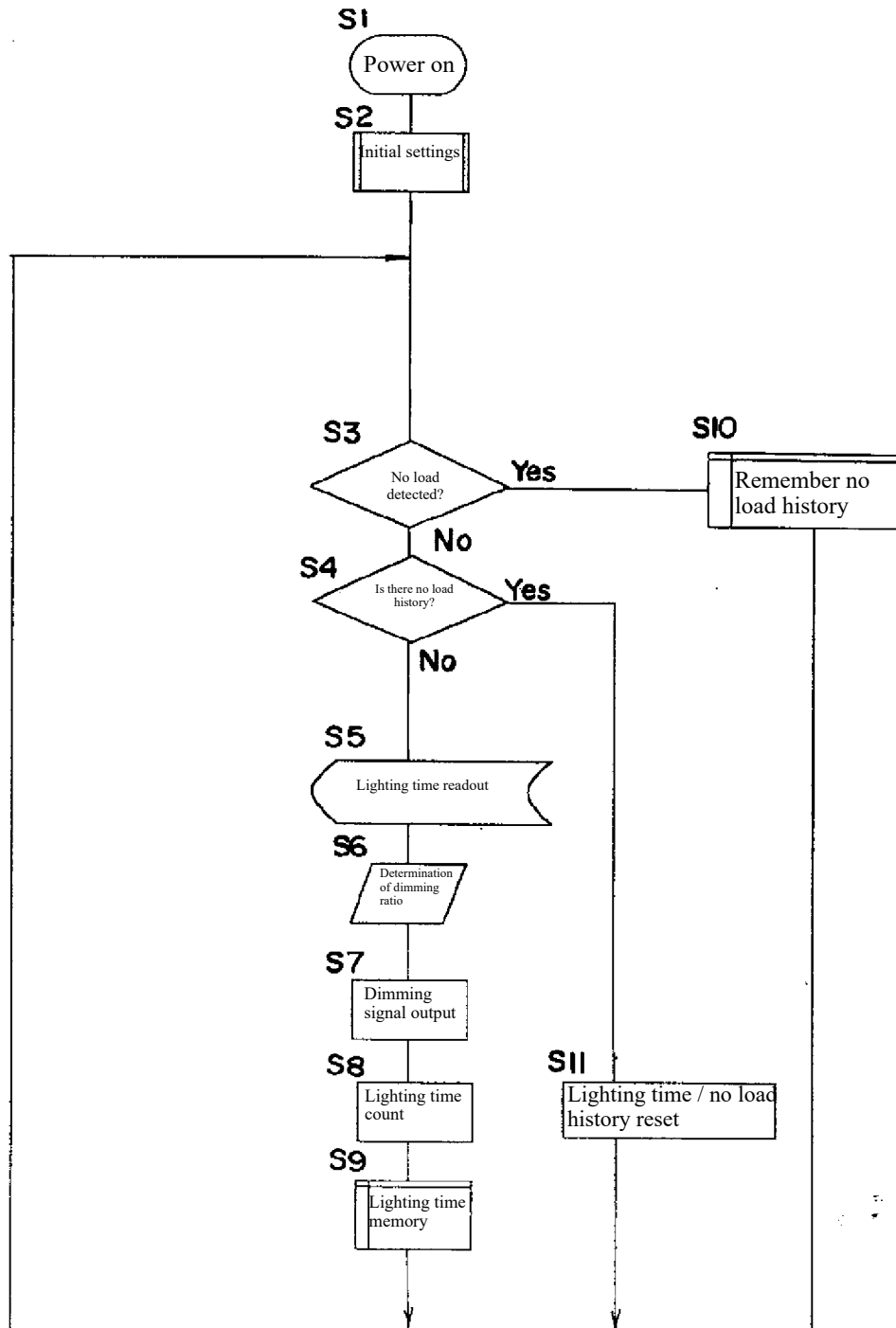
[FIG. 15]



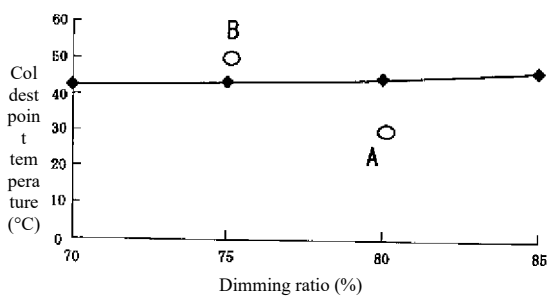
[FIG. 17]



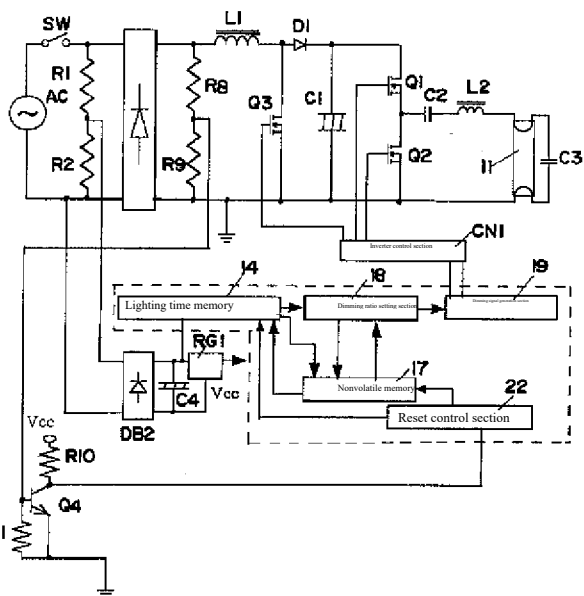
[FIG. 18]



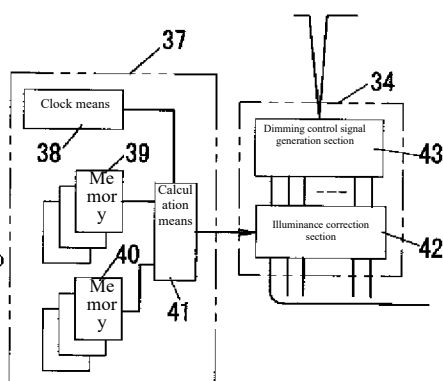
[FIG. 34]



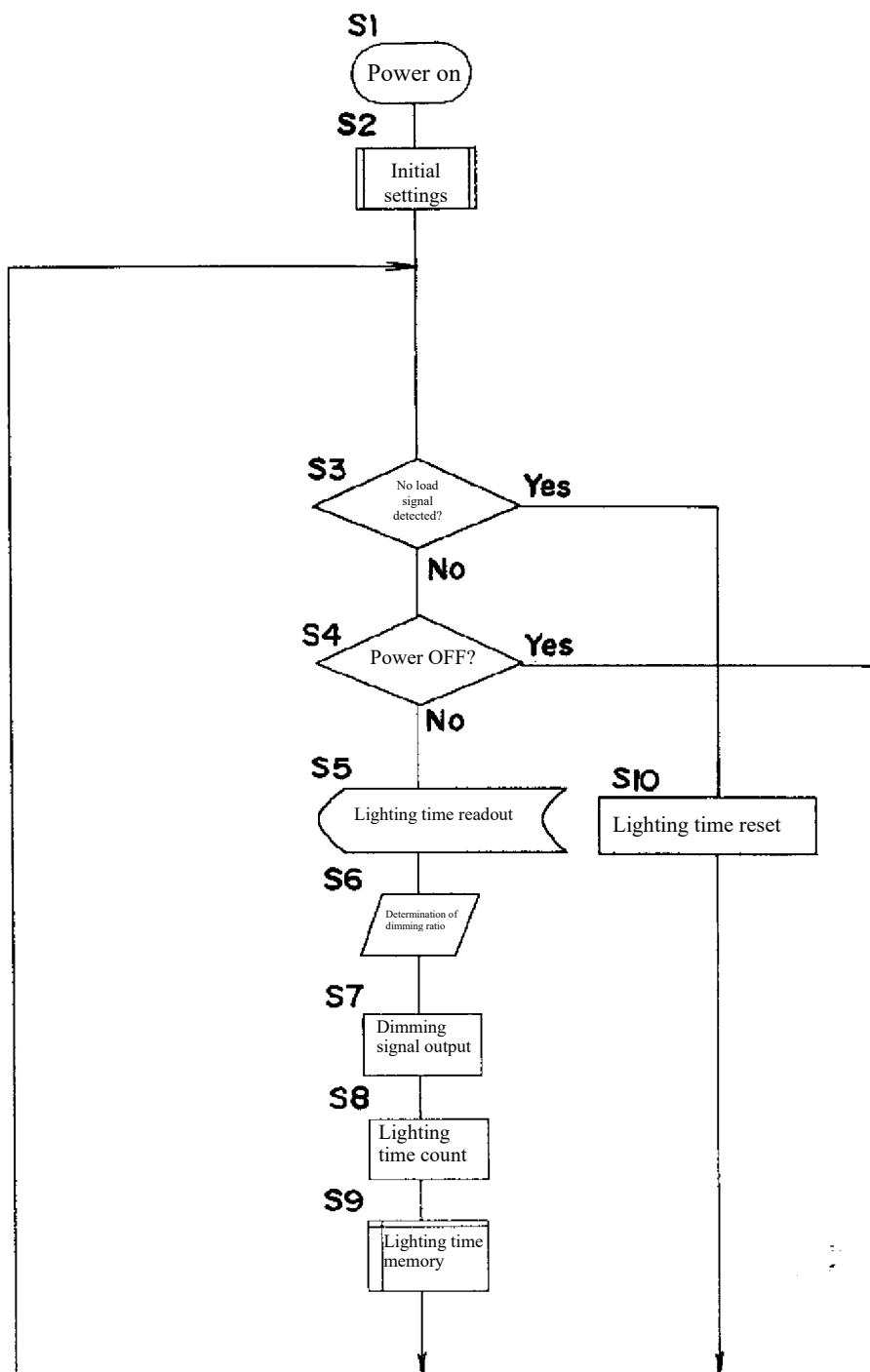
[FIG. 23]



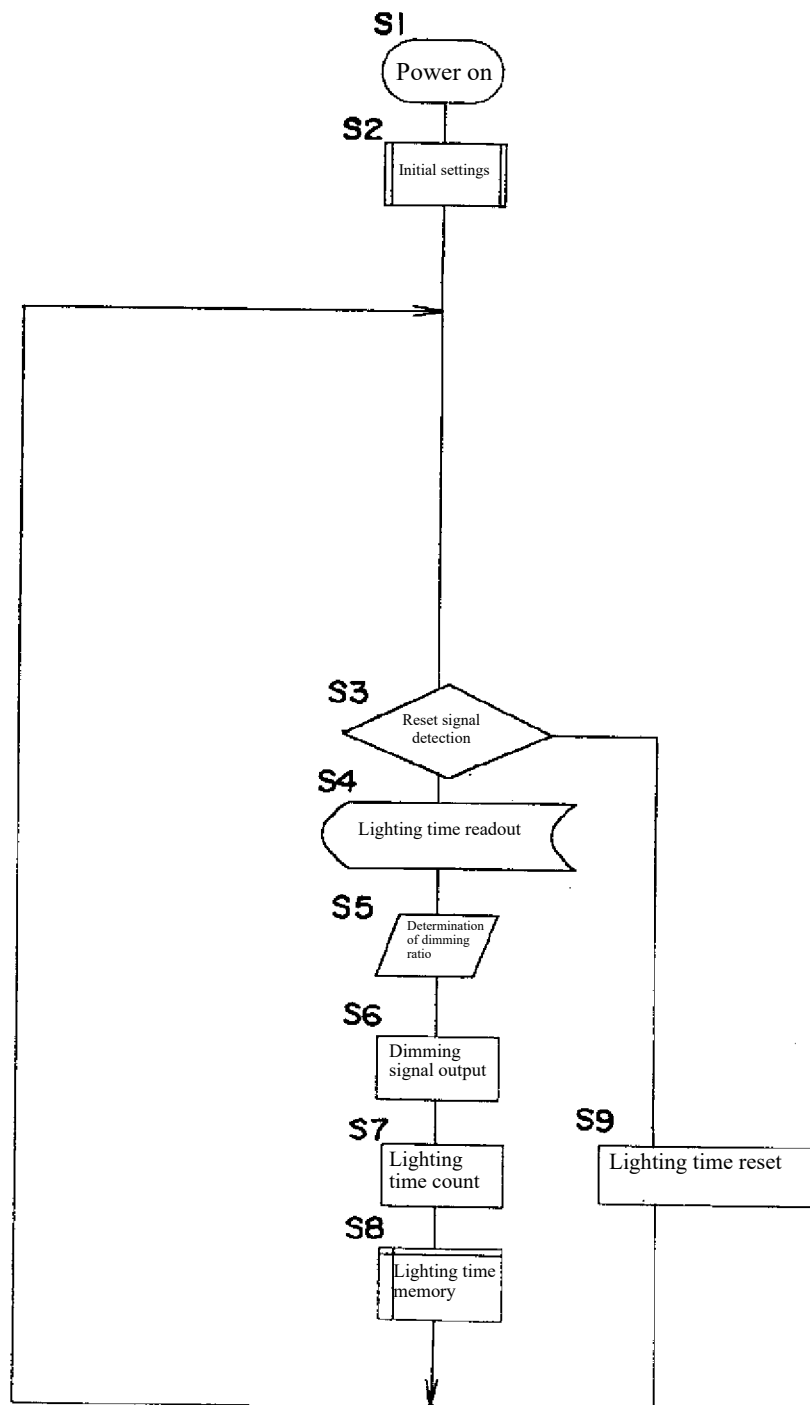
[FIG. 37]



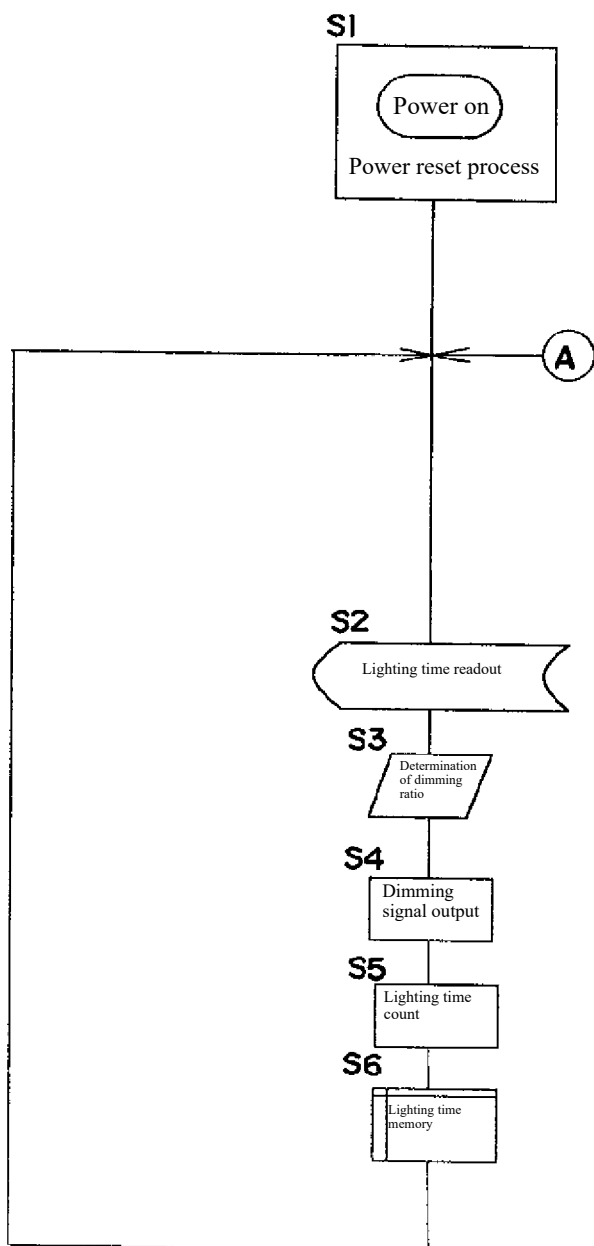
[FIG. 20]



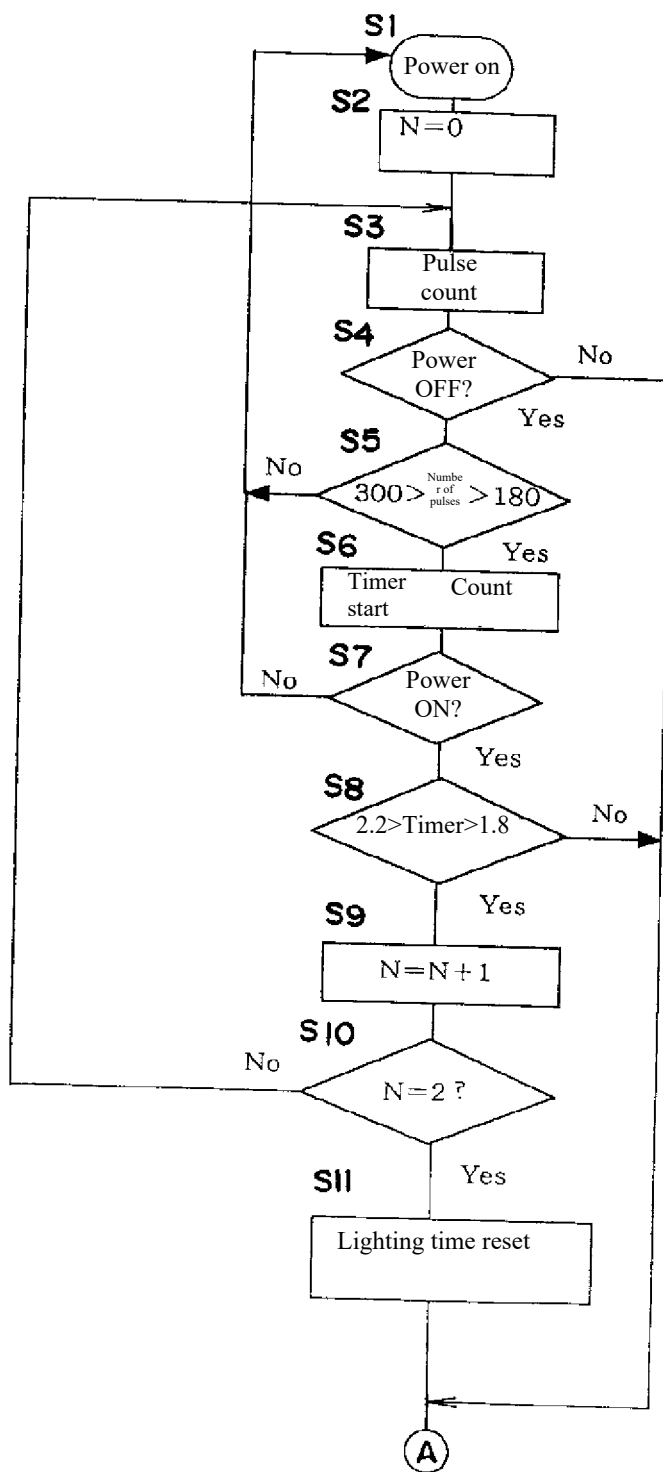
[FIG. 22]



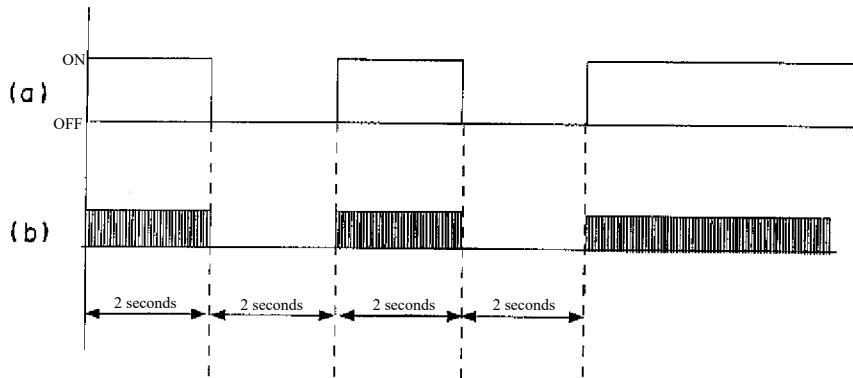
[FIG. 24]



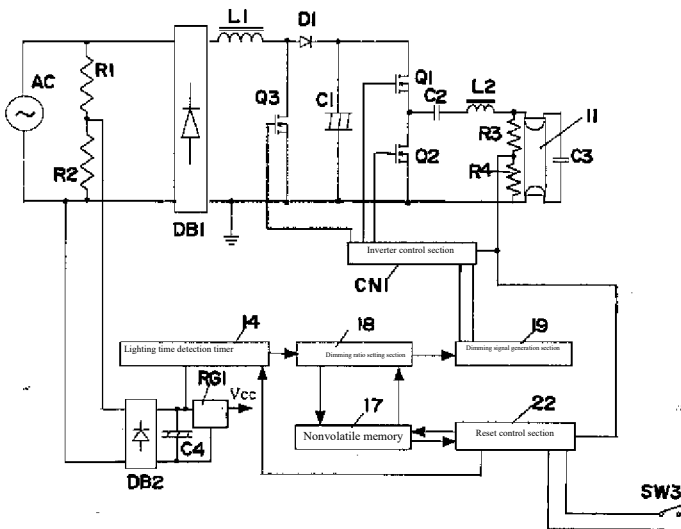
[FIG. 26]



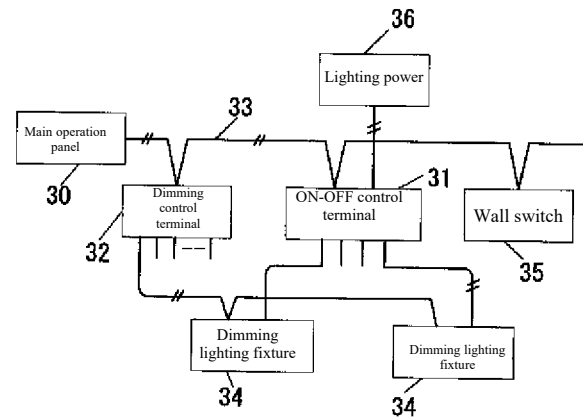
[FIG. 25]



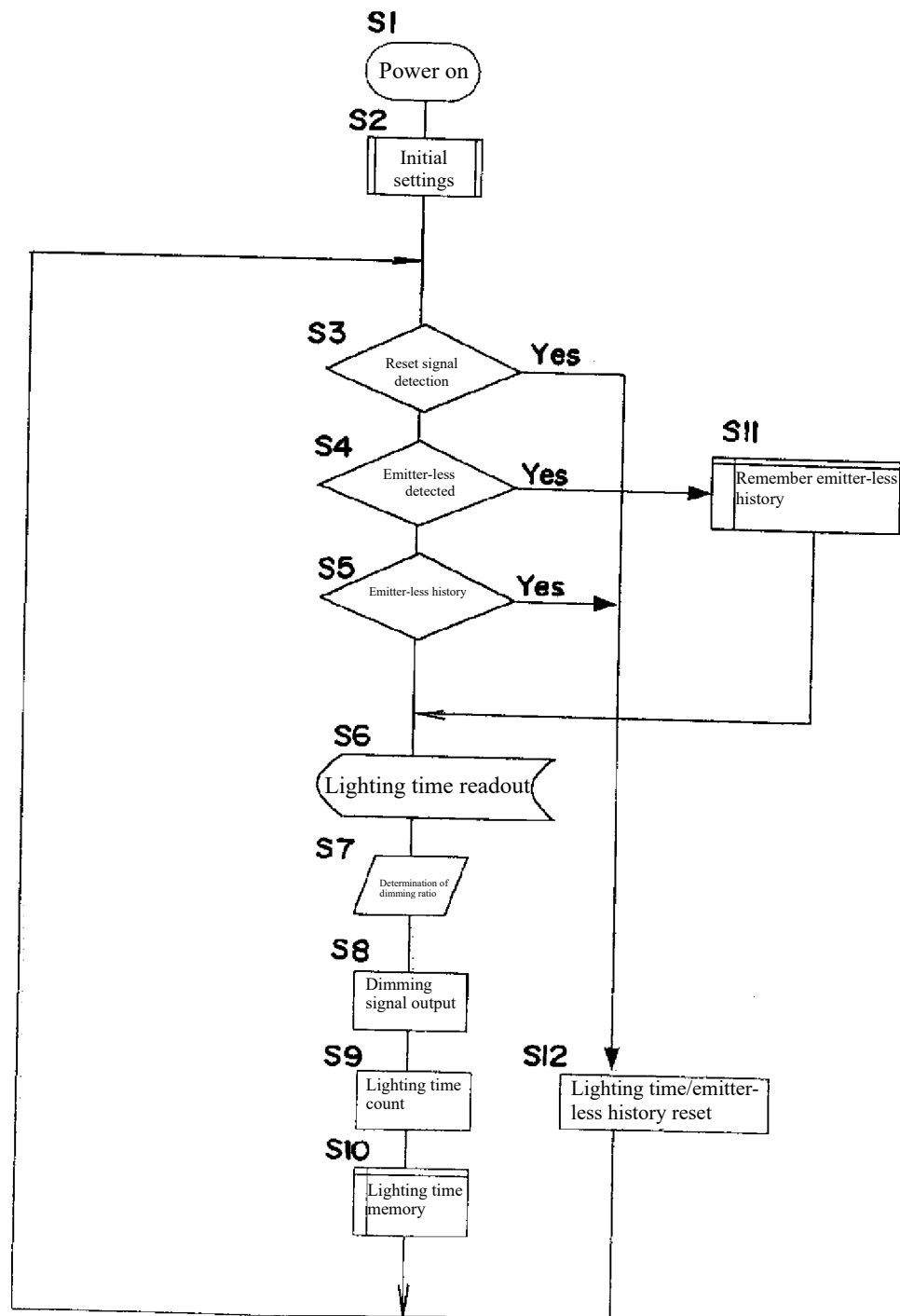
[FIG. 27]



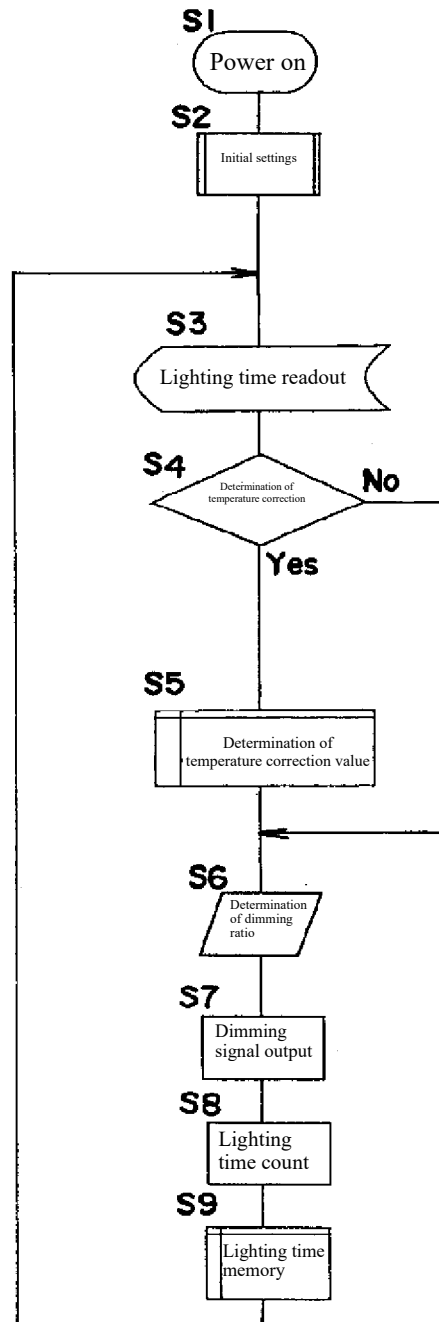
[FIG. 36]



[FIG. 28]



[FIG. 30]



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F term (reference) 3K072 AA02 BA05 BB01 BB10 BC01
BC03 DB03 DD04 EA01 EA02
EB01 EB04 EB05 EB07 GA03
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