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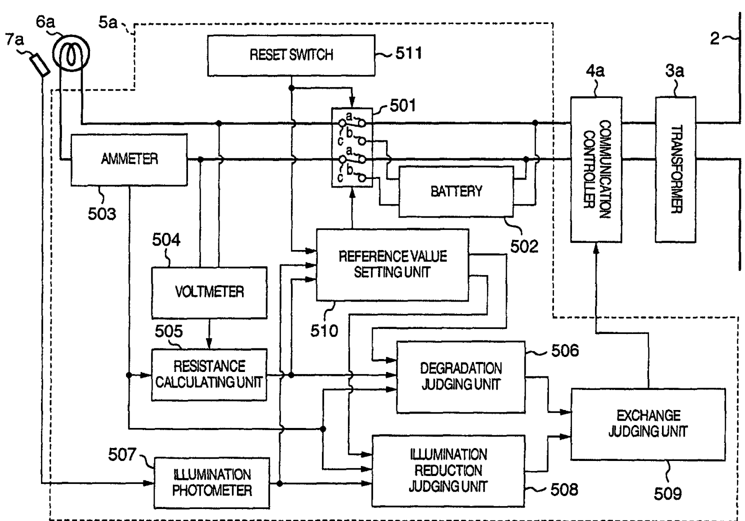
(54) LAMP STATE DETECTOR AND LAMP STATE MONITOR USING LAMP STATE DETECTOR

(57) It is judged on the basis of the illuminance of the light, emitted from a lamp, which has been measured by an illumination photometer whether or not the exchange of the lamp is required, whereby when the illuminance of the lamp has been reduced due to the blackening of the lamp, the time when exchanging the lamp can be judged before the illuminance of the lamp has become equal to or lower than the necessary illuminance. In addition, it is judged on the basis of the resistance value of the lamp which has been measured by a resistance measuring device whether or not the exchange of the lamp is required, whereby when the illuminance of the lamp has been reduced due to the degradation of the filament, the time when exchanging the lamp can be judged before the illuminance of the lamp has become equal to or lower than the necessary illuminance. As a result, for both of the reduction of the illuminance of the lamp due to the blackening of the lamp and the reduction of the illuminance of the lamp due to the breaking of the filament, the time when exchanging the lamp can be judged before the illuminance of the lamp has become equal to or lower than the necessary illuminance.

FIG. 2



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Description

TECHNICAL FIELD

[0001] The present invention relates to a lamp state detector for detecting the states of a large number of lamps installed in airports, expressways or the like and a lamp state monitoring apparatus employing the same.

BACKGROUND ART

[0002] While a large number of lamps (mainly, the halogen lamps), for the purpose of conducting aircrafts and so forth, are installed in the passages for the aircrafts in an airport, with respect to the halogen lamps, it is known that the illuminance thereof is reduced due to the blackening of the lamp resulting from that the halogen gases are left out, and so forth and due to the breaking of the filament resulting from the degradation of the filament. Since the reduction of the illumination of the illuminance of the lamps is an obstacle to the conduction for the aircrafts, one lamp, before the illuminance thereof has become equal to or lower than the necessary illuminance, needs to be exchanged for a new lamp.

[0003] As an example of the apparatus for monitoring the state of the halogen lamp, the apparatus wherein in order to prevent previously the breaking of the filament in the halogen lamp, the value of the current which is caused to flow through the filament of the halogen lamp is measured, and when the value of the measured current has exceeded the setting value which is previously set, an operator is warned of that the breaking of the filament will occur in a short time is described in JP-A-62-249393 (hereinafter, referred to as "a first prior art" for short, when applicable).

[0004] In addition, it is described in JP-A-60-250593 (hereinafter, referred to as "a second prior art" for short, when applicable) that the illuminance of the lamp is measured, and the reduction of the illuminance of the lamp is detected by comparing the measured illuminance of the lamp with the setting value which is previously set, and also an operator is informed of the time when exchanging the lamp on the basis of the measured illuminance of the lamp.

[0005] As described above, while as the causes of reducing the illuminance of the halogen lamp, the blackening of the lamp and the breaking of the filament are both known, it has been judged that both of the causes have the correlation. That is, it has been judged in the halogen lamp that when the filament has undergone the breaking of the filament, the lamp has undergone the blackening, while the lamp has undergone the blackening, the filament has undergone the breaking of the filament. Therefore, conventionally, if either one of the estimation of the breaking of the filament based on the measurement of the current which is caused to flow through the filament as in the first prior art or the detection of the blackening of the lamp based on the measurement of the illuminance of the lamp as in the second prior art has only to be carried out, then this has been judged to be sufficient.

[0006] However, as a result of studying repeatedly the cause of the reduction of the illuminance of the halogen lamp by the present inventors and other persons, it has been made clear that the breaking of the filament and the blackening of the lamp are respectively the individual events, and also the reduction of the illuminance of the lamp is caused by one of them. That is, it has been newly made clear that there is the case where even when the filament has undergone the breaking of the core, the lamp has not undergone the blackening at all, or there is the case where even when the lamp has undergone the blackening, the filament has not undergone the breaking of the core at all. In addition, it has also been made clear that when the illuminance of the lamp has been reduced due to the blackening of the lamp, the illuminance has been gradually reduced for a relatively long lapse of time, whereas when the illuminance has been reduced due to the breaking of the filament, the illuminance has been abruptly reduced for a short lapse of time.

[0007] As described above, in the first prior art, since the breaking of the filament is estimated on the basis of the value of the current which is caused to flow through the filament, it is impossible to detect the reduction of the illuminance due to the blackening of the lamp. In other words, in the case where the illuminance of the lamp has been reduced due to the blackening of the lamp though the filament has not undergone the breaking of the filament at all, since the current which is caused to flow through the filament is not changed at all, it is impossible to detect the reduction of the illuminance. As a result, the exchange of the lamp can not be carried out before the illuminance of the lamp has become equal to or lower than the necessary illuminance.

[0008] On the other hand, in the second prior art, the time at which the old lamp is exchanged for a new one is reported on the basis of the illuminance which has been measured. Therefore, in the case where the illuminance of the lamp has been abruptly reduced due to the breaking of the filament, it is difficult to report the time when exchanging the lamp before the illuminance of the lamp has become equal to or lower than the necessary illuminance. In other words, since the illuminance has been abruptly reduced in the breaking of the filament, if the exchange time is reported from a time point when the illuminance begins actually to be reduced, the illuminance of the lamp may have already been reduced to the level equal to or lower than the necessary illuminance before carrying out the exchange of the lamp in some cases.

[0009] As described above, in the first prior art and the second prior art, the exchange of the lamp may not be carried out before the illuminance of the lamp has become the necessary illuminance in some cases.

DISCLOSURE OF INVENTION

[0010] An object of the present invention is to provide a lamp state detector which is capable of judging the time when the lamp should be exchanged before the illuminance of the lamp has become equal to or lower than the necessary illuminance for both of the reduction of the illuminance of the lamp due to the blackening of the lamp and the reduction of the illuminance of the lamp due to the breaking of the filament, and a lamp state monitoring apparatus employing the same.

[0011] In order to attain the above-mentioned object, the present invention may provide measuring the illuminance of the light which has been emitted from a lamp and also a resistance value of the lamp to judge on the basis of the illuminance and the resistance value which have been measured whether or not the exchange of the lamp is required.

[0012] As described above, since it is judged on the basis of the illuminance and the resistance value which have been measured whether or not the exchange of the lamp is required, when the illiminance of the lamp has been reduced due to the blackening of the lamp, it is possible to judge on the basis of the illuminance which has been measured the time when the lamp should be exchanged before the illuminance of the lamp has become equal to or lower than the necessary illuminance. In addition, when the filament has been degraded to undergo the breaking of the core to reduce the illuminance of the lamp, the degradation of the filament is detected on the basis of the resistance value, which has been measured, before the filament has undergone the breaking of the core, whereby it is possible to judge the time when the lamp should be exchanged before the illuminance of the lamp has become equal to or lower than the necessary illuminance. In other words, for both of the reduction of the illuminance of the lamp due to the blackening of the lamp and the reduction of the illuminance of the lamp due to the breaking of the filament, it is possible to judge the time when the lamp should be exchanged for a new one before the illuminance of the lamp has become equal to or lower than the necessary illuminance.

BRIEF DESCRIPTION OF DRAWINGS

[0013] Fig. 1 is a block diagram showing a configuration of a lamp state monitoring apparatus as a preferred embodiment of the present invention; Fig. 2 is a block diagram,showing a configuration of a lamp state detector 5a shown in Fig. 1; Fig. 3 is a graphical representation showing the relation between the lighting accumulating total time and the resistance ratio; Fig. 4 is a diagram showing an example of the display in a display panel 91 of a lamp state display device 9 shown in Fig. 1; Fig. 5 is a cross sectional view showing the structure of a chassis 51 in which a lamp 6a, an illumination photometer 7a and the like shown in Fig. 1 are all accommodated; Fig. 6 is a block diagram showing a configuration of a lamp state monitoring apparatus as another embodiment of the present invention; Fig. 7 is a block diagram showing a configuration of a lamp state detector 5a shown in Fig. 6; Fig. 8 is a graphical representation showing the relation between the current flowing through a lamp and the lighting accumulating total time; Fig. 9 is a graphical representation showing the relation between the rated current lighting time and the lamplight filament breaking probability; Fig. 10 is a diagram showing an example of the display in the display panel 91 of the lamp state display device 9 shown in Fig. 6; Fig. 11 is a cross sectional view showing the structure of the chassis 51 in which the lamp 6a, the illumination photometer 3a and the like shown in Fig. 6 are all accommodated; Fig. 12 is an enlarged view showing the illumination photometer 7a shown in Fig. 11 and the vicinity thereof; and Fig. 13 is a top view when the inside of the chassis 51 is viewed from the upper side.

BEST MODE FOR CARRYING OUT THE INVENTION

[0014] Embodiments of the present invention will hereinafter be described in detail with reference to the accompanying drawings.

(Embodiment 1)

[0015] Fig. 1 shows a lamp state monitoring apparatus as a preferred embodiment of the present invention. In this connection, the lamp state monitoring apparatus of the present embodiment is the apparatus for monitoring the states of a large number of halogen lamps (hereinafter, referred to as "lamps" for short, when applicable) which are installed in the passages or the like for the aircrafts in an airport.

[0016] In Fig. 1, a constant current source 1 supplies the A.C. current to a plurality of communication controllers 4a to 4n through a power line and transformers 3a to 3n. The communication controllers 4a to 4n utilize as their power source a part of the A.C. current supplied thereto and also output the remaining A.C. current to lamp state detectors 5a to 5n which are electrically connected thereto, respectively.

[0017] While the lamp state detector 5a will hereinbelow be described, since each of other lamp state detectors also has the same configuration as that of the lamp state detector 5a and operates in the same manner as that in the lamp state detector 5a, the description thereof is omitted here for the sake of simplicity. Fig. 2 shows a configuration of the lamp state detector 5a. The A.C. current which has been outputted from the communication controller 4a is inputted to an input terminal a of a power source switching unit 501 in the lamp state detector 5a to be outputted to a lamp 6a through an output terminal c of the lamp state switching unit 501. The lamp 6a emits the light by supplying the A.C. current thereto. In addition, in the lamp state detector 5a, a part of the A.C. current which has been outputted from the communication controller 4a is supplied to a battery 502 to charge the battery 502 with the electric charges.

[0018] In the lamp state detector 5a, an ammeter 503 measures the effective value of the A.C. current which is caused to flow through the lamp 6a to output the current effective value I thus measured to a resistance calculating unit 505, a degradation judging unit 506 and an illuminance reduction judging unit 508. In addition, a voltmeter 504 measures the effective value of the A.C. voltage which is applied across the lamp 6a to output the voltage effective value V thus measured to the resistance calculating unit 505. Then, the resistance calculating unit 505 obtains the resistance value R of the lamp 6a on the basis of both of the current effective value I and the voltage effective value V which have been inputted thereto. In this connection, the resistance value R can be obtained on the basis of (Expression 1).

$$R = V/I \qquad \text{(Expression 1)}$$

[0019] The resistance calculating unit 505 outputs the resistance value R which has been obtained on the basis of (Expression 1) to the degradation judging unit 506. In such a way, since the resistance value of the lamp 6a is measured by the ammeter 503, the voltmeter 504 and the resistance calculating unit 505, those constituent elements may also be called collectively the resistance measuring device.

[0020] The degradation judging unit 506, in order to judge the time when the lamp should be exchanged before the filament has undergone the breaking, judges the degradation state of the filament of the lamp 6a on the basis of the current effective value I and the resistance value R, and the reference current value I0 and the reference resistance value R0 which have been outputted from a reference value setting unit 510. In this connection, the reference resistance value R0 is the resistance value of the lamp 6a which is obtained when the current having the reference current value I0 is caused to flow through the lamp 6a in which the filament is not yet degraded at all, and the method of setting the reference current value I0 and the reference resistance value R0 in the reference value setting unit 510 will be described later. The degradation judging unit 506, as the judgement of the degradation of the filament, substitutes the values of the current effective value I, the resistance value R, the reference current value I0 and the reference resistance value R0 into (Expression 2) to confirm that (Expression 2) is established.

$$\frac{R}{R0}\cdot\left[\frac{I0}{I}\right]^{\kappa 1} > \alpha 1 \qquad \text{...... (Expression 2)}$$

[0021] In this connection, in the left side of (Expression 2), the ratio of the value, when the current having the reference current value I0 is caused to flow through the lamp 6a, which is obtained by changing the resistance value R thereinto to the reference resistance value R0 (hereinafter, referred to as "the resistance ratio" for short, when applicable) is calculated, and $\alpha 1$ in the right side of (Expression 2) is the degradation judgement barometer. In addition, $\kappa 1$ is the constant which exhibits the dependency characteristics of the lamp resistance on the lamp current. Then, since it becomes clear that $\kappa 1$ is 0.46 in the case of the halogen lamp, in the present embodiment as well, the relation of $\kappa 1 = 0.46$ is employed.

[0022] Next, the description will hereinbelow be given with respect to the method of setting the degradation judgement barometer $\alpha 1$. Fig. 3 is a graphical representation showing the relation between the lighting accumulating total time of the lamp and the resistance ratio. In this connection, Fig. 3 shows the case where at a time point when the lighting accumulating total time has reached about 910[hr], the filament of the lamp undergoes the breaking of the core. As shown in the figure, when the lighting accumulating total time is substantially equal to or lower than about 600[hr], the resistance ratio is about 1.0, and thereafter, the resistance ratio is gradually increased until the filament undergoes the breaking. The phenomenon that the resistance ratio is gradually increased in such a way results from that the filament of the lamp has the property in which the resistance of the filament is gradually increased along with the degradation of the filament. Then, at a time point when the lighting accumulating total time has reached about 910[hr] (at a time point when the resistance ratio has become 1.1), the filament of the lamp undergoes the breaking in the end and hence the resistance ratio becomes infinity. This phenomenon results from that the breaking of the filament of the lamp makes the resistance value infinity. In such a way, the resistance ratio of the lamp is held at 1.0 for about 600[hr] from a time point when starting the lighting, i.e., when the filament of the lamp is in the sound state. Thereafter, the resistance ratio is gradually increased to 1.1 along with the progress of the degradation of the filament to undergo the breaking of the filament in the end to become infinity. In the present embodiment, since the old lamp is exchanged for a new one before the filament of the old lamp begins to be degraded and the filament of the lamp undergoes the breaking in the end, the degradation judgement barometer $\alpha 1$ is set to 1.02 which is the value of the resistance ratio in the initial stage of the degradation of the filament.

[0023] The degradation judging unit 506, when the value of the left side of (Expression 2) has exceeded 1.02 as the degradation judgement barometer $\alpha 1$, i.e., when (Expression 2) is established, judges that the filament of the lamp 6a has been degraded. In other words, in the case where the value, when the current having the reference current value I0 is caused to flow through the lamp 6a, which is obtained by changing the resistance value R thereinto has become larger than the reference resistance value R0 by 2%, the degradation judging unit 506 judges that the filament of the lamp 6a has been degraded. In such a way, in the present embodiment, the degradation judgement for the filament of the lamp is carried out by utilizing the phenomenon that the resistance value of the filament is increased as the filament of the lamp is further degraded. In this connection, while in the present embodiment, the relation of $\alpha 1 = 1.02$ is employed as the degradation judgement barometer, it is to be understood that the value of the degradation judgement barometer $\alpha 1$ is limited to 1.02, and the suitable value of the resistance ratio which is suitable for exchanging the old lamp for a new one before the filament of the lamp has undergone the breaking in the end may be obtained on the basis of the tests and the like to be set.

[0024] The degradation judging unit 506, when (Expression 2) is established, outputs "1", while when (Expression 2) is not established, outputs "0". That is, the degradation judgement unit 506, when the filament of the lamp 6a has been degraded, outputs "1", while when the filament of the lamp 6a has not yet been degraded, outputs "0". The result of the degradation judgement for the filament of the lamp 6a which is made by the degradation judging unit 506 is inputted to an exchange judging unit 509.

[0025] A photoelectronic device 7a receives the light which has been emitted from the lamp 6a and then outputs the electrical signal corresponding to the number of photons of the light thus emitted to the illumination photometer 507. Then, the illumination photometer 507 obtains the illuminence E of the light, which has been emitted from the lamp 6a, on the basis of the electrical signal which has been outputted from the photoelectronic device 7a and then outputs the information relating to the illuminance E thus obtained to an illuminance reduction judgement unit 508. In this connection, while in the present embodiment, the photoelectronic device 7a is described separately from the illumination photometer 503, the photoelectronic device and the illuminanation photometer may also be collectively called the illuminanation photometer. The illuminance reduction judging unit 508, on the basis of the current effective value I and the illuminance E which have been inputted thereto, and the reference current value I0 and the reference illuminance E0 which have been outputted from a reference value setting unit 510, judges whether or not the illuminance of the lamp 6a has been reduced to the degree at which the exchange of the lamp is required. In this connection, the reference illuminance E0 is the illuminance of the light which has been emitted from the lamp 6a when the current having the reference current value I0 is caused to flow through the lamp 6a which is in the state of being still free from the degradation of the filament. Then, the method of setting the reference illuminance E0 in the reference value setting unit 510 will be described later. The illuminance reduction judging unit 508 substitutes the values of the current effective value I, the illuminance E, the reference current value I0 and the reference illuminance E0 into (Expression 3) to confirm whether or not (Expression 3) is established.

$$\frac{E}{E0}\cdot\left[\frac{I0}{I}\right]^{\kappa 2} > \beta 1 \qquad \text{...... (Expression 3)}$$

[0026] In this connection, in (Expression 3), $\beta 1$ is the illuminance reduction judgement barometer, and is set to 0.5 in the present embodiment. In addition, $\kappa 2$ is the constant which exhibits the dependency characteristics of the lamp illuminance on the lamp current. Then, since it becomes clear that $\kappa 2$ is about 5.90 in the case of the halogen lamps, in the present embodiment as well, the relation of $\kappa 2 = 5.90$ is employed.

[0027] In the left side of (Expression 3), there is calculated the ratio of the illuminance value, when the current having the reference current value I is caused to flow through the lamp 6a, which is obtained by changing the illuminance E thereinto to the reference illuminance E0 (hereinafter, referred to as "the illuminance ratio" for short, when applicable). In the present embodiment, when the illuminance ratio is lower than 0.5, i.e., when (Expression 3) is established, it is judged that the illuminance of the lamp 6a has been reduced down to the degree at which the old lamp needs to be exchanged for a new one. In other words, when the illuminance value, when the current having the reference current value I0 is caused to flow through the lamp 6a, which is obtained by changing the illuminance E thereinto has become equal to or lower than half the reference illuminance E0, it is judged that the illuminance of the lamp 6a has been reduced down to the degree at which the old lamp needs to be exchanged for a new one. In such a way, in the present embodiment, the illuminance reduction judgement is carried out. In this connection, while in the present embodiment, $\beta 1 = 0.5$ is employed as the illuminance reduction barometer, it is to be understood that the value of the illuminance reduction judgement barometer $\beta 1$ is not limited to 0.5, and hence the value of the illuminance ratio which is suitable for judging that the exchange of the lamp is required may be obtained on the basis of the tests and the like to be set therefor.

[0028] The illuminance reduction judging unit 508, when (Expression 3) is established, outputs "1", while when (Expression 3) is not established, outputs "0". That is, the illuminance reduction judging unit 508, when the illuminance of the lamp 6a has been reduced down to the degree at which the exchange of the lamp is required, outputs "1", while when the illuminance of the lamp 6a has not yet been reduced down to the degree at which the exchange of the lamp is required, outputs "0". Then, the result of the illuminance reduction judgement for the lamp made by the illuminance reduction judging unit 508 is inputted to the exchange judging unit 509.

[0029] The exchange judging unit 509, when at least one of the degradation judging unit 506 and the illuminance reduction judging unit 508 has outputted "1", judges that the exchange of the lamp 6a is required to output "1". In this connection, the exchange judging unit 509, when both of the degradation judging unit 506 and the illuminance reduction judging unit 508 have outputted "0s", judges that the exchange of the lamp 6a is not required to output "0". The output of the exchange judging unit 509 is outputted as the output of the lamp state detector 5a to the communication controller 4a. In such a way, since the time when exchanging the lamp 6a is judged by the degradation judging unit 506, the illuminance reduction judging unit 508 and the exchange judging unit 509, those constituent elements may also be collectively called the judgement unit.

[0030] In a manner as described above, the lamp state detector 5a judges whether or not the exchange of the lamp 6a is required, and outputs the judgement result thereof to the communication controller 4a. In this connection, each of other lamp state detectors similarly judges whether or not the exchange of the associated lamp is required and then outputs the judgement result thereof to the associated communication controller.

[0031] The communication controllers 4a to 4n, at the time when "1s" have been outputted from the corresponding lamp state detectors, superimpose the signals exhibiting the identification numbers which are previously set in the corresponding lamps on the A.C. current which is caused to flow through the power line 2. For example, when it is judged in the lamp state detector 5a and the lamp state detector 5n that the exchange of the respective lamps is required, the communication controller 4a superimposes the signal exhibiting the identification number of the lamp 6a on the A.C. current, and the communication controller 4n superimposes the signal exhibiting the identification number of the lamp 6n on the A.C. current. The signals which have been superimposed on the A.C. current are received at a signal receiver 8 through a transformer 3z. Then, the signal receiver 8, from the signals which have been received thereat, decodes the identification number of the lamp which has been judged to be exchanged and then outputs the identification number thus decoded to a lamp state display unit 9. In this connection, since the power line carrying technology wherein in such a way, the information is transmitted with the signals superimposed on the A.C. current flowing through the power line is the technology which is the already known technology, the detailed description with respect to the transmission/reception of the signals is omitted here for the sake of simplicity. The power line carrying technology is, for example, described in JP-A-10-92588. In such a way, in the present embodiment, since the information (the identification number) of the lamp which has been judged to be exchanged for a new one is transmitted by utilizing the power line over which the current is to be supplied to each of the lamps, there is no necessity to provide specially the signal line for the information transmission, and hence it is possible to realize the monitoring of the states of the lamps at the low cost.

[0032] In this connection, while in Fig. 1, only one system is shown in which a large number of lamps 6a to 6n are electrically connected to one constant current source 1, in actual, a large number of such systems are provided in the airport, and the states of the lamps are similarly detected in the individual systems. Then, the lamp states which have been detected are collectively transmitted to the lamp state display unit 9.

[0033] The lamp state display unit 9, on the basis of the identification numbers which have been inputted thereto, displays any of the lamps which have been judged to be exchanged for new ones on the display panel. Fig. 4 shows an example of the display in a display panel 91 of the lamp state display unit 9. As shown in the figure, in the display panel 91, the lamps are divided every system to be displayed in the form of the circles, respectively. In addition, the circle corresponding to the lamp which has been judged to be exchanged for a new one (hereinafter, referred to as "the exchange required lamp" for short, when applicable), and the circle corresponding to the lamp for which it has been judged that the exchange thereof is not required (hereinafter, referred to as "the exchange unrequired lamp" for short, when applicable) are displayed with the different colors. For example, the exchange required lamp is displayed with the red circle, while the exchange unrequired lamp is displayed with the blue circle. In addition, the system name of the system having the exchange required lamp(s) is displayed with the color different from that of the system name of the system which is constituted by only the exchange unrequired lamps. In addition thereto, the system having the exchange required lamp(s) and the numbers of the lamps in the system of interest are displayed on an exchange required lamp display column 92 which is specially provided. Since any of the lamps for which the exchange is required is displayed in such a way, an observer can recognize readily any of the lamps for which the exchange is required and hence can exchange at once any of the lamps, for which the exchange is required, for new ones.

[0034] Next, the description will hereinbelow be given with respect to the method of setting the reference values, which method is carried out in the work of exchanging the lamp(s), using the lamp state detector 5a shown in Fig. 2.

[0035] While with respect to any of the lamps which are displayed on the above-mentioned display panel 91 since the exchange is required for any of the lamps, a worker exchanges any of the lamps for new ones, at the time when the exchange of any of those lamps has been completed, the worker presses down a reset switch 511 shown in Fig. 2. At the time when the reset switch 511 has been pressed down, the switching signal is inputted to the power source switching unit 501. Then, in the power source switching unit 501, the input terminal a is switched over to the input terminal b. As a result, instead of the A.C. current which has been supplied to the lamp 6a through the communication controller 4a until now, the current which has been outputted from the battery 502 is newly supplied to the lamp 6a. In this connection, as described above, the battery 502 is always held in the state of being charged with the electric charges by the A.C. current which is supplied through the communication controller 4a. In addition, the output current of the battery 502 is adjusted in such a way that at the time when having electrically connected to the lamp 6a, the value of the current which is outputted from the battery 502 becomes the preset value (the reference current value I0). In this connection, for the reference current value I0, any of the values may be set as long as it is enough to light the lamp.

[0036] After a lapse of a fixed time period (after a lapse of 1 minutes in the present embodiment) after the battery 502 begins to supply the current to the lamp 6a, the resistance value R which has been calculated in the resistance calculating unit 506 and the illuminance E which has been measured in the illumination photometer are respectively set as the reference resistance value R0 and the reference illuminance E0 in the reference value setting unit 510. In addition, the reference current value I0 is previously set in the reference value setting unit 510. In this connection, the reason that the reference values are set 1 minute after the battery 502 begins to supply the current to the lamp 6a is that it takes a time of about 1 minute for the brightness of the lamp 6a to be stabilized. The reference value setting unit 510, at the time when the setting of the reference values has been completed, outputs the switching signal to the power source switching unit 501. At the time when having received the switching signal, the power source switching unit 501 switches the input terminal b from the input terminal a.

[0037] As described above, during the exchange of the lamp, the reference resistance value R0 and the reference illuminance E0 are both set in the reference value setting unit 510.

[0038] Fig. 5 is a cross sectional view showing the structure of a chassis in which the transformer 3a, the communication controller 4a, the lamp state detector 5a, the lamp 6a and the photoelectronic device 7a of the present embodiment are all accommodated. As shown in Fig. 5, the transformer 3a, the communication controller 4a, the lamp state detector 5a, the lamp 6a and the photoelectronic device 7a are all accommodated in the chassis 51 which is embedded in the earth of the passage or the like for the aircrafts. Within the chassis 51, the light which has been emitted from the lamp 6a is collected to an optical filter 53 by a reflecting mirror 52. Then, the optical filter 53 transmits therethrough only the light having a predetermined wavelength (color) of the light thus collected thereto, while reflects the light having other wavelengths (colors). The light which has been transmitted through the optical filter 53 (hereinafter, referred to as "the transmitted light" for short, when applicable) is then transmitted through a tempered glass 54 to be emitted to the outside of the chassis 51.

[0039] On the other hand, the photoelectronic device 7a is arranged between the lamp 6a and the optical filter 53. Then, the light which has been reflected by the optical filter 53 (hereinafter, referred to as the reflected light for short, when applicable) is condensed by a condenser lens 55. The photoelectronic device 7a receives effectively the condensed light. In this connection, the illumination photometer 507 of the lamp state detector 5a, on the basis of the number of photons of the light which has been received by the photoelectronic device 7a (the reflected light), the illuminance of the transmitted light. Then, since the number of photons of the reflected light and the illuminance of the transmitted light show the fixed relation, the illuminance of the transmitted light can be obtained with precision. In such a way, the reason that the illuminance of the transmitted light is obtained on the basis of the number of photons of the reflected light in the present embodiment is as follows.

[0040] In the case where the number of photons of the transmitted light is directly measured, the photoelectronic device needs to be arranged on the optical path of the transmitted light which has been transmitted through the optical filter 53, and as a result there arises the problem that the photo-electronic device can not but block off the transmitted light. Then, in the present embodiment, the illuminance of the transmitted light will be obtained on the basis of the number of photons of the reflected light which has not been emitted to the outside of the chassis 51 at all. By adopting this method, the illuminance of the transmitted light can be measured with the simple structure without blocking off the transmitted light at all.

[0041] While above, the description has been given with respect to the arrangement of the lamp 6a, the photoelectronic device 7a and the like in the chassis 51, since other lamps and photoelectronic devices and the like are arranged in the same manner as that in the lamp 6a, the photoelectronic device 7a and the like, the description thereof is omitted here for the sake of simplicity.

[0042] As described above, according to the present embodiment, the degradation judgement and the illuminance reduction judgement for the filament are carried out on the basis of the resistance values and the illuminance of the lamps 6a to 6n which have been respectively measured in the lamp state detectors 5a to 5n and when it is judged on the basis of at least one of them that the lamp of interest should be exchanged for a new one, it is judged that the lamp of interest should be exchanged for a new one. Therefore, for both of the reduction of the illuminance of the lamp due to the blackening of the lamp and the reduction of the illuminance of the lamp due to the breaking of the filament resulting from the degradation of the filament, the time when exchanging the lamp can be judged before the illuminance of the lamp of interest has become equal to or lower than the necessary illuminance. As a result, the conduction for the aircrafts can be surely carried out.

[0043] In this connection, while in the present embodiment, the constant current source is employed as the power source for supplying the electric power to the lamps 6a to 6n, alternatively, the constant voltage source may also be employed.

(Embodiment 2)

[0044] The description will hereinbelow be given with respect to the lamp state monitoring apparatus as another embodiment of the present invention. Then, the configuration of the lamp state monitoring apparatus of the present embodiment is mainly different in the following points from that of the above-mentioned embodiment 1.

① The information relating to the lamp state which has been detected in the lamp state detector is transmitted over the signal dedicated line.

② For the judgement of the degradation, the value of the voltage which is applied to the filament of the lamp is utilized.

③ The life of the lamp is estimated on the basis of the rated current lighting time.

④ The photoelectronic device for measuring the number of photons of the light which has been emitted from the lamp is made movable.

⑤ The lamp state is quantatively displayed on the display panel of the lamp state display device.

[0045] The points of the present embodiment different from the embodiment 1 will hereinbelow be described in detail.

[0046] Fig. 6 shows a configuration of the lamp state monitoring apparatus of the present embodiment, and Fig. 7 shows a configuration of a lamp state detector 5a' of the present embodiment. In this connection, since each of other lamp state detectors has the same configuration as that of the lamp state detector 5a' and operates in the same manner as that in the lamp state detector 5a', the description thereof is omitted here for the sake of simplicity. In Fig. 7, the A. C. current which is caused to flow through the power line 2 is supplied to the lamp 6a through the transformer 3a and the lamp state detector 5a'. In the lamp state detector 5a', the ammeter 503 measures the current effective value I as the effective value of the D.C. current which is caused to flow through the lamp 6a and then outputs the current effective value I thus measured to a degradation judging unit 506', an illuminance reduction judging unit 508' and a life estimating unit 512. In addition, the voltmeter 504 measures the voltage effective value V as the effective value of the A.C. voltage which is applied across the lamp 6a and then outputs the voltage effective value V thus measured to the degradation judging unit 506'. In addition, a rated value storage unit 513 stores therein previously a rated current value In, a rated voltage value Vn and a rated illuminance En which are set as the specification of the lamp 6a and outputs the rated current value In and the rated voltage value Vn out of them to the degradation judging unit 506' and also outputs the rated current value In and the rated illuminance En out of them to the illuminance reduction judging unit 508'.

[0047] The degradation judging unit 506' substitutes the current effective value I, the voltage effective value V, the rated current value In and the rated voltage value Vn which have been inputted thereto into (Expression 4) to confirm whether or not (Expression 4) is established.

$$\frac{V}{Vn}\cdot\left[\frac{In}{I}\right]^{\kappa 3} > \alpha 2 \qquad \text{...... (Expression 4)}$$

[0048] In this connection, in (Expression 4), $\alpha 2$ is the degradation judgement barometer and is set to 1.08 in the present embodiment. In addition, $\kappa 3$ is the constant which exhibits the dependency characteristics of the lamp voltage on the lamp current. Since it becomes clear that in the case of the halogen lamps, $\kappa 3$ is about 1.85, in the present embodiment as well, the relation of $\kappa 3$ = 1.85 is employed.

[0049] The left side of (Expression 4) represents the ratio of the voltage value, when the current having the rated current value In is caused to flow through the lamp 6a, which is obtained by changing the voltage effective value V thereinto to the rated voltage value Vn (hereinafter, referred to as "the voltage ratio" for short, when applicable). In the present embodiment, when the voltage ratio exceeds 1.08, i.e., when (Expression 4) is established, it is judged that the filament of the lamp 6a has already been degraded. In other words, when the voltage value, when the current having the rated current value In is caused to flow through the lamp 6a, which is obtained by changing the voltage effective value V thereinto has become larger than the rated voltage value Vn by 8%, it is judged that the filament of the lamp 6a has already been degraded. This judgement is the degradation judgement utilizing the phenomenon that the voltage value has been increased along with the increase of the resistance value due to the degradation of the lamp. In this connection, while in the present embodiment, the relation of $\alpha 2$ = 1.08 is employed as the degradation judgement barometer, it is to be understood that the value of the degradation judgement barometer $\alpha 2$ is not limited to 1.08, but the value of the voltage ratio which is suitable for exchanging the lamp before the filament of the lamp has undergone the breaking may be obtained on the basis of the tests and the like to be set.

[0050] The degradation judgement unit 506', when (Expression 4) is established, outputs "1", while when (Expression 4) is not established, outputs "0". That is, the degradation judging unit 506', when the filament of the lamp 6a has already been degraded, outputs "1", while the filament of the lamp 6a is not yet degraded, outputs "0". The voltage ratio and the value of the degradation judgement barometer $\alpha 2$, and the result of the degradation judgement for the filament which have been obtained by the degradation judging unit 506' are inputted as the output of the lamp state detector 5a' to the modem 10a.

[0051] The current effective value I, the rated current value In and the rated illuminance En are all inputted to the illuminance reduction judgeing unit 508', and in addition thereto, the illuminance E which has been measured by the illumination photometer 507 is inputted to the illuminance reduction judgeing unit 508'. Then, the illuminance reduction judgeing unit 508' substitutes the values of the current effective value I, the illuminance E, the rated current value In and the rated illuminance En which have been inputted thereto into (Expression 5) to confirm whether or not (Expression 5) is established.

$$\frac{E}{En}\cdot\left[\frac{In}{I}\right]^{\kappa 2} > \beta 1 \qquad \text{...... (Expression 5)}$$

[0052] In this connection, in (Expression 5), $\beta 1$ represents the illuminance reduction judgement barometer and is set to 0.5 in the present embodiment similarly to the embodiment 1. In addition, $\kappa 2$ represents the constant which exhibits the dependency characteristics of the lamp illuminance on the lamp current, and in the present embodiment as well, the relation of $\kappa 2$ = 5.90 is employed similarly to the embodiment 1.

[0053] The left side of (Expression 5) represents the ratio of the illuminance, when the current having the rated current value In is caused to flow through the lamp 6a, which is obtained by changing the illuminance E thereinto to the rated illuminance E0 (hereinafter, referred to as "the illuminance ratio" for short, when applicable). In the present embodiment, when the illuminance ratio has become lower than 0.5, i. e, when (Expression 5) is established, it is judged that the illuminance of the lamp 6a has been reduced to the degree at which the lamp needs to be exchanged. In other words, when the illuminance, when the current having the rated current In is caused to flow through the lamp 6a, which is obtained by changing the illuminance E thereinto has become equal to or lower than half the rated illuminance En, it is judged that the illuminance of the lamp 6a has been reduced down to the degree at which the lamp needs to be exchanged for a new one. In such a way, in the present embodiment, the judgement for the illuminance reduction is carried out. In this connection, while in the present embodiment, the relation of $\beta 1$ = 0.5 is employed as the illuminance reduction judgement barometer, it is to be understood that the value of the illuminance reduction judgement barometer $\beta 1$ is not limited to 0.5, but the value of the illuminance ratio which is suitable for judging that the exchange of the lamp is required may be obtained on the basis of the tests and the like to be set.

[0054] The illuminance reduction judging unit 508', when (Expression 5) is established, outputs "1", while when (Expression 5) is not established, outputs "0". That is, the illuminance reduction judging unit 508', when the illuminance of the lamp 6a has been reduced down to the degree at which the exchange of the lamp is required, outputs "1", while when the illuminance of the lamp 6a has not yet been reduced down to the degree at which the exchange of the lamp is required, outputs "0". Then, the illuminance ratio and the value of the illuminance reduction judgement barometer β1, and the result of the illuminance reduction judgement which have been obtained by the illuminance reduction judging unit 508' are inputted as the output of the lamp state detector 5a' to the modem 10a.

[0055] In the lamp state detector 5a', a reset switch 511, at the time when the exchange of the lamp 6a has been carried out, is pressed down by a worker. At the time when the reset switch 511 has been pressed down, the reset signal is inputted to the life estimating unit 512. Then, the life estimating unit 512, from a time point when the reset signal has been inputted thereto, calculates the lighting accumulating total time of the lamp 6a. The procedure thereof will hereinbelow be described in detail.

[0056] The life estimating unit 512, at the time when the reset signal has been inputted thereto, stores therein the current effective value I at that time point (e.g., 4[A]), and also starts to count a time. Then, the life estimating unit 512 compares the current effective value I (4[A]) thus stored therein with the new current effective value I which has been outputted from the ammeter 503 and continues to count a time until the current effective value I which has been outputted from the ammeter 503 changes from 4[A]. If the current effective value I which has been outputted from the ammeter 503 changes from 4[A] to 5[A] for example, then the life estimating unit 512 stores therein a time (e.g., 100 [hr]) which has been counted until that time point and then counts a time until the current effective value I changes from 5[A]. In such a way, the life estimating unit 512 obtains both of the current effective value I and the time for which the current having that value is caused to flow through the lamp 6a, and stores therein the current effective value I and the time with the current effective value I and the time made correspond to each other.

[0057] In addition, the life estimating unit 512, on the basis of the current effective value I and the time t which have been stored therein with the current effective value I and the time t made correspond to each other, changes the time t into the time tn in the case where the rated current value In is caused to flow through the lamp 6a (the rated current lighting time). Fig. 8 is a graphical representation showing the relation between the effective value of the current which is caused to flow through the lamp and the lighting accumulating total time. The life estimating unit 512 carries out the change of the time on the basis of the graph shown in Fig. 8. For example, when the current of 4[A] is caused to flow through the lamp for a time of 100[hr], if that time, from the graph 4 of Fig. 8, is changed into the time tn in the case where the rated current (6.6[A] in the present embodiment) is caused to flow through the lamp, the time tn becomes 0.2[mhr]. The life judging unit 512 accumulates the time tn thus obtained as the time for which the rated current value In is caused to flow through the lamp, i.e., as the rated current lighting time.

[0058] Then, the life estimating unit 512 obtains the lamplight filament breaking probability on the basis of the rated current lighting time tn thus accumulated. Fig. 9 is a graphical representation showing the relation between the rated current lighting time tn and the lamplight filament breaking probability. The life estimating unit 512, on the basis of the graph of Fig. 9, obtains the lamplight filament breaking probability from the rated current lighting time tn to judge whether or not the lamplight filament breaking probability thus obtained exceeds 80[%] as the setting threshold. When it is judged that the lamplight filament breaking probability thus obtained exceeds 80[%], the life estimating unit 512 judges that the probability that the lamp will undergo the breaking of the filament is high, i.e., the lamp is nearly dead to output "1". On the other hand, it is judged that the lamplight filament breaking probability thus obtained does not exceed 80 [%], the life estimating unit 512 judges that the probability that the lamp will undergo the breaking of the filament is low to output "0". The lamplight filament breaking probability which has been obtained by the life estimating unit 512, the setting threshold and the result of the life judgement are outputted as the output of the lamp state detector 5a' to the modem 10a.

[0059] In Fig. 6, the modems 10a to 10n transmit the information which has been outputted from the lamp state detectors 8a' to 5n', together with the identification numbers of the corresponding lamps, to the modem 10z over the signal dedicated line 11. The modem 10z outputs the information of the lamps which has been transmitted from the modems 10a to 10n, with the information of the lamps made correspond to the identification numbers of the lamps, to the lamp state display unit 9. In such a way, in the present embodiment, since the information of the lamp states is transmitted over the signal dedicated line 11, the amount of transmitable information can be increased as compared with the case where the power line carrier is employed.

[0060] Fig. 10 is a diagram showing an example of the display in the display panel 91 of the lamp state display unit 9. Points of the present embodiment different from the embodiment 1 are that any of the lamps which have been judged to be nearly dead is displayed, and that a lamp state parameter display unit 93 is provided.

[0061] Similarly to the embodiment 1, in the display panel 91, the lamp is displayed in the form of the circle every system. In addition, the circle corresponding to the exchange required lamp, the circle corresponding to the exchange unrequired lamp, and the circle corresponding to the lamp which has been judged to be nearly dead (hereinafter, referred to as "the nearly dead lamp" for short, when applicable) are respectively displayed with the different colors. For example, the exchange required lamp is displayed in the form of the red circle, the exchange unrequired lamp is displayed in the form of the blue circle, and the nearly dead lamp is displayed in the form of the yellow circle. In addition, what lamps the circles show is displayed on a display column 93.

[0062] The display panel 91 has a lamp state parameter display column 94, and the system name and the lamp number in the system of interest are both displayed on the lamp state parameter display column 94, and also the system name and the lamp number can be changed by manipulating buttons 95 and 96, which are provided in such a way as to correspond thereto, by an observer. In addition, the voltage ratio (the left side of (Expression 4)), the illuminance ratio (the left side of (Expression 5)) and the lamplight filament breaking probability are displayed together with the respective thresholds on the lamp state parameter display column 94. In this connection, by the setting threshold for the voltage ratio is meant the degradation judgement barometer $\alpha2$, and by the setting threshold for the illuminance ratio is meant the illuminance reduction judgement barometer $\beta1$. By carrying out the display in such a way, an observer grasps at a glance whether or not the time when exchanging the lamp is closing, and by what cause of the lamp the exchange is required. In this connection, in the display panel 91, for the exchange required lamp, the reason that the exchange is required may also be displayed by the expression of "the lamp blackening" or "the filament degradation".

[0063] Fig. 11 is a cross sectional view showing the structure of the chassis in which the transformer 3a, the lamp state detector 5a', the lamp 6a, the photoelectronic device 7a and the modem 10a in the present embodiment are all accommodated. As described above, since if the photoelectronic device is arranged on the optical path of the transmitted light which has been transmitted through the optical filter 53, then the light will be blocked off, in the embodiment 1, the photoelectronic device 7a was arranged between the lamp 6a and the optical filter 53, whereas in the present embodiment, the movable photoelectronic device 7a is arranged on the optical path of the transmitted light. The movable photoelectronic device 7a will hereinbelow be described.

[0064] Fig. 12 is an enlarged view showing the vicinity of the movable photoelectronic device 7a (the area A in Fig. 11). In Fig. 12, the photoelectronic device 7a for detecting the number of photons is installed on a rotor 121 of a ultrasonic motor. In addition, the rotor 121 of the ultrasonic motor is installed on a stator 122 of the ultrasonic motor. In addition, the detected value in the photoelectronic device 7a is transmitted to a contact 123 to be inputted to the lamp state detector 5a'. Then, the motion of the ultrasonic motor will hereinbelow be described in detail with reference to Fig. 13. Fig. 13 is a top view when the inside of the chassis 51 shown in Fig. 11 is viewed from the upper side. Now, the photoelectronic device 7a is installed on the rotor 121 of the ultrasonic motor. In the figure, reference numeral 131 designates the position of the photoelectronic device 7a during the standby of the measurement, and reference numeral 132 designates the position of the photoelectronic device 7a during the measurement. Then, when the photoelectronic device 7a is located at the position 132, since the photoelectronic device 7a is positioned on the optical path and also comes in contact with the contact 123, the electrical signal corresponding to the number of photons of the light which has been emitted from the lamp 6a is inputted to the lamp state detector 5a'. On the other hand, when the photoelectronic device 7a is located at the position 131, since the photoelectronic device 7a is positioned out of the optical path of the transmitted light and also does not come in contact with the contact 123, no electrical signal is inputted to the lamp state detector 5a'. In such a manner, by adopting the movable photoelectronic device 7a which is constructed in such a way that the movable photoelectronic device 7a is moved between the position 132 located on the optical path of the transmitted light and the position 131 located out of the optical path of the transmitted light, when the number of photons is not measured, the photoelectronic device 7a is positioned out of the optical path of the transmitted light, while only when the number of photons is measured, the photoelectronic device 7a can be arranged on the optical path of the transmitted light. If the measurement of the number of photons is carried out for a short time period, then the interrupt of the transmitted light can be suppressed to a short time period and hence the measurement of the illuminance can be carried out without impeding the conduction of the aircrafts. In addition, since the transmitted light which has been transmitted through the optical filter 53 is directly measured, the measurement accuracy is enhanced as compared with the embodiment 1. In this connection, the timing of measuring the number of photons, for example, either may be made when the current effective value I is changed, or may be instructed on the basis of the manual by an observer.

[0065] In this connection, since the ultrasonic motor is the known technology, the detailed description with respect to the construction and the like thereof is omitted here for the sake of simplicity. In addition, while in the present embodiment, the description has been given with respect to the case where the ultrasonic motor is utilized, alternatively, the more general electromagnetic motor or the like may also be utilized.

[0066] According to the present embodiment as described above, since the degradation judgement for the filament and the reduction judgement for the illuminance based on the voltage value of the lamp 6a are carried out, for both of the illuminance reduction of the lamp due to the blackening of the lamp and the illuminance reduction of the lamp due to the breaking of the filament, it is possible to judge the time when exchanging the lamp before the illuminance of the lamp has become equal to or lower than the necessary illuminance. Therefore, it is possible to carry out the conduction of the aircrafts.

[0067] In addition, in the present embodiment, since the lamplight filament breaking probability is presented to an observer, an observer can estimate how long the lamp will undergo the breaking of the filament and hence the plan of exchanging the lamp can be readily laid.

[0068] In this connection, while in the present embodiment, the constant current source has been employed as the power source for supplying the electric power to the lamps 6a to 6n, alternatively, the constant voltage source may also be employed. But, in this case, the degradation of the filament of the lamp is judged on the basis of the current which is caused to flow through the lamp.

[0069] In addition, while the present embodiment is different in the points of ① to ⑤ from the embodiment 1, it is to be understood that even if all of the points ① to ⑤ are not changed for the embodiment 1, the present embodiment is established as the lamp state monitoring apparatus even with the configuration in which the points of ② and ④ are changed or even with the configuration in which only the point ⑤ is changed. Thus, there are conceivable the configurations of the various combinations.

[0070] While in the embodiments 1 and 2 as described above, the example in which the halogen lamp is employed as the lamp has been described, the present invention can be applied to the lamp as long as it is the lamp in which the illuminance is reduced due to either the blackening or the degradation of the filament similarly to the halogen lamp.

[0071] In addition, while in the embodiments 1 and 2, the description has been given with respect to the case where the state monitoring of the lamps which are arranged in the airport in order to conduct the aircrafts is carried out, it is to be understood that in addition to the lamps which are arranged in the airports, the present invention can also be applied to the lamps which are arranged in the expressways or the like.

[0072] In addition, while in the embodiments 1 and 2, the lamp state detector for carrying out the degradation judgement and the illuminance reduction judgement for the filament is provided for each of a plurality of lamps, the lamp state detectors can also be integrated with one another. That is, only the measurement devices such as the ammeter, the voltmeter and the photoelectronic device are provided in each of the lamps. Then, after the measured values obtained from the measurement devices have been collectively inputted into one computer, the state of each of the lamps may also be judged in the computer of interest.

[0073] Finally, the description will hereinbelow be given with respect to the method of installing the lamp state monitoring apparatus as described above. While when installing the lamp state monitoring apparatus, it is conceivable that the overall system is newly installed, in the case where the lamps are already installed, other configuration may be added thereto. For example, when the lamp state monitoring apparatus of the embodiment 1 is configured in the case where the airport lamp system including a plurality of lamps and the power line over which the lamps are supplied with the electric power is installed in the airport, the change may be carried out in which the communication controllers 4a to 4n, the lamp state detectors 5a to 5n, the photoelectronic devices 7a to 7n, the signal receiver 8 and the lamp state display unit 9 are newly provided. On the other hand, when the lamp state monitoring apparatus of the embodiment 2 is configured, the change may be carried out in which the lamp state detectors 5a' to 5n', the photoelectronic devices 7a to 7n, the lamp state display unit 9, the modems 10a to 10n, 10z and the signal dedicated line 11 are newly provided.

INDUSTRIAL APPLICABILITY

[0074] The present invention can be applied to the state monitoring of a large number of lamps which are installed in the airports, the expressways or the like. By this application, the exchange of the lamp in the airports, the expressways or the like can be carried out before the illuminance of the lamp has been reduced down to the level equal to or lower than the necessary illuminance.

Claims

1. A lamp state detector comprising: an illumination photometer for measuring the illuminance of the light which has been emitted from a lamp; a resistance measuring device for measuring the resistance value of said lamp; and a judgement unit for on the basis of the illuminance which has been measured by said illumination photometer and the resistance value which has been measured by said resistance value measuring device, judging whether or not the exchange of said lamp is required.

2. A lamp state detector according to claim 1, wherein said judgement unit includes: an illuminance reduction judging unit for on the basis of the illuminance which has been measured, judging whether or not the illuminance of the light which has been emitted from said lamp has been reduced down to the illuminance at which the exchange of said lamp is required; and a degradation judging unit for on the basis of the resistance value which has been measured, judging whether or not a filament of said lamp has been degraded down to the degree at which the exchange of said lamp is required, wherein when it is judged by said illuminance reduction judging unit that the illuminance of the light which has been emitted from said lamp has been reduced down to the illuminance at which the exchange of said lamp is required, or when it is judged by said degradation judging unit that the filament of said lamp has been degraded down to the degree at which the exchange of said lamp is required, it is judged that the exchange of said lamp is required.

3. A lamp state detector comprising: an illumination photometer for measuring the illuminance of the light which has been emitted from a lamp; a voltage measuring device for measuring the value of the voltage which is applied to said lamp; and a judgement unit for on the basis of the illuminance which has been measured by said illumination photometer and the voltage value which has been measured by said voltage measuring device, judging whether or not the exchange of said lamp is required.

4. A lamp state detector according to claim 3, wherein said judgement unit includes: an illuminance reduction judging unit for on the basis of the illuminance which has been measured, judging whether or not the illuminance of the light which has been emitted from said lamp has been reduced down to the illuminance at which the exchange of said lamp is required; and a degradation judging unit for on the basis of the value of the voltage which has been measured, judging whether or not a filament of said lamp has been degraded down to the degree at which the exchange of said lamp is required, wherein when it is judged by said illuminance reduction judging unit that the illuminance of the light which has been emitted from said lamp has been reduced down to the illuminance at which the exchange of said lamp is required, or when it is judged by said degradation judging unit that the filament of said lamp has been degraded down to the degree at which the exchange of said lamp is required, it is judged that the exchange of said lamp is required.

5. A lamp state detector comprising: a lamp for emitting the light; an optical filter for transmitting therethrough only the light having a predetermined wavelength out of the light which has been emitted from said lamp, and reflecting the light having other wavelengths; an illumination photometer provided between said lamp and said optical filter for receiving the light which has been reflected by said optical filter to obtain the illuminance of the light which has been transmitted through said optical filter; a resistance measuring device for measuring the resistance value of said lamp; and a judgement unit for on the basis of the illuminance which has been measured by said illumination photometer and the resistance value which has been measured by said resistance measuring device, judging whether or not the exchange of said lamp is required.

6. A lamp state detector comprising: a lamp for emitting the light; an optical filter for transmitting therethrough only the light having a predetermined wavelength out of the light which has been emitted from said lamp, and reflecting the light having other wavelengths; an illumination photometer for measuring the illuminance of the light which has been received; an illumination photometer moving unit for moving said ilumination photometer between a first position which is located on an optical path of the light which has been transmitted through said optical filter and a second position which is located out of said optical path; a resistance measuring device for measuring the resistance value of said lamp; and a judgement unit for on the basis of the illuminance which has been measured when said illumination photometer is located at said first position, and the resistance value which has been measured by said resistance measuring device, whether or not the exchange of said lamp is required.

7. A lamp state monitoring apparatus comprising:

a plurality of lamp state detectors each having an illumination photometer for measuring the illuminance of the light which has been emitted from a lamp, a resistance measuring device for measuring the resistance value of said lamp, and a judgement unit for on the basis of the illuminance which has been measured by said illumination photometer and the resistance value which has been measured by said resistance measuring device, judging whether or not the exchange of the lamp is required;
a plurality of communication controllers, which are respectively provided in said plurality of lamp state detectors, for when it has been judged in said judgement unit that the exchange of the lamp is required, outputting the identification number which is previously set in that lamp; and
a display unit for on the basis of the identification number(s) which has(have) been outputted from said plurality of communication controllers, displaying thereon the lamp(s) for which it has been judged that the exchange thereof is required.

8. A lamp state monitoring apparatus comprising:

a plurality of lamps which are respectively installed in an airport;
a plurality of lamp state detectors, which are respectively provided in said plurality of lamps, for judging whether or not the exchange of the lamp(s) is required;
a plurality of communication controllers, which are respectively provided in said plurality of lamp state detectors, for when it has been judged in said plurality of lamp state detectors that the exchange of the lamp(s) is required, outputting the identification number(s) which is(are) previously set in the lamp(s); and

a display unit for displaying thereon the lamp(s) for which it has been judged on the basis of the identification number(s) which has(have) been outputted from said plurality of communication controllers that the exchange thereof is required.

9. A display device, wherein of a plurality of lamps which are installed in an airport, the lamp(s) for which the exchange thereof is required is(are) displayed, and also at least one of the blackening of the lamp(s) and the degradation of the filament(s) of the lamp(s) is displayed as the reason that the lamp(s) is(are) required to be exchanged.

10. A method of exchanging a lamp, wherein it is judged on the basis of the illumination of the light which has been emitted from the lamp of interest whether or not the lamp should be exchanged, and it is judged on the basis of the resistance value of said lamp whether or not said lamp should be exchanged, and when it has been judged in at least one of the judgement based on the illuminance and the judgement based on the resistance value that said lamp should be exchanged, said lamp is exchanged.

11. A method of changing an airport lamp system, wherein the work of installing, for an airport lamp system having a plurality of lamps which are installed in an airport, and a power line over which the electric power is transmitted from a power source to said plurality of lamps, illumination photometers for measuring the illuminance of the light which has been emitted from said lamps, resistance measuring devices for measuring the resistance values of said lamps, and judgement units for on the basis of the illuminance which has been measured by said illumination photometers and the resistance values which have been measured by said resistance measuring devices, judging whether or not the exchange of said lamps is required is carried out.

12. A method of changing an airport lamp system, wherein the work of installing, for an airport lamp system having a plurality of chassises which are respectively installed in an airport and in which lamps are respectively accommodated, and a power line over which the electric power is transmitted from a power source to said lamps, instead of said chassises in which said lamps are respectively accommodated, chassises in which lamps, illumination photometers for measuring the illuminance of the light which has been emitted from said lamps, resistance measuring devices for measuring the resistance values of said lamps, and judgement units for on the basis of the illuminance which has been measured by said illumination photometers and the resistance values which have been measured by said resistance measuring devices, judging whether or not the exchange of the lamp(s) is required are respectively accommodated is carried out.

13. A method of changing an airport lamp system according to one of claims 11 and 12, wherein the work of installing a display unit for displaying thereon the judgement results provided by said judgement units and a signal line over which the judgement results provided by said judgement units are transmitted to said display unit is carried out.

FIG. 1

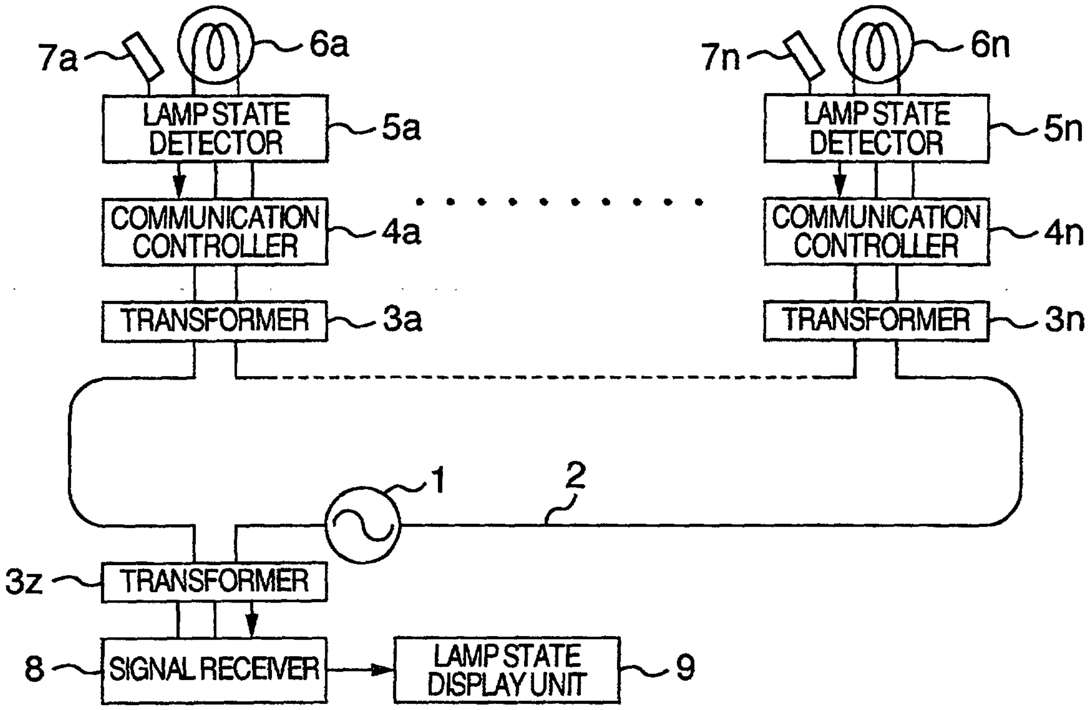

7a
6a
LAMP STATE DETECTOR
5a
COMMUNICATION CONTROLLER
4a
TRANSFORMER
3a
7n
6n
LAMP STATE DETECTOR
5n
COMMUNICATION CONTROLLER
4n
TRANSFORMER
3n
1
2
3z
TRANSFORMER
8
SIGNAL RECEIVER
LAMP STATE DISPLAY UNIT
9

FIG. 5

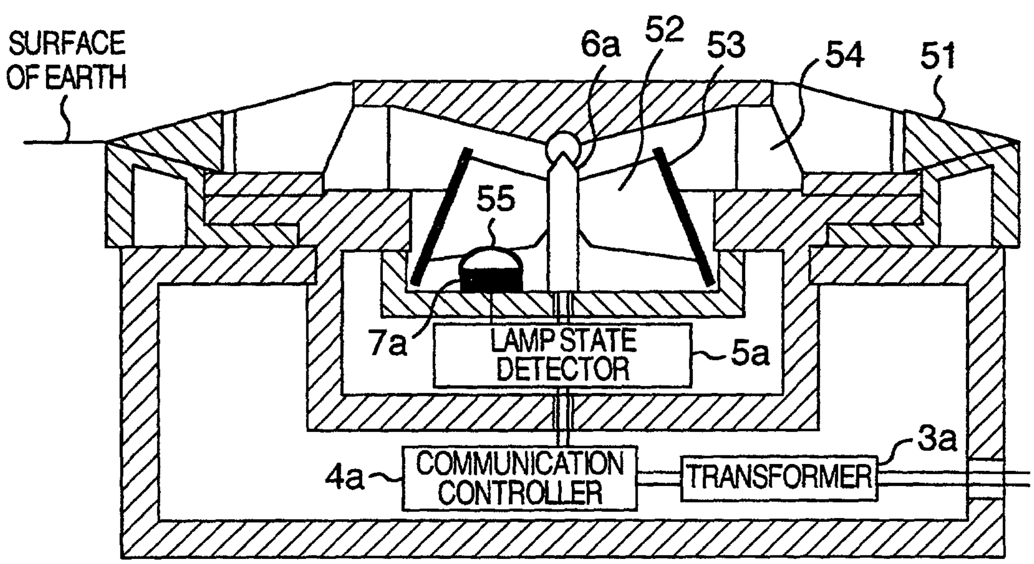

SURFACE OF EARTH
6a
52
53
54
51
55
7a
LAMP STATE DETECTOR
5a
3a
4a
COMMUNICATION CONTROLLER
TRANSFORMER

FIG. 2

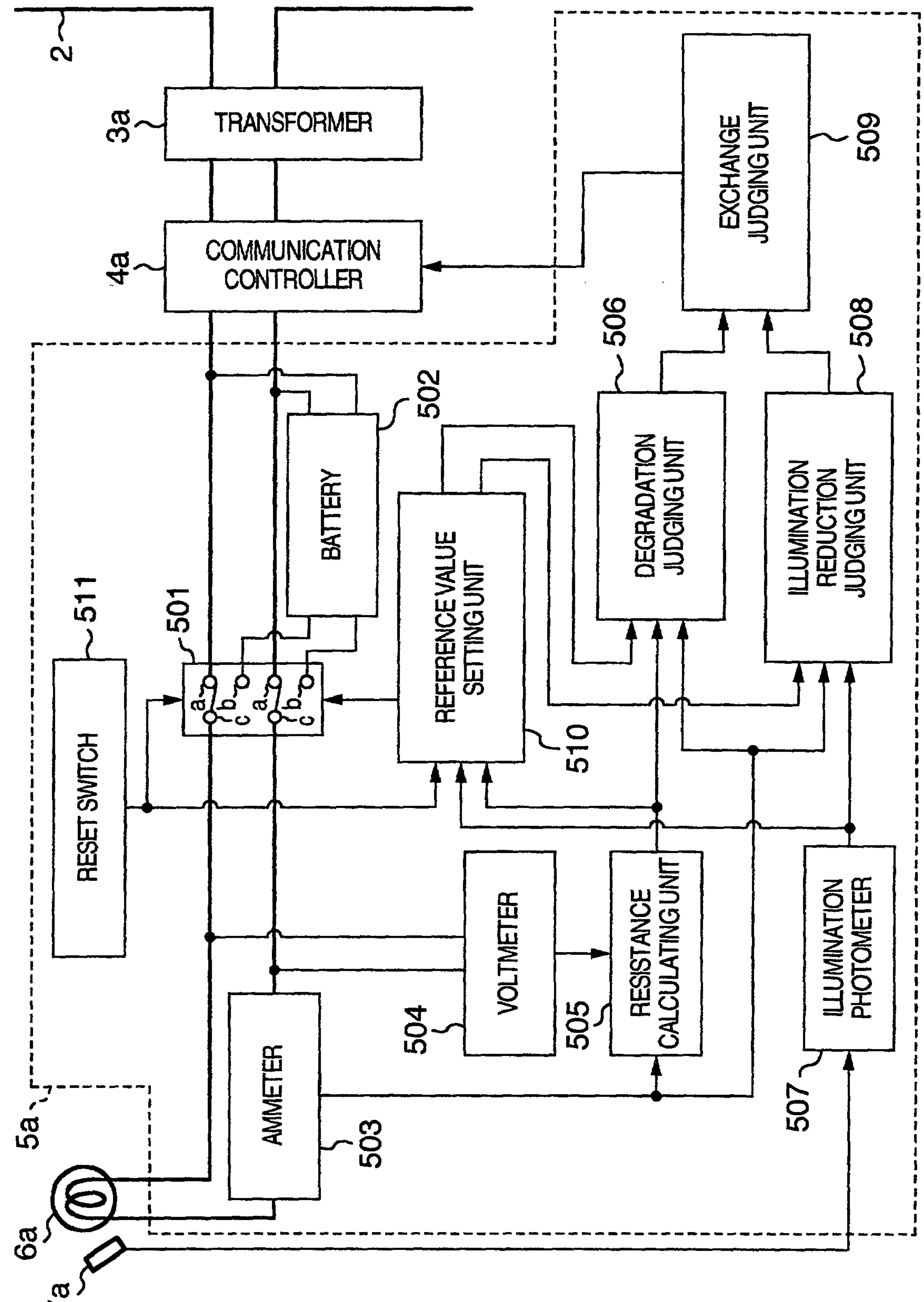

2
3a
TRANSFORMER
4a
COMMUNICATION CONTROLLER
EXCHANGE JUDGING UNIT
509
506
508
502
BATTERY
REFERENCE VALUE SETTING UNIT
510
DEGRADATION JUDGING UNIT
ILLUMINATION REDUCTION JUDGING UNIT
511
501
RESET SWITCH
a
b
c
VOLTMETER
504
RESISTANCE CALCULATING UNIT
505
ILLUMINATION PHOTOMETER
507
AMMETER
503
5a
6a
7a

FIG. 3

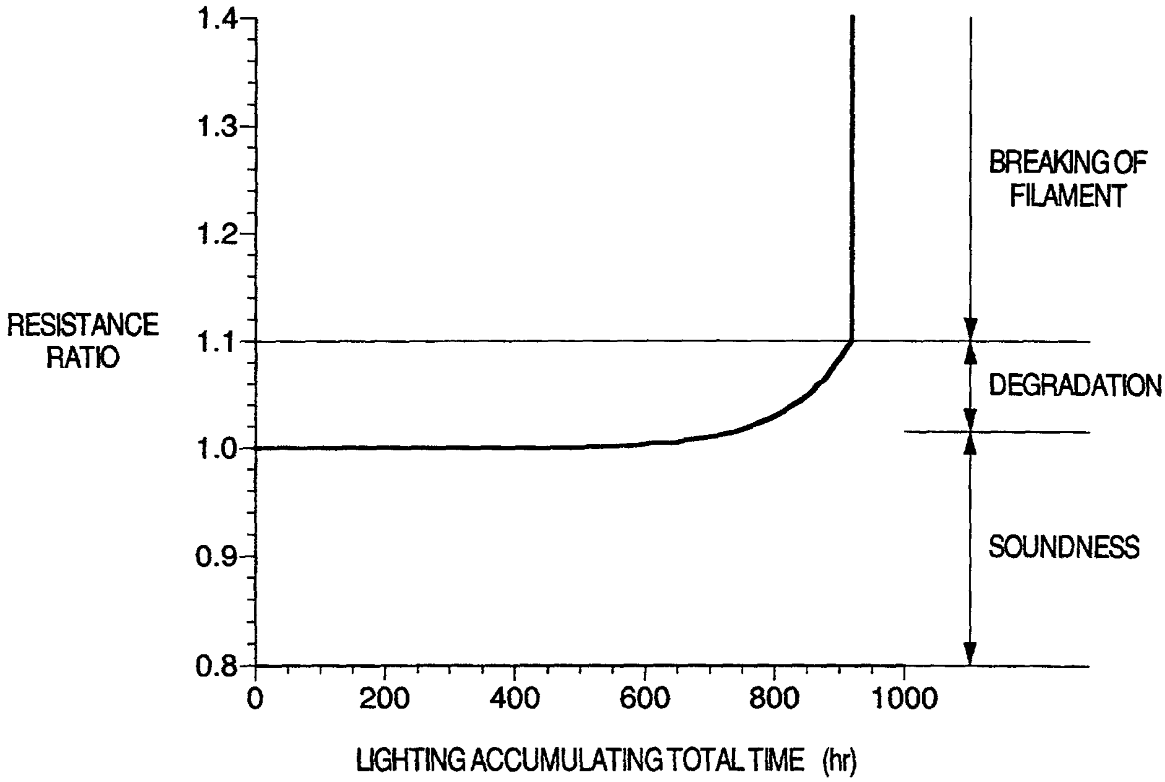

1.4
1.3
1.2
1.1
1.0
0.9
0.8
RESISTANCE RATIO
0
200
400
600
800
1000
LIGHTING ACCUMULATING TOTAL TIME (hr)
BREAKING OF FILAMENT
DEGRADATION
SOUNDNESS

FIG. 4

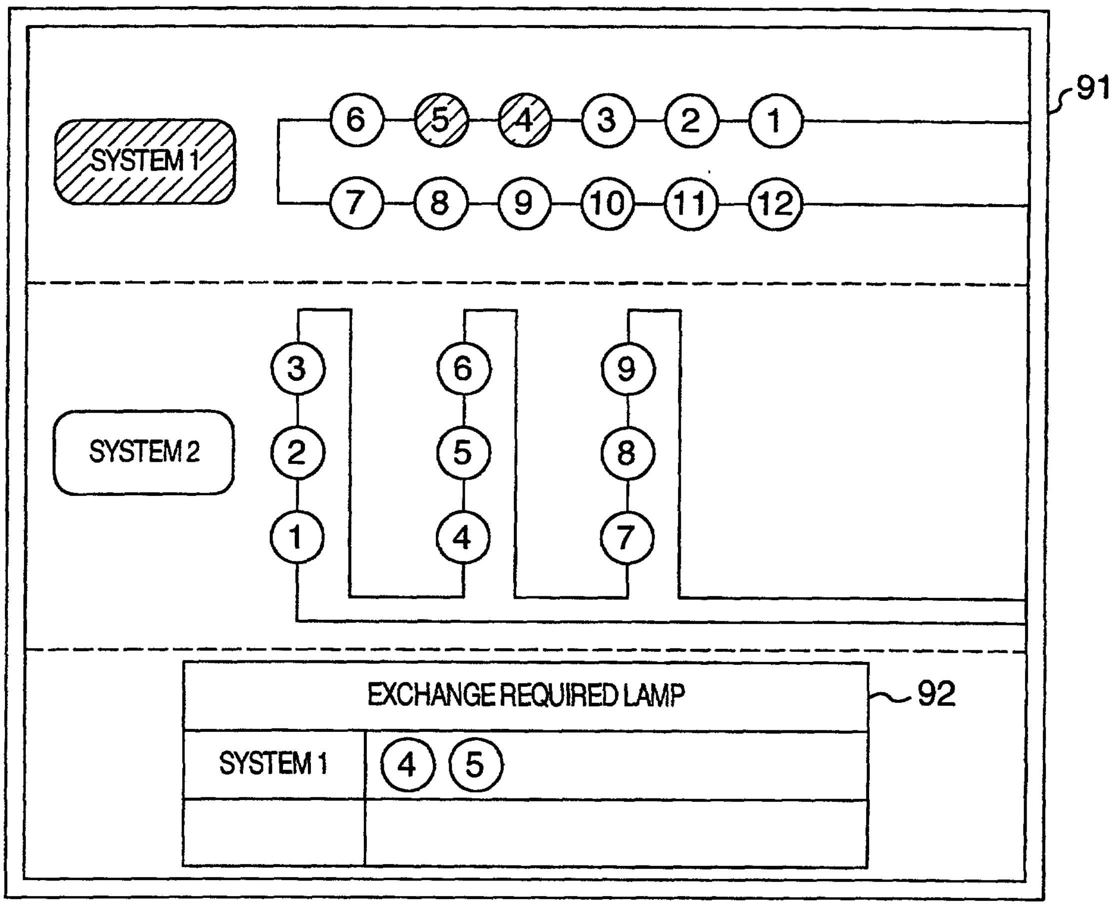

91
SYSTEM 1
6
5
4
3
2
1
7
8
9
10
11
12
SYSTEM 2
3
2
1
6
5
4
9
8
7
EXCHANGE REQUIRED LAMP
92
SYSTEM 1
4
5

FIG. 6

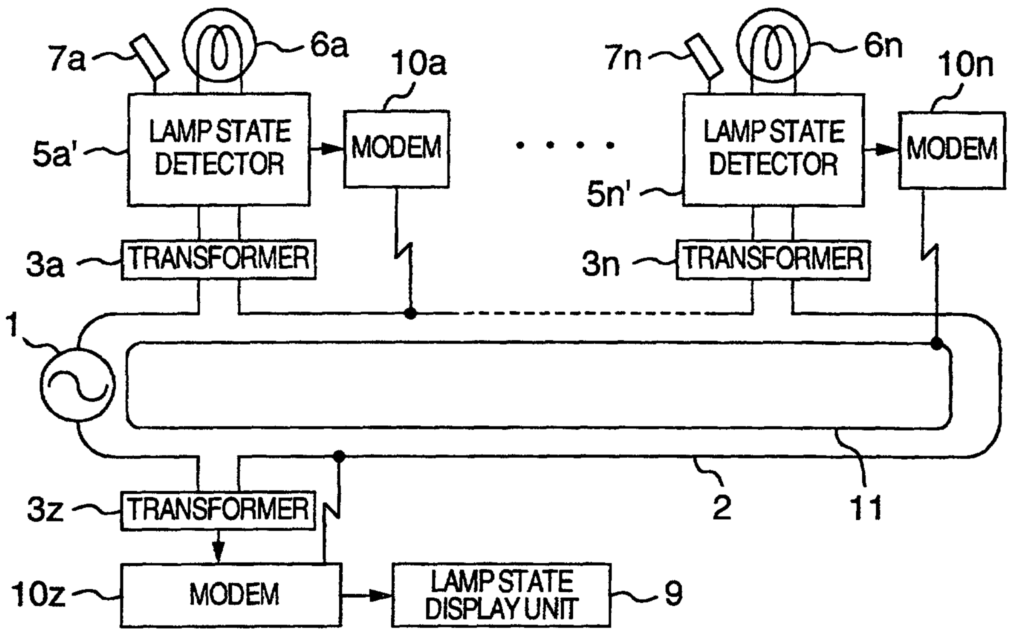

7a
6a
10a
LAMP STATE DETECTOR
MODEM
5a'
7n
6n
10n
LAMP STATE DETECTOR
MODEM
5n'
3a
TRANSFORMER
3n
TRANSFORMER
1
2
11
3z
TRANSFORMER
10z
MODEM
LAMP STATE DISPLAY UNIT
9

FIG. 11

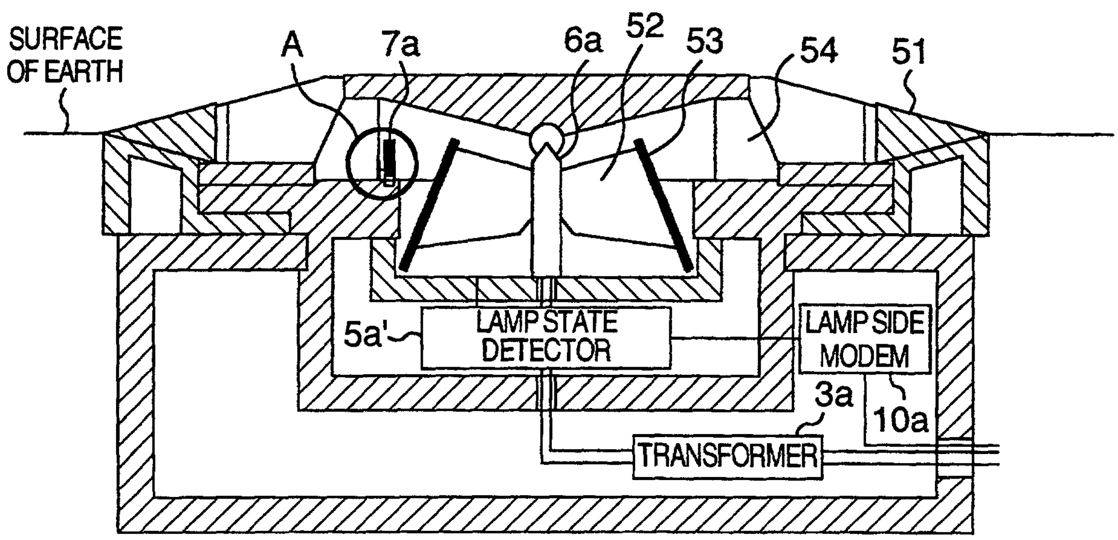

SURFACE OF EARTH
A
7a
6a
52
53
54
51
5a'
LAMP STATE DETECTOR
LAMP SIDE MODEM
3a
10a
TRANSFORMER

FIG. 7

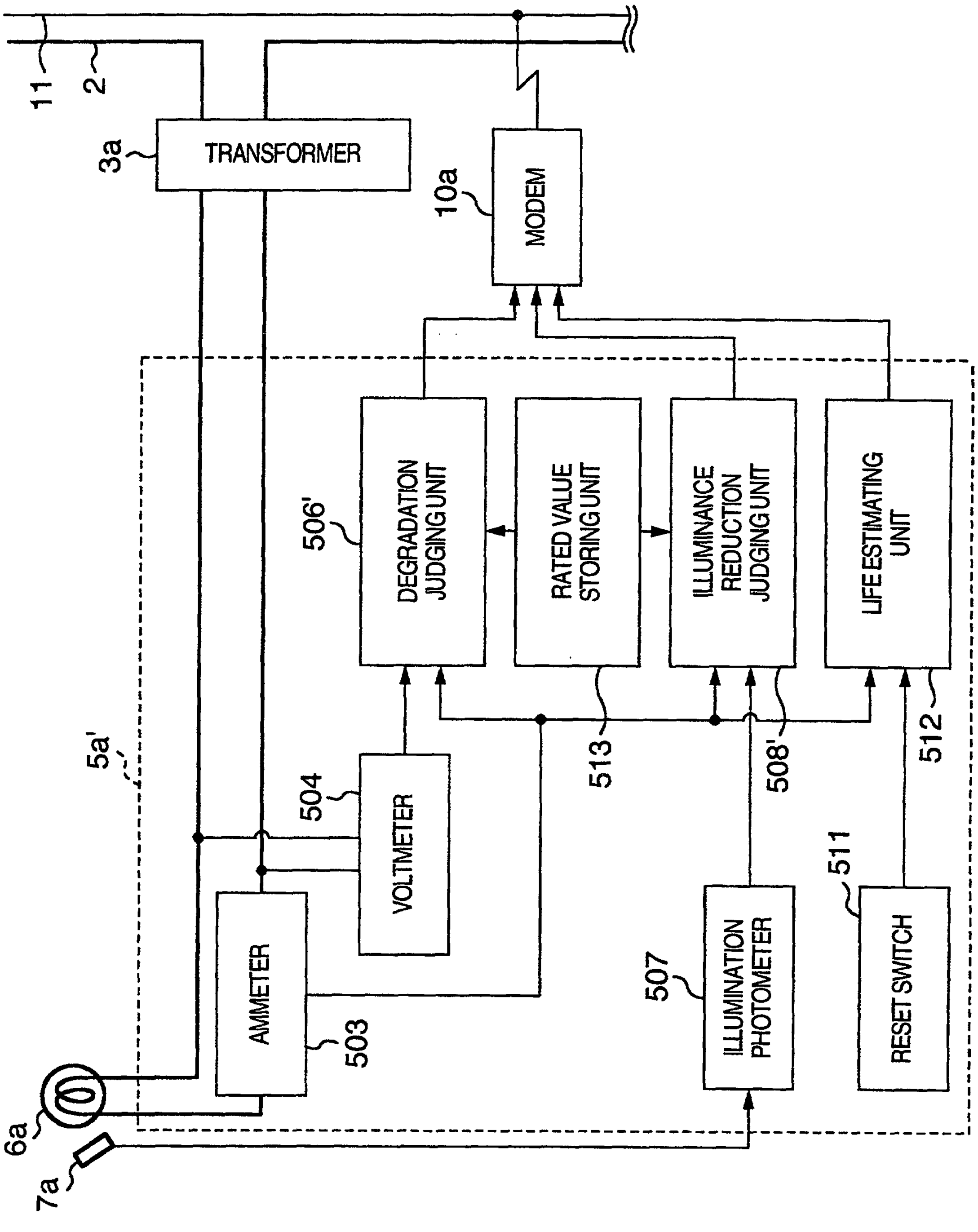

11
2
3a
TRANSFORMER
10a
MODEM
5a'
506'
DEGRADATION JUDGING UNIT
RATED VALUE STORING UNIT
ILLUMINANCE REDUCTION JUDGING UNIT
LIFE ESTIMATING UNIT
504
VOLTMETER
513
508'
512
AMMETER
503
507
ILLUMINATION PHOTOMETER
511
RESET SWITCH
6a
7a

FIG. 8

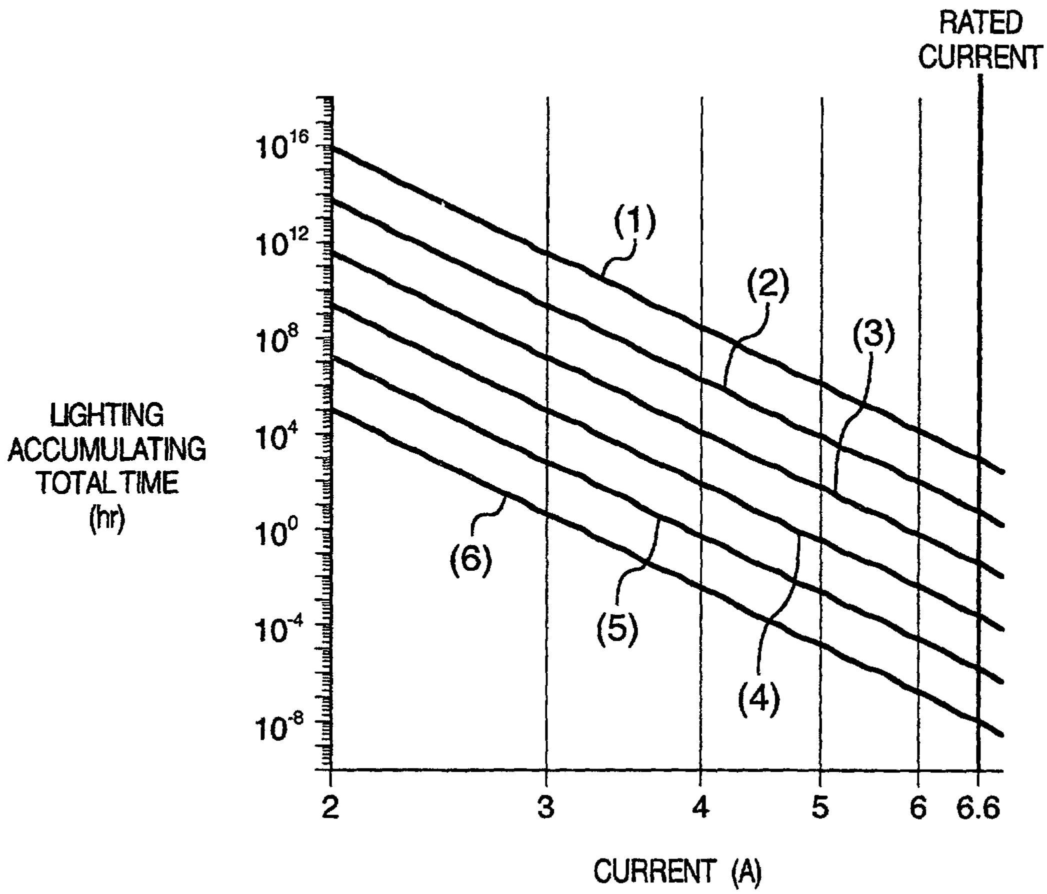

RATED
CURRENT
LIGHTING
ACCUMULATING
TOTAL TIME
(hr)
10^16
10^12
10^8
10^4
10^0
10^-4
10^-8
(1)
(2)
(3)
(4)
(5)
(6)
2
3
4
5
6
6.6
CURRENT (A)

FIG. 9

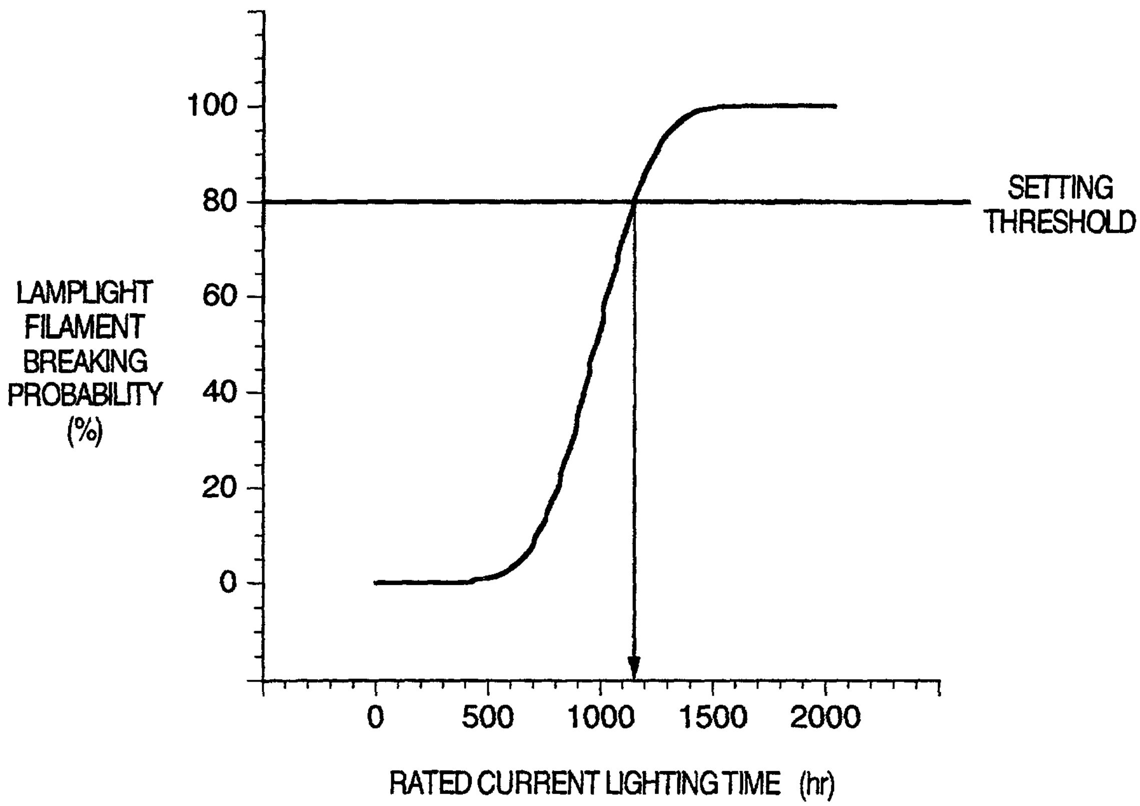

100
80
60
40
20
0
LAMPLIGHT FILAMENT BREAKING PROBABILITY (%)
SETTING THRESHOLD
0
500
1000
1500
2000
RATED CURRENT LIGHTING TIME (hr)

FIG. 10

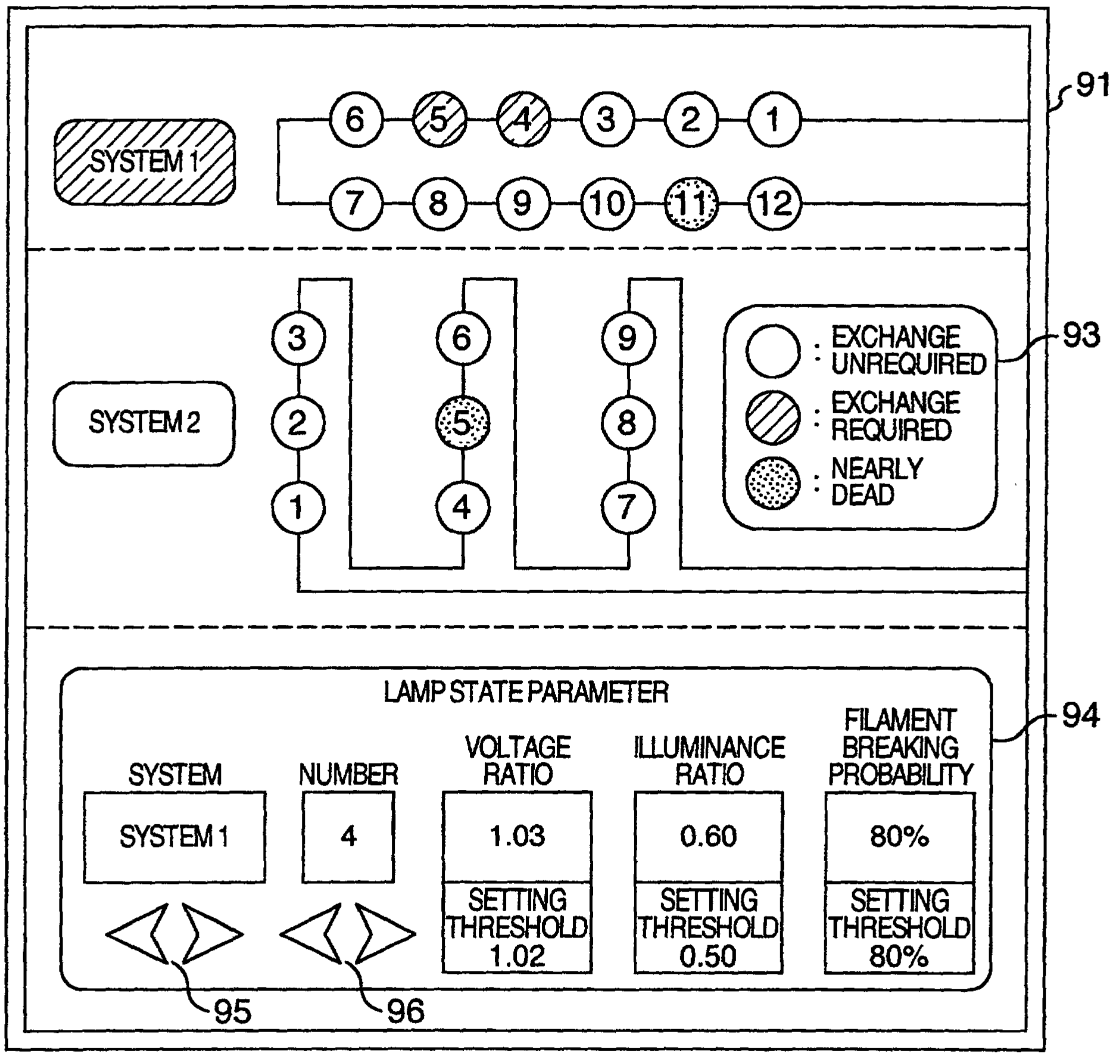

SYSTEM 1
6
5
4
3
2
1
7
8
9
10
11
12
91
SYSTEM 2
3
2
1
6
5
4
9
8
7
: EXCHANGE UNREQUIRED
: EXCHANGE REQUIRED
: NEARLY DEAD
93
LAMP STATE PARAMETER
SYSTEM
SYSTEM 1
NUMBER
4
VOLTAGE RATIO
1.03
SETTING THRESHOLD 1.02
ILLUMINANCE RATIO
0.60
SETTING THRESHOLD 0.50
FILAMENT BREAKING PROBABILITY
80%
SETTING THRESHOLD 80%
94
95
96

FIG. 12

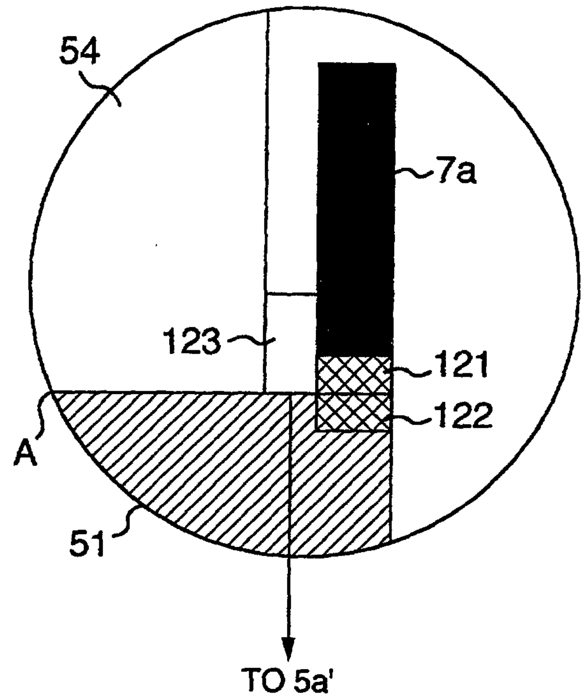
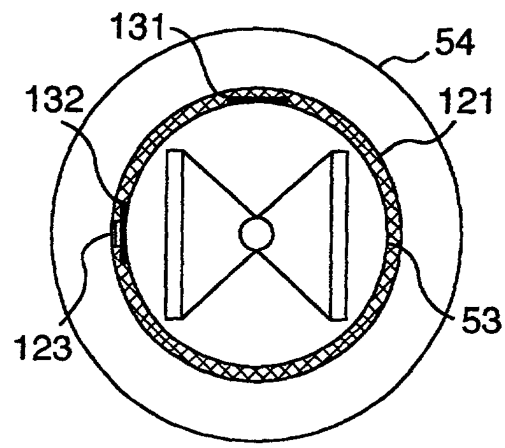


FIG. 13



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP99/07110

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] H05B37/03

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] H05B37/03

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1940-1996 Toroku Jitsuyo Shinan Koho 1994-2000
Kokai Jitsuyo Shinan Koho 1971-2000 Jitsuyo Shinan Toroku Koho 1996-2000

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP, 4-62793, A (Toshiba Corporation), 27 February, 1992 (27.02.92), Full text; Figs. 1 to 4 (Family: none)	8,9 1-7, 10-13
A	JP, 4-174997, A (Toshiba Corporation), 23 June, 1992 (23.06.92), Full text; Figs. 1 to 8 (Family: none)	1-8, 10-13
A	JP, 4-298990, A (Toshiba Corporation & Toshiba Eng. Co., Ltd.), 22 October, 1992 (22.10.92), Full text; Figs. 1 to 6 (Family: none)	1-8, 10-13
Y A	JP, 62-2497, A (Hitachi, Ltd.), 08 January, 1987 (08.01.87), Full text; Figs. 1 to 2 (Family: none)	8,9 1-7,10-13
A	JP, 2-239595, A (Hitachi, Ltd.), 21 September, 1990 (21.09.90), Full text; Figs. 1 to 8 (Family: none)	1-8, 10-13

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 March, 2000 (06.03.00)	21 march, 2000 (21.03.00)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP99/07110

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 4-290971, A (Hitachi, Ltd.), 15 October, 1992 (15.10.92), Full text; Figs. 1 to 3 (Family: none)	1-8, 10-13
A	JP, 10-308287, A (Hitachi, Ltd. & Hitachi Process Computer Eng. Inc.), 17 November, 1998 (17.11.98), Full text; Figs. 1 to 2 (Family: none)	1-8, 10-13

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