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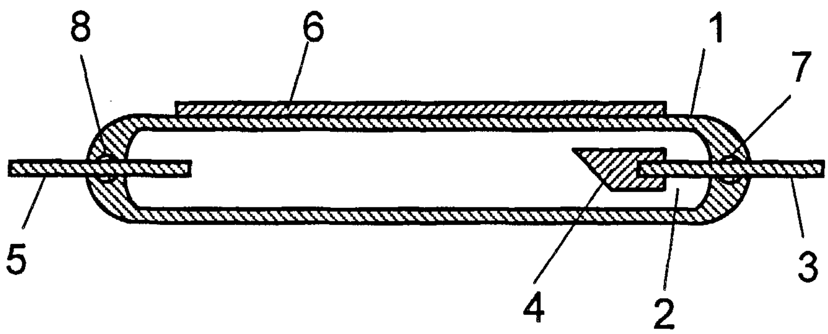
(54) Title: DISCHARGE LAMP AND ELECTRONIC FLASH DEVICE USING THE SAME

(57) Abstract

In a discharge lamp, at least one of two main electrodes disposed at both ends of the discharge lamp includes a sintered metal member (4) having a slope with respect to another main electrode. A tip of the slope is positioned within a space covered by a trigger electrode (6) coated on an outer surface of the discharge lamp in a limited area with respect to the entire circumference of the bulb. This structure allows the discharge lamp to emit light at a stable level constantly. An electronic flash device using this discharge lamp can emit the light precisely.



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DESCRIPTION

Discharge Lamp and Electronic Flash Device Using the Same

Technical Field

The present invention relates to discharge lamp employed as an artificial light source in an electronic flash device incorporated in a photographic camera, and the electronic flash device mounted to a photographic camera. More particularly, the present invention relates to a discharge lamp emitting stable light by stabilizing a discharge current and an emitting waveform, and the electronic flash device using the same lamp.

Background Art

Fig. 8 is a cross section of a conventional discharge lamp.

In Fig. 8, main electrodes 118 and 121 are sealed at both the ends of glass bulb 117. Trigger electrode 122 made of transparent and conductive coating is provided on the entire outer surface of bulb 117. Bulb 117 contains a necessary amount of rare gas such as xenon. Main electrode 118 comprises metallic member 119 and sintered metal member 120 mounted to the tip of metallic member 119. Metallic member 119 is made of tungsten, Kovar or the like. Sintered metal member 120 is made by sintering tungsten powder, tantalum powder, or mixed powder of tungsten and tantalum.

The conventional discharge lamp structured above is built in, e.g. an electronic flash device as shown in Fig. 9. Fig. 9 illustrates an automatic electronic flash device which automatically controls the amount of light emitted from the discharge lamp by sensing the light radiated to a photographic object. Power source 123 supplies a high voltage (approx. 300V), and charges main-discharging capacitor 124 with a charging current, thus approx. 300V is applied across capacitor 124. Trigger circuit 125 produces a high trigger voltage to energize discharge lamp 126. Light-emitting control section 127 stops discharge lamp 126 to emit the light on its way. Photo-receptor 128 comprises photo-receiving element 129 and circuit 130 producing a light-emitting-stopping signal.

An operation of the conventional automatic electronic flash device structured above is described hereinafter.

Capacitor 124 is charged at a high voltage with the charging current from power source 123. Trigger circuit 125 is activated to apply a high voltage to a trigger electrode of discharge lamp 126. Then discharge lamp 126 is energized to emit light by charged energy stored in capacitor 124, thereby radiating a photographic object. The light reflected from the object enters photo-receiving element 129. When the amount of light entering to photo-receiving element 129 reaches a given amount, circuit 130 outputs a light-emitting-stopping signal to light-emitting control section 127. Section 127 then conducts switching operation thereby stopping the discharge lamp 126 to emit the light.

Fig. 10 shows waveforms of discharge-current of the conventional discharge lamp. Fig. 11 shows waveforms of the light emitted from the same bulb. Discharge lamp 126 is energized with a trigger voltage produced by trigger circuit 125, and lamp 126 is discharged by the energy charged in capacitor 124. The waveforms in Fig. 10 illustrate time-varient discharge current. This discharge-current rises sharply approx. at the same time when the trigger voltage is applied, and then starts flowing. When light-emitting-stopping section 127 does not operate switching on the way of emitting the light, i.e. when section 127 is in a complete emitting mode, this flash device finishes discharging by consuming all energy charged in capacity 124 toward an photographic object away from the camera.

On the other hand, brightness of discharge lamp 126 starts increasing not simultaneously with the start of flowing the discharge current but with some time lag, as shown in Fig. 11. When the conventional discharge lamp shown in Fig. 8 is employed, the discharge current of this bulb 126 draws different waveforms marked with 200 and 250 in Fig. 10 at each firing of the lamp, and no stable waveforms are obtained. Light emission of lamp126 also draws different waveforms marked with 300 and 350 in Fig. 11 at each firing, and no stable waveforms are obtained. In particular, the unstable light emission waveforms as shown in Fig. 11 cause a reduction in precision in automatic light emission control.

It is necessary to detect precisely an amount of reflective light—out of the light emitted from discharge lamp 126—from a photographic object for realizing precise control over the light emission from lamp 126. For that purpose, photo receptor 128 should synchronizes exactly with an emission timing of lamp 126. There are two methods for activating photo receptor 128; (1) Trigger circuit 125 energizes discharge lamp 126, and the discharge current shown in Fig. 10 starts flowing. At the same time, an operable voltage is supplied to photo-receptor 128. (2) When the discharge current reaches a given amount, this is detected and then the operable voltage is supplied to photo-receptor 128.

When method (2) is employed for powering photo-receptor 128, light-emitting waveform varies every time the discharge lamp fires as shown in Fig. 11 and this causes the following inconvenience: Although photo receptor 128 is ready to detect reflective light from the object, if lamp 126 would delay emitting as shown with waveform 350, receptor 128 receives external lights other than the reflective light from the object during this delay, i.e. a period before lamp 126 starts emitting. Then, receptor 128 cannot receive the reflective light exactly from the object, and thus the light amount radiated to the object is less than an appropriate amount.

On the contrary, when photo-receptor 128 starts operating later than discharge lamp 126, e.g. as shown with waveform 300 in Fig. 11, lamp126 have already started emission before receptor 128 becomes ready to receive the reflective light from the object. The reflective light is thus not received by receptor 128 until receptor 128 is ready, and thus the light amount radiated to the object exceeds the appropriate amount.

The discussion described above proves that a slight time lag between a light emission timing and an operation start timing of the photo-receptor affects the amount of light emission only a little when the object is away from the camera. However, it affects the amount of light emission substantially when the object is close to the camera.

Summary of the Invention

The present invention addresses the problem discussed above and aims to provide a discharge lamp emitting light with stable waveforms of both discharge-current and light-emission. This discharge lamp is employed in an electronic flash device which emits the light by consuming the energy charged in a main capacitor, so that the electronic flash device emitting stable light is obtainable.

The discharge lamp of the present invention comprises the following elements:

(a) a glass bulb;

(b) a pair of main electrodes sealed in at both ends of the bulb;

(c) a trigger electrode provided on outer surface of the glass bulb in part in circumference direction and in a longitudinal direction of the bulb; and

(d) rare gas sealed in the bulb.

At least one of the main electrodes includes a metallic member sealed at a first end of the bulb and sintered metal member disposed in the bulb and mounted to this metallic member. The sintered metal member slopes with respect to another main electrode opposite thereto and the tip of the slope is positioned within a limited space covered by the trigger electrode.

This structure allows the discharge lamp to produce constantly stable waveforms of both the discharge current and light emission.

An electronic flash device of the present invention comprises the following elements:

(a) a power source;

(b) a main discharging capacitor to be charged by the power source;

(c) a trigger circuit; and

(d) the discharge lamp discussed above having a trigger electrode on an outer surface of a glass bulb—the trigger circuit applying a voltage to the trigger electrode—for emitting light by consuming energy charged in the main discharging capacitor.

The discharge lamp of the present invention is used in the electronic flash device discussed above, so that the device produces constantly stable waveform of light emission. When the discharge lamp is employed in an automatic electronic flash device that controls light emission automatically, precise control over light emission can be expected. The automatic light emission control stops the lamp to emit the light when received amount of reflective light—out of emitted light of the discharge lamp—from a photographic object reaches an appropriate amount.

Brief Description of Drawings

Fig. 1 is a perspective view of a discharge lamp in accordance with a first exemplary embodiment of the present invention.

Fig. 2 is a cross section of the discharge lamp taken on lines 50－50 in Fig. 1.

Fig. 3 is a cross section of the discharge lamp taken on lines 60－60 in Fig. 1.

Fig. 4 is an enlarged perspective view of a main electrode of the discharge lamp.

Fig. 5 shows a waveform of discharge current of the discharge lamp.

Fig. 6 is a waveform of emitted light from the discharge lamp.

Fig. 7 is a cross section of a discharge lamp in accordance with a second exemplary embodiment of the present invention.

Fig. 8 is a cross section of a conventional discharge lamp.

Fig. 9 is an electric circuit of an electronic flash device, for general use, that can automatically control light-emission.

Fig. 10 shows a waveform of discharge current of the conventional discharge lamp.

Fig. 11 shows a waveform of light emitted from the conventional discharge lamp.

Detailed Description of Preferred Embodiments

Exemplary embodiments of the present invention are demonstrated with reference to the accompanying drawings.

(Exemplary Embodiment 1)

Fig. 1 is a perspective view of a discharge lamp in accordance with the first exemplary embodiment of the present invention. Fig. 2 is a cross section of the same discharge lamp taken on lines 50－50 in Fig. 1, and Fig. 3 is a cross section of the same discharge lamp taken on lines 60－60 in Fig. 1. Fig. 4 is an enlarged perspective view of a main electrode of the same discharge lamp. Fig. 5 shows a waveform of discharge-current of the same discharge lamp, and Fig. 6 is a waveform of emitted light from the same discharge lamp.

In Fig. 1 and Fig. 2, main electrodes 2 and 5 are sealed at both the ends of glass bulb 1. First main electrode 2 has metallic member 3 and sintered metal member 4. Metallic member 3 is formed by cutting a stick of tungsten, Kovar or the like. Sintered metal member 4 is made by solidifying powder of tungsten or tantalum, or mixed powder of them, and sintering the solid powder. Sintered metal member 4 is mounted to the tip of metallic member 3 by welding or caulking.

Fig. 4 is an enlarged perspective view of a main electrode of the same discharge lamp. In Fig. 4, sintered metal member 4 is shaped in a cylinder having a slope on a first end, and mounted to metallic member 3 at a second end. Another main electrode 5 sealed at another end of the bulb 1 is made of the same material as metallic member 3.

Trigger electrode 6 is made of transparent and conductive coating coated in a longitudinal direction on the outer surface of bulb 1. The coated area is limited by angle 75, shown in Fig. 3, with respect to the entire circumference of bulb 1.

In Fig. 2, a necessary amount of rare gas such as xenon gas is sealed in bulb 1. Bead-glasses 7 and 8 are used for sealing main electrodes 2 and 5 within bulb 1. Main electrode 2 is sealed in bulb 1 at a first end of bulb 1 so that upper tip 80, shown in Fig. 4, of sintered metal member 4 is located within area 70, shown in Fig. 3, above which trigger electrode 6 is coated.

In the discharge lamp of the present invention structured above, trigger electrode 6 is coated on an area limited by an angle of 90 degree with respect to the axis of bulb 1 and in a longitudinal direction of bulb 1. This discharge lamp replaces a conventional discharge lamp 126 used in an electronic flash device shown in Fig. 9, and various data are measured. The resultant data are described below.

The electronic flash device is fired ten times in a complete emitting mode, and discharge current as well as light emitted are observed each time. Fig. 5 and Fig. 6 show these data. Each Fig. shows only one waveform because the discharge current and the light emitted are hardly changed by each firing in respective waveforms, thus the waveforms are stable enough, although the conventional device have shown different waveforms at each firing.

The first embodiment as discussed above proves that the discharge lamp of the present invention can produce stable waveforms of the discharge current and light emitted. An electronic flash device using this discharge lamp can constantly emit the light with a stable waveform. In particular, when this discharge lamp is used in an automatic electronic flash device, light emission can be precisely controlled. The automatic electronic flash device allows the discharge lamp to stop emitting the light when the received amount of reflective light, out of the light emitted, from a photographic object reaches an appropriate amount.

(Exemplary Embodiment 2)

Fig. 7 is a cross section of a discharge lamp in accordance with the second exemplary embodiment of the present invention.

In this second embodiment, both the ends of glass bulb 9 are shielded with metallic sealant members 10 and 11. Main electrode 12 and 15 are mounted to sealant members 10 and 11 respectively. Electrode 12 is made of the same material as main electrode 2 used in the first embodiment. Electrode

15 is made of tungsten, Kovar or the like. Trigger electrode 16 is, as same as in the first embodiment, coated on the outer surface of bulb 9 in the longitudinal direction and in part with respect to the entire circumference of bulb 9. A necessary amount of rare gas such as xenon is sealed in bulb 9. A relative positional relation between trigger electrode 16 and main electrode 12 is the same as the first embodiment. The second embodiment can effect the same advantages as the first.

In the first and second embodiments discussed above, main electrodes 2 and 12 are made of sintered metal member and shaped in a cylinder having a slope on the first end as shown in Fig. 4. A polygonal pillar, e.g. a pentagon pillar or hexagon pillar, having a slope on its first end can replace the cylinder. Main electrode 5 is made of a single metal; however it can be made of the same material as electrode 2, or it can be replaced with main electrode 118 of the conventional discharge lamp shown in Fig. 8.

Main electrode 12 shown in Fig. 7 and used in the second embodiment can be formed by mounting only sintered metal member 14 directly to metallic sealant member 10, instead of mounting sintered metal member 14 to metallic member 13. Main electrode 15 can be made of the same material as main electrode 12 or sintered metal only instead of the metallic member.

Regarding the relative positional relation between trigger electrode 6 or 16 and the tip of main electrode 2 or 12, the center of tip preferably meets the center of the limited area coated by the trigger electrode. However, the center of tip can be positioned at any place within the limited space.

Regarding the limited area coated by trigger electrode with respect to the entire circumference of the bulb in both the embodiments, an angle with respect to the axis of the bulb can range from 10° to 200°. This range of angle produces stable light emission free from any practical problems. However, if the angle is less than 10°, the tip of main electrode is laid possibly out of the limited space covered by the trigger electrode in the assembling of the discharge lamp. Therefore, angle 75 shown in Fig. 3 needs at least 10°. When angle 75 exceeds 200°, the waveforms of discharge-current and light-emission become unstable as shown in Fig. 10 and Fig. 11.

The exemplary embodiments of the discharge lamp of the present invention are described above with reference to the accompanying drawings, and when the discharge lamp is used in an electronic flash device, stable waveforms of light emission can be constantly produced by the device.

When the discharge lamp is used in an automatic electronic flash device shown in Fig. 9, a highly precise automatic electronic flash device is achievable.

The discharge lamp of the present invention, as discussed above, has the following structure: at least one of two main electrodes slopes with respect to the opposite main electrode, and the tip of the slope is positioned in a limited space covered by the trigger electrode coated on the outer surface of the discharge lamp. The coated area is in the longitudinal direction and in part with respect to the entire circumference of the bulb. This structure allows the bulb to produce constantly stable waveforms of discharge current and light emission of the discharge lamp. An electronic flash device employing this discharge lamp can constantly produce a stable waveform of light emission. In particular, when this discharge lamp is used in an automatic electronic flash device, the light emission can be controlled precisely.

Industrial Applicability

The present invention relates to discharge lamps and electronic flash devices employing the same lamps. In the discharge lamp of the present invention, at least one of two main electrodes slopes with respect to the opposite main electrode, and the tip of the slope is positioned in a limited space covered by the trigger electrode coated in a limited area on the outer surface of the discharge lamp. This structure allows the bulb to emit stable light constantly. This discharge lamp is employed in an electronic flash device, so that the light emission can be controlled precisely.

CLAIMS

1. A discharge lamp comprising:

a glass bulb;

a pair of main electrodes sealed in at both ends of said glass bulb respectively;

a trigger electrode provided on an outer surface of said bulb in a longitudinal direction and in a limited area with respect to an entire circumference of said bulb; and

rare gas sealed in said bulb.

wherein at least one of said main electrodes includes a metallic member sealed at a first end of said bulb and sintered metal member mounted to the metallic member, and

wherein the sintered metal member has a slope with respect to another main electrode opposite thereto, and a tip of the slope is positioned in a space covered by the limited area.

2. A discharge lamp comprising:

a glass bulb;

a pair of metallic sealant members sealing both ends of said glass bulb;

a pair of main electrodes mounted to said metallic sealant members respectively;

a trigger electrode provided on an outer surface of said bulb in a longitudinal direction and in a limited area with respect to an entire circumference of said bulb; and

rare gas sealed in said bulb.

wherein at least one of said main electrodes includes a metallic member mounted to said metallic sealant member and sintered metal member mounted to the metallic member, the sintered metal member facing to another main electrode, and

wherein the sintered metal member has a slope with respect to another main electrode opposite thereto, and a tip of the slope is positioned in a space covered by the limited area.

3. The discharge lamp as defined in Claim1 or 2, wherein the sintered metal member is shaped in a cylinder having a first end sloped and a second end coupled to the metallic member.

4. The discharge lamp as defined in Claim 1 or 2, wherein the sintered metal member is shaped in a polygonal pillar having a first end slanted and a second end coupled to the metallic member.

5. A discharge lamp comprising:

a glass bulb;

a pair of metallic sealant members sealing both ends of said glass bulb;

a pair of main electrodes mounted to said metallic sealant members respectively;

a trigger electrode provided on an outer surface of said bulb in a longitudinal direction and in a limited area with respect to an entire circumference of said bulb; and

rare gas sealed in said bulb.

wherein at least one of said main electrodes is made of sintered metal member, and

wherein the sintered metal member has a slope with respect to another main electrode opposite thereto, and a tip of the slope is positioned in a space covered by the limited area.

6. The discharge lamp as defined in Claim 1, 2, or 5, wherein said trigger electrode is provided in the limited area having an angle ranging from 10° to 200° with respect to an axis of said glass bulb.

7. A discharge lamp comprising:

a light-transparent bulb containing rare gas sealed;

a pair of main electrodes sealed at both ends of said bulb;

a trigger electrode provided on an outer face of said bulb in a longitudinal direction and in part with respect to an entire circumference of said bulb; and

a slope formed on at least one of said main electrodes and positioned at a space covered by said trigger electrode.

8. An electronic flash device comprising:

a power source;

a main discharging capacitor charged by said power source;

a trigger circuit;

a discharge lamp of which trigger electrode receives a voltage from said trigger circuit, and emitting light by consuming energy charged in said main discharging capacitor,

wherein said discharge lamp comprises:

a glass bulb;

a pair of main electrodes sealed in at both ends of said glass bulb respectively;

a trigger electrode provided on an outer surface of said bulb in a longitudinal direction and in a limited area with respect to an entire circumference of said bulb; and

rare gas sealed in said bulb.

wherein at least one of said main electrodes includes a metallic member sealed at a first end of said bulb and sintered metal member mounted to the metallic member, and

wherein the sintered metal member has a slope with respect to another main electrode opposite thereto, and a tip of the slope is positioned in a space covered by the limited area.

9. An electronic flash device comprising:

a power source;

a main discharging capacitor charged by said power source;

a trigger circuit;

a discharge lamp of which trigger electrode receives a voltage from said trigger circuit, and emitting light by consuming energy charged in said main discharging capacitor,

wherein said discharge lamp comprises:

a glass bulb;

a pair of metallic sealant members sealing both ends of said glass bulb;

a pair of main electrodes mounted to said metallic sealant members respectively;

a trigger electrode provided on an outer surface of said bulb in a longitudinal direction and in a limited area with respect to an entire circumference of said bulb; and

rare gas sealed in said bulb.

wherein at least one of said main electrodes includes a metallic member mounted to said metallic sealant member and sintered metal member mounted to the metallic member, the sintered metal member facing to another main electrode, and

wherein the sintered metal member has a slope with respect to another main electrode opposite thereto, and a tip of the slope is positioned in a space covered by the limited area.

10. An electronic flash device comprising:

a power source;

a main discharging capacitor charged by said power source;

a trigger circuit;

a discharge lamp of which trigger electrode receives a voltage from said trigger circuit, and emitting light by consuming energy charged in said main discharging capacitor,

wherein said discharge lamp comprises:

a glass bulb;

a pair of metallic sealant members sealing both ends of said glass bulb;

a pair of main electrodes mounted to said metallic sealant members respectively;

a trigger electrode provided on an outer surface of said bulb in a longitudinal direction and in a limited area with respect to an entire circumference of said bulb; and rare gas sealed in said bulb.

wherein at least one of said main electrodes is made of sintered metal member, and

wherein the sintered metal member has a slope with respect to another main electrode opposite thereto, and a tip of the slope is positioned in a space covered by the limited area.

11. The electronic flash device as defined in Claim 8, 9 or 10, wherein said trigger electrode is provided in the limited area having an angle ranging from 10° to 200° with respect to an axis of said glass bulb.

12. An electronic flash device comprising:

a power source;

a main discharging capacitor charged by said power source;

a trigger circuit;

a discharge lamp of which trigger electrode is energized by said trigger circuit, and emitting light by consuming energy charged in said main discharging capacitor,

wherein said discharge lamp comprises:

a light-transparent bulb containing noble gas sealed;

a pair of main electrodes sealed in at both ends of said bulb;

a trigger electrode provided on an outer face of said bulb in part with respect to an entire circumference of said bulb; and

a slope formed on at least one of said main electrodes and positioned at a space covered by said trigger electrode.

13. The electronic flash device as defined in Claim 8, 9, 10 or 12

further comprising:

a photo-receptor for receiving reflective light, out of light emitted from said discharge lamp, from a photographic object;

a light-emission-stopping-signal-generating circuit for operating a light-emission-stopping signal when said light receptor receives the reflective light up to a predetermined amount; and

a light-emission control section for stopping said discharge lamp to emit light by receiving the light-emission-stopping signal.

FIG. 1

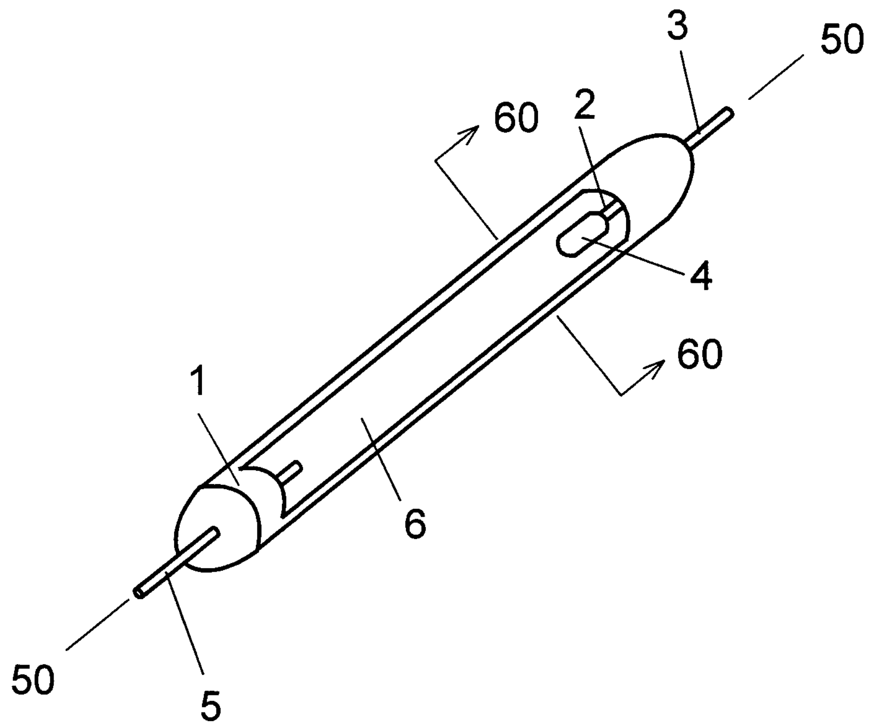


FIG. 2

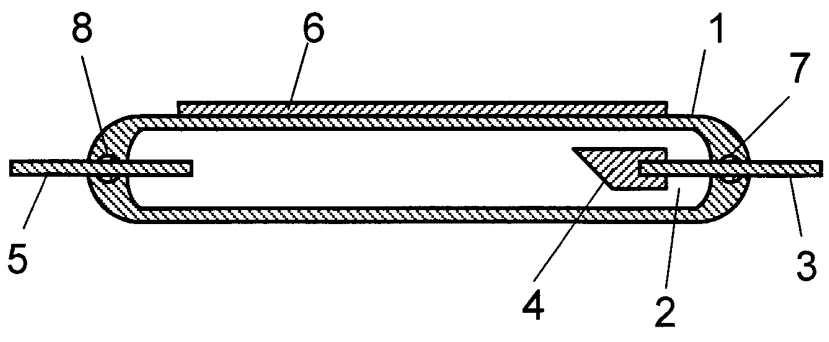


FIG. 3

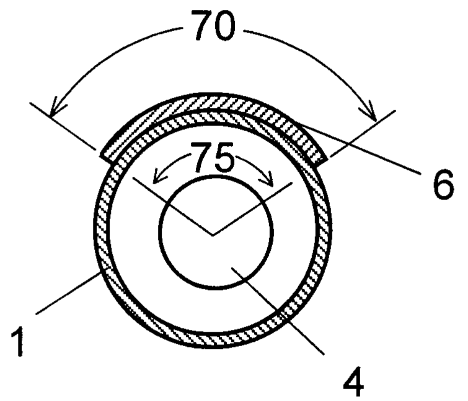


FIG. 4

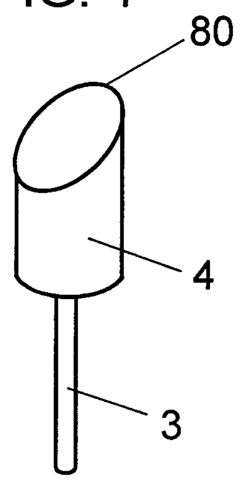


FIG. 5

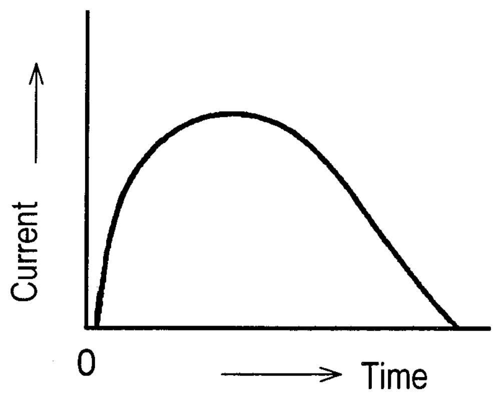


FIG. 6

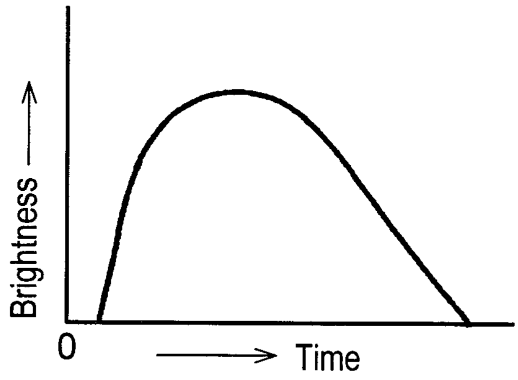


FIG. 7

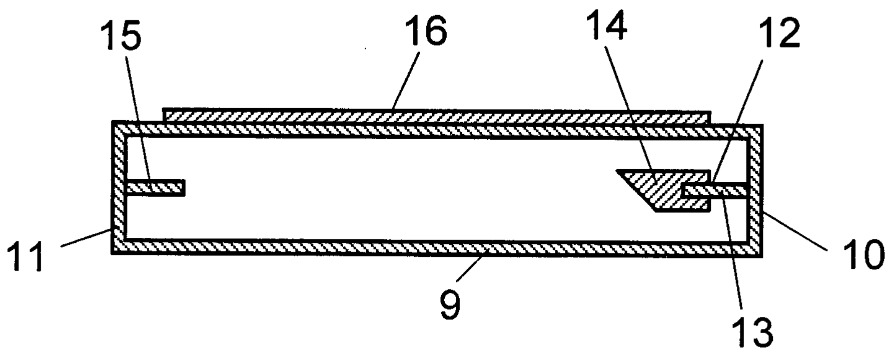


FIG. 8

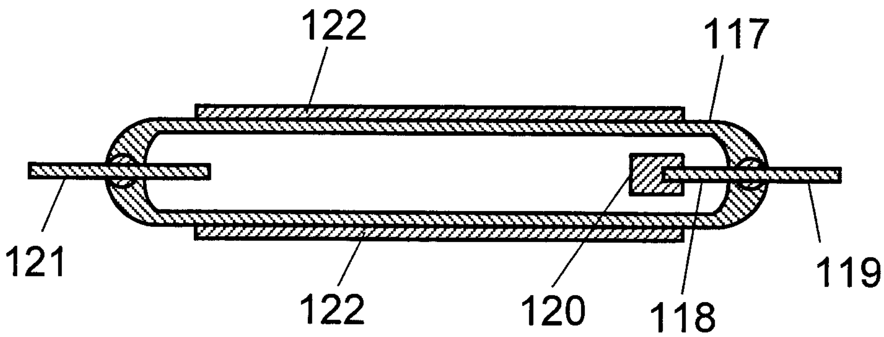


FIG. 9

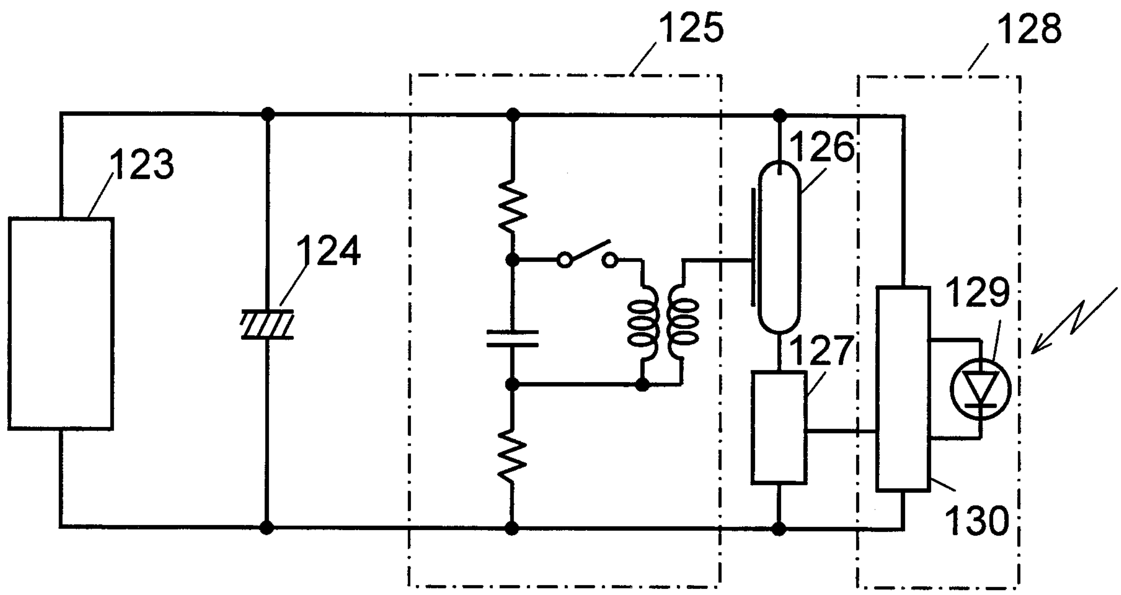


FIG. 10

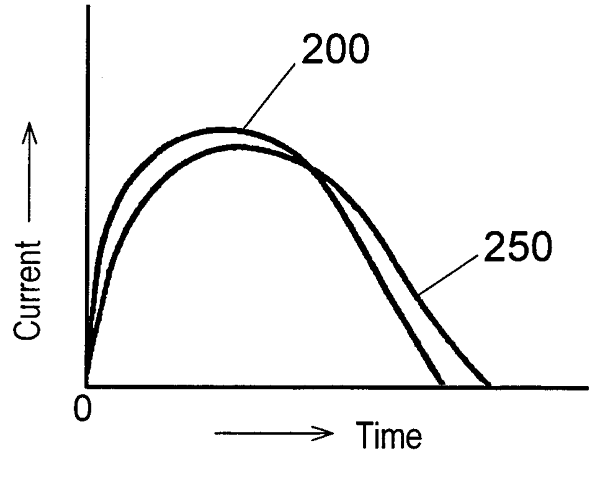
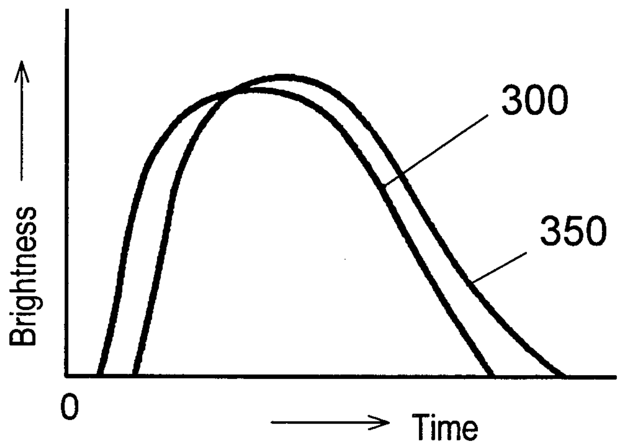


FIG. 11



Reference numerals in the drawings

1. Glass bulb
2. Main electrode
3. Metallic member
4. Sintered metal member
5. Main electrode
6. Trigger electrode
9. Glass bulb
10. Metallic sealant member
11. Metallic sealant member
12. Main electrode
13. Metallic member
14. Sintered metal member
15. Main electrode
16. Trigger electrode
80. Tip

INTERNATIONAL SEARCH REPORT

International Application No
PCT/JP 00/02680

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01J61/80 H01J61/067 H01J61/54 H01J61/90

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)
IPC 7 H01J H05B

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

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

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 758 819 A (GOLDBERG J) 11 September 1973 (1973-09-11)	1,6-8, 11,12
Y		13
A	column 3, line 10 - line 48 column 4, line 16 - line 22 figure 1	2-5,9,10
X	PATENT ABSTRACTS OF JAPAN vol. 007, no. 008 (E-152), 13 January 1983 (1983-01-13) & JP 57 165948 A (RICOH KK), 13 October 1982 (1982-10-13)	1,6-8, 11,12
Y	abstract; figures 4,6A,6B	13
Y	US 4 082 982 A (HIRATA SHINJI) 4 April 1978 (1978-04-04) abstract; figure 1	13

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
22 August 2000	29/08/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Zuccatti, S

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y A	US 4 001 624 A (COSCO ROBERT J ET AL) 4 January 1977 (1977-01-04) column 1, line 18 - line 25 column 4, line 9 - line 12; figure 1	1,6,7, 11-13 2-5,9,10
Y	US 3 968 392 A (BUCHTA HANS PETER ET AL) 6 July 1976 (1976-07-06) column 2, line 29 - line 57	1,6,7, 11-13
A	PATENT ABSTRACTS OF JAPAN vol. 010, no. 348 (P-519), 22 November 1986 (1986-11-22) & JP 61 147242 A (USHIO INC), 4 July 1986 (1986-07-04) abstract	1-13
A	PATENT ABSTRACTS OF JAPAN vol. 005, no. 019 (E-044), 4 February 1981 (1981-02-04) & JP 55 146856 A (USHIO INC), 15 November 1980 (1980-11-15) abstract	2,5,9,10
A	US 5 304 897 A (SANO TAKESHI ET AL) 19 April 1994 (1994-04-19) column 1, line 32 -column 2, line 2; figure 21	1,7
A	EP 0 473 164 A (TOSHIBA LIGHTING & TECHNOLOGY) 4 March 1992 (1992-03-04) figures 1-4,8	1,7

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Information on patent family members

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