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(54) High pressure sodium discharge tube support structure.

(57) A high pressure sodium lamp is provided with an outer envelope (1,2) containing a rare gas at a pressure of approximately one atmosphere. A metallic reflective layer (5) is disposed on a portion (2) of the outer envelope for defining a reflector. The lamp comprises a discharge device (10) mounted within the outer envelope and provided with a pair of conductors (14,15). The pair of conductors (14,15) are configurated to have a breakdown voltage between them greater than a certain value and to maintain the breakdown voltage between the conductors and the metallic reflector greater than the certain value.

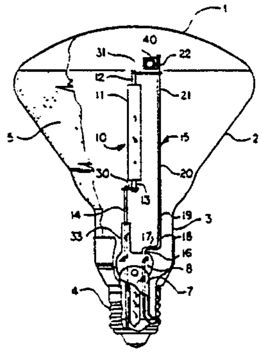

FIG.1

HIGH PRESSURE SODIUM DISCHARGE TUBE SUPPORT STRUCTURE

The present invention relates to high pressure sodium vapor high intensity discharge lamps, and more particularly to the support structure for a high pressure sodium discharge light source within the lamp.

High pressure sodium discharge lamps are comprised of a discharge device mounted in an evacuated outer envelope. The discharge device is typically a ceramic discharge vessel comprised of alumina or sapphire and having conductive terminals for receiving an operating voltage. The conductive terminals are niobium which is used because its coefficient of thermal expansion matches that of alumina and because it is resistant to sodium vapor. Titanium solder is used in connections to the niobium.

The outer envelope is evacuated in order to thermally isolate the discharge device, and to avoid reactions of any gas within the outer envelope with the discharge device. Nitrogen, which is used in the outer envelope of other types of high intensity discharge lamps, cannot be used in high pressure sodium lamps because of its reactivity with niobium and titanium at high temperature.

The evacuated outer envelope of high pressure sodium lamps must be strong and able to withstand severe mechanical impacts without breaking. If the lamp outer envelope were to break, it would implode scattering glass fragments and create a safety hazard.

It has been the practice to manufacture high pressure sodium lamps with evacuated outer envelopes, and to make those envelopes sufficiently strong to avoid breakage. However, high envelope strength is not feasible in the case of many reflector lamps. Reflector lamp envelopes have a large face that merges with the envelope side walls at an edge portion having a small radius of curvature. The atmospheric pressure acting on the evacuated envelope causes high stress concentrations in the edge portion and makes it susceptible to breakage. Moreover, reflector lamps have thin blown glass envelopes and cannot be strengthened by making them substantially thicker. Incandescent reflector lamps having blown glass envelopes uniformly contain a fill gas with an internal pressure of about one atmosphere. With the inner and outer pressures acting on the envelope being approximately equal, no implosion will occur if the envelope breaks and there is less apt to be flying glass fragments.

There has been some consideration of gas filled high pressure sodium lamps. U.S. patent 3,932,781 issued to Jozef C.I. Peeters et al discloses a high pressure sodium lamp having an outer envelope that is gas filled to inhibit evaporation of the alumina discharge tube. This reduces the deposition of alumina on the outer envelope and the attendant reduction in light output. The results of experiments involving such a lamp are also disclosed in the article by R.J. Campbell et al, "Evaporation studies of the sintered aluminum oxide discharge tubes used in high pressure sodium (HPS) lamps", Journal of the IES, July 1980, pages 233-239.

The introduction of a fill gas into the outer envelope of a high pressure sodium discharge lamp presents the problem of voltage breakdown through the gas. These lamps have closely spaced metal parts having a potential difference of around 4000 volts during lamp operation. In the high vacuum of conventional high pressure sodium lamps electrical breakdown between the lamp parts was not a problem. A fill gas has the potential of ionizing and providing a conductive path between the internal lamp parts at the different potentials and electrical breakdown can occur.

Accordingly, it is an object of the invention to provide a high pressure sodium discharge lamp having a gas filled outer envelope in which electrical breakdown through the fill gas is prevented.

It is another object of the invention to provide a high pressure sodium lamp that is practicable to be operated in any orientation without electrical breakdown through the gas filled in the outer envelope.

It is another object of the invention to provide support structure for the discharge device of a lamp that will operate in a rare gas atmosphere without electrical breakdown through the rare gas.

According to the invention a high pressure sodium lamp is comprised of an outer envelope containing a rare gas at a pressure of approximately one atmosphere. A metallic reflective layer is disposed on a portion of the outer envelope for defining a reflector. Mounting means mounts the discharge device of the lamp within the outer envelope and is comprised of a pair of conductors for providing a conductive path to the discharge device. The pair of conductors are configured to have a breakdown voltage between them greater than a certain value, and to maintain the breakdown voltage between the conductors and the metallic reflector greater than the certain value.

In a preferred embodiment of a high pressure sodium lamp according to the invention, the lamp comprises means within the outer envelope connected across conductors supplying voltage to the discharge device for exhibiting a high impedance below a certain applied voltage and a low impedance above a certain applied voltage. The voltage at which the impedance changes is selected to be lower than the breakdown voltage through the gas atmosphere within the outer envelope.

In another preferred embodiment the lamp comprises thermal control means for controlling the relative thermal dissipation of the ends of the discharge device for rendering its operating voltage insensitive to the orientation of the lamp during the lamp orientation. Thus also the risk of voltage breakdown through the gas filled outer envelope is further reduced. In one embodiment the thermal control means is comprised of a heat shield on the end of the discharge device closest to the lamp base. In another embodiment the thermal control means is comprised of different length of the electrode mounting means mounting the discharge electrode, resulting in the one electrode being closer to the adjacent end wall than the other electrode to its adjacent end wall. In yet another embodiment the thermal control means is comprised in that the discharge device has end walls of different thickness. The thicker end wall dissipating more heat than the thinner end wall and thus operating at a lower temperature then the thinner end wall.

Embodiments of the invention will be explained with reference to accompanying drawings, in which:

Fig. 1 is a partial vertical section of an HPS reflector lamp with blown glass envelope according to the invention;

Fig. 2 is an isometric view of the discharge tube support structure shown in Fig. 1;

Fig. 3 is a partial cross section of the support structure shown in Fig. 2;

Fig. 4 is a partial vertical section of an HPS reflector lamp with a blown glass envelope in which the discharge tube has thermal control structure;

Fig. 5 is a vertical section of a high pressure sodium discharge tube having unsymmetrical structure for thermal control;

Fig. 6 is a partial vertical section of an HPS reflector lamp according to the invention having structure for preventing internal electrical breakdown;

Fig. 7 is a partial vertical section of an HPS reflector lamp like that shown in Fig. 1 and having structure for preventing internal electrode breakdown; and

Fig. 8 is a graph illustrating the relative magnitudes of different voltages that characterize the lamp operation.

Fig. 1 illustrates a high pressure sodium reflector lamp having a blown glass envelope. The envelope has a transparent or translucent front dome 1 from which light is emitted during lamp operation. A mid-section 2 converges toward a narrow neck 3 which terminates at the base end of the lamp envelope. A lamp base 4 is mounted on the base end of the envelope opposite the front dome 1.

A reflective layer 5 is disposed over at least a portion of the converging mid-section 2 of the lamp envelope. It is illustrated extending up to the edge of the dome 1 of the lamp envelope, and down onto a part of the narrow neck 3. The reflective layer 5 is typically metallic aluminum which is vapor deposited on the inner surface of the envelope. A high pressure sodium discharge device 10 is mounted axially symmetrically within the envelope and emits light which is incident on the reflective layer 5. The convergence of the envelope mid-section 2 having the reflective layer 5 is effective to reflect light from the light source 10 in a forward direction through the dome end of the envelope so as to concentrate the light and give it directivity.

The high pressure sodium discharge device 10 has a translucent body 11 and a pair of terminals 12, 13 each extending from a respective end of the tubular body 11. When a sufficiently high voltage is applied across the terminals 12 and 13, an electrical discharge is established between a pair of spaced internal electrodes (not shown) within the tubular body 11 and intense visible light is emitted.

The discharge device 10 is mounted within the envelope by a frame structure which also comprises conductors for applying an operating voltage to the discharge device. The base end of the envelope is closed by a stem 7 which is terminated at a pinch seal 8. A pair of rigid support conductors 14, 15 emerge from the pinch seal 8 and extend longitudinally of the envelope toward the dome end 1. The shorter conductor 14 has a free end which is connected to the terminal 13 of the discharge device by a conductive link 21. Similarly, the free end of the longer conductor 15 is attached to the terminal 12 by the conductive link 22. Each of the support conductors 14, 15 extend into the pinch seal 8 and are connected by respective conductive leads to the lamp base 4, in a conventional manner. Consequently, a voltage applied across the lamp base 4 is developed across the terminals 12, 13 of the high pressure sodium discharge device 10 for energizing it to emit light.

In order to avoid the danger of implosion upon breakage of the outer envelope 1, the outer envelope contains rare gas at a fill pressure of about 700 torr at room temperature. At the lamp operating temperature, the rare gas pressure is greater than one atmosphere (760 torr), in one example 930 torr. So there is no substantial pressure difference across the wall of the lamp envelope, as the occuring range of pressure difference is of the same magnitude as barometric variations. Consequently, if the envelope is broken there will be no substantial pressure difference to accelerate glass fragments and cause flying fragments of the broken envelope. The rare fill gas within the outer envelope thus makes it safe to use thin blown glass outer envelopes in high pressure sodium reflector lamps.

The use of a rare fill gas in the outer envelope of a high pressure sodium lamp has certain consequences for the lamp's characteristics. These in turn dictate that the lamp incorporate certain structural features.

A major and substantial consequence of the use of the rare fill gas is the lowering of the breakdown voltage between internal lamp components. The American National Standards Institute (ANSI) recommends that the lamp be able to withstand an a.c. voltage of 4,000 volts peak. Commercially available high pressure sodium lamp starters produce a voltage pulse of up to 4000 volts having a duration of one millisecond. Conventional high pressure sodium lamps have a high internal vacuum of less than 10^{-4} torr in their outer envelope. As a result, internal metal components, such as discharge device mounting frame parts, can be as close as about three millimeters without a breakdown occurring at 4000 volts applied to the lamp.

The higher pressure rare gas fill increases the probability of internal voltage breakdown being caused by the 4,000 volt starting pulse. In order to avoid breakdown from occurring, the metallic components of the discharge device mounting structure are shaped to maximize the distance between the support conductors 14 and 15 that have an electrical potential between them during lamp operation.

As shown in Fig. 2, the discharge device 10 is positioned on the lamp center line, and the short straight conductor 14 is on one side of the center line. The conductor 15 emerges from the pinch seal 8 on the opposite side of the lamp center line, and after a short length 16 it is bent perpendicular to the conductor 14. The section 17 of the conductor 15 extends perpendicularly away from the conductor 14, and is bent to define a portion 18 extending parallel to the conductor 14. The next portion 19 extends away from the imaginary plane defined by the conductor 14 and the portions 16 and 17 of the conductor 15. The next section 20 again extends parallel to the lamp longitudinal direction, and the successive section 21 extends back toward the original line of direction of the section 18. The last section 22 of the conductor 15 extends along the same line of direction as the section 18. This structure allows sufficient separation between the conductors 14 and 15 and at the same time avoids the conductor 15 from coming too close to the reflective layer 5, which is typically a metallic and conductive layer such as aluminum.

Section 16 of the conductor 15 is the part that is closest to the conductor 14. This is where electrical breakdown is most likely to occur. In order to reduce the likelihood of breakdown, a glass sleeve 33 covers the portion of the conductor 14 opposite the section 16 of the conductor 15. The glass sleeve 33 increases the breakdown voltage between the conductors 14 and 15. The gas krypton was used in a reflector lamp having the glass sleeve 33 and did not break down. Thus, krypton fill gas provides a practicable way of eliminating the implosion problem.

In order to establish the effectiveness of the glass sleeve 33, high pressure sodium reflector lamps were made which were identical except that some had the sleeve and some did not. The lamps had 70 watt HPS discharge devices mounted in an RL-38 outer envelope filled with krypton at a pressure of 700 torr. The space between the conductor 14 and the section 16 of the conductor 15 was eight millimeters. After the lamp reached normal operating temperature, and power was interrupted, the application of a 4,000 volt one microsecond pulse caused arcing between the conductors 14 and 15, in the lamp without a glass sleeve. For the lamp with the glass sleeve 33, no arcing occurred as long as the terminal 13 of the HPS discharge device 10 was at least 13 millimeters from the conductor 15.

To further improve the breakdown characteristics of the lamp internal structure, all metallic parts are configured to eliminate sharp points and edges. Sharp points create regions of electric field concentration and may facilitate localized ionization of the rare fill gas which could initiate a breakdown between the conductors 14 and 15. In HPS lamps the discharge device is frequently attached to the supporting conductors by thin metallic ribbons or straight rigid rods. In the present invention, connectors 30 and 31 are made from wire having a circular cross section and are wrapped around the respective discharge device terminal and support conductor in the manner shown in Fig. 3. This eliminates the sharp edges or ends inherent in the prior art structure and avoids any attendant reduction in breakdown voltage. In a lamp having argon at 700 torr in the outer envelope, the curved connectors 30, 31 increased the breakdown voltage by 1000 peak a.c. volts relative to straight rod connectors.

A getter support 40 is attached to the section 22 at the free end of the conductor 15. This position maximizes the distance of the getter support 40 from the conductor 14 and also avoids reducing the internal breakdown voltage of the mounting frame structure.

The rare fill gas also contributes to dissipation of heat developed in the discharge device 10 during lamp operation. HPS discharge devices have minimum operating temperatures. If they are not sufficiently heated during operation their internal sodium vapor pressure will be too low and the light output will be substantially reduced. In order to compensate for thermal losses through the rare fill gas, the discharge device 10 is physically smaller than a discharge device for the same wattage used in an evacuated HPS lamp. The lamps described herein have a discharge device lenght of 41.8 millimeters as compared to the standard 48.0 millimeter length, and a 4.0 millimeter inside diameter as compared to the 4.8 millimeter standard. The smaller physical size reduces the area of the discharge device through which heat can transfer to the rare fill gas so that the discharge device operates at the correct temperature even though substantial amounts of thermal energy can be transferred through the rare gas.

The smaller HPS discharge device 10 results in a lamp for which the beam spread is substantially determined by the position of the discharge device along the center line of the lamp. This is shown by the data in the following Table I. The beam spread of the lamp can be set between 15 and 96 degrees by selecting the position of the discharge device within an interval of 15 millimeters. This broad range in beam spread was achieved with an RL-38 outer envelope.

TABLE I

Mount Height (mm)	Beam Spread (deg.)	ANSI Notation
72	15	NSP
74	23	SP
82	53	WFL
87	96	VWFL

The RL-38 bulb has a seal length (the distance from the base of the stem 7 to the dome 1) of 130 mm. The mount height is measured from the base of the stem 7 to the center of the discharge device 11. The lamps for which data is reported in Table I had a discharge device 41.8 mm in length, with an arc length of about 21 mm.

In the case of very wide flood lamps the HPS discharge device 10 is relatively closer to the dome end of the lamp envelope 1. This results in the lamp voltage being strongly dependent upon the orientation of the lamp during operation. When the lamp is operated in a base-up orientation the cooler end of the discharge device 10 will be at the dome end of the discharge envelope. Consequently, the sodium amalgam within the discharge device will condense at that end. On the other hand, when the lamp is operated in a base-down orientation the colder end of the discharge device will be at the bas end of the discharge device 10 and that is where the sodium amalgam will condense.

In the base-up orientation, the lamp voltage will too high because of excessive reflected heat back onto the end of the discharge device which elevates the discharge device temperature. It was found that for the 70 watt lamp, the lamp voltage was 49.6 volts in the base-down orientation and 62.6 volts in the base-up orientation. The discharge device may be made unsymmetrical in order to eliminate the lamp voltage sensitivity to lamp operating position.

Fig. 4 illustrates an HPS reflector lamp having a discharge device 10′ with a heat reflector 35 at its end closest to the lamp base. The heat reflector is effective for reflecting internally generated heat back into the discharge device 10′ and maintaining the end of the discharge device 10′ with the heat reflector 35 at a higher temperature. Those elements of the lamp shown in Fig. 4, which correspond to the elements of the lamp shown in Fig. 1 have the same reference numerals.

An alternative to the use of a heat reflector is the asymmetrical discharge device 10″ shown in Fig. 5. A pair of discharge electrodes 36, 37 are mounted internally at the ends of connectors 12 and 13, respectively. The distance from an electrode tip to an end wall of the discharge device 10 affects the end temperature of the discharge device; the shorter the distance the higher the temperature. A discharge device 10″ with an electrode tip to end wall distance for the electrode 36 of 7.75 millimeters and the tip to wall dimension for the electrode 37 of 7.25 millimeters was used in a reflector lamp with an RL-38 outer envelope. As shown in Table II, the 0.5 millimeter shorter distance reduced the variation in operating voltage to less than one volt.

TABLE II

Electrode configuration	lamp voltage base down	lamp voltage base up	Δv
asymmetrical	48.4	49.2	0.8
symmetrical	49.6	62.6	13.0

An asymmetrical discharge device can also be realized with equal electrode tip to end wall distances for both electrodes but with end walls of different thicknesses. The thicker end wall will dissipate more heat than the thinner end wall and thus operate at a lower temperature than the thinner end wall. By making the discharge device end wall that is closer to the envelope dome thicker than the more distant end wall, the heat reflected back from the envelope dome will be dissipated and the sensitivity of lamp operating voltage to position will be diminished.

Another approach to preventing electrical breakdown between the internal support conductors is to provide a circuit path within the lamp that will become conductive before unintentional breakdown occurs. The lamp shown in Fig. 6 includes an HPS discharge device 50 mounted within a lamp envelope by support conductors 51, 52 in the manner previously described. A voltage across the conductors 51, 52 is the voltage which is applied to the discharge device 50 for operating it. The lamp outer envelope contains the rare gas argon at a pressure of the order of 700 torr.

A switching device 60 is incorporated in the lamp to define a circuit path having a selected breakdown voltage which is lower than the breakdown voltage between the conductors 51 and 52. The circuit path is isolated from the argon atmosphere in the lamp envelope and has a normally high impedance. When the voltage between the support conductors 51 and 52 exceeds a certain threshold voltage a low impedance circuit path is established between the conductors 51, 52 through the switching device 60.

The switching device 60 is a spark gap device comprised of a non-conductive cylindrical wall 61 and conductive end closures 62, 63 and having an internal chamber. Internal electrodes 64, 65 are each mounted on a respective one of the conductive end closures 62, 63. Lead 66 extends from the conductive end closure 62, and lead 67 extends from the conductive end closure 63. The leads 66 and 67 are each connected to a respective one of the conductors 52, 51 so that the potential applied across the discharge device 50 is also applied across the spark gap device 60. The chamber of the spark gap device 60 has a gas fill selected to establish a particular breakdown voltage.

The voltage difference between the conductors 51 and 52 is applied through the leads 66 and 67 to the respective conductive end closures 62 and 63. Consequently, the voltage difference between the conductors 51 and 52 exists between the internal electrodes 64, 65. When that voltage difference exceeds the selected breakdown voltage of the spark gap device 60, the gas fill within the spark gap device 60 ionizes and a discharge or spark occurs between the internal electrodes 64 and 65. The spark gap device 60 has a low impedance and is conductive, and the voltage difference between the conductors 51 and 52 is short circuited before breakdown of the argon fill gas within the lamp outer envelope can occur.

When the voltage between the conductors 51 and 52 decreases below the switching device threshold voltage, the discharge through the gas fill within the device 60 stops and its impedance increases to the normal high impedance value. The switching device 60 is a self-restoring device and can be repeatedly switched to its low impedance conductive state and each time it will return to its high impedance condition after the applied voltage decreases below its threshold voltage.

Fig. 7 illustrates a reflector lamp having a discharge switching device like that incorporated in the lamp of Fig. 6. The controlled and isolated discharge path provided by the switching device is particularly advantageous in a reflector lamp. The reflector lamp includes a reflective layer such as metallic aluminum which is conductive. The metallic reflective layer can provide part of a breakdown path between the conductors 51 and 52. For example, an electrical breakdown could occur through the argon fill gas between the conductor 51 and the reflective layer, and between the reflective layer and the conductor 52. The metallic conductive layer would thus provide part of the breakdown path between the conductors.

Fig. 8 illustrates the relationship among the various voltage magnitudes which define the modes of operation of the invention. The starting voltage V_s of the discharge device 10 is typically around 2500 volts for a high pressure sodium lamp; the 70 watt discharge device used in the lamps made and discussed herein have a starting voltage of less than 1800 volts. The maximum voltage V_{max} that the lamp should withstand is nominally 4,000 volts. The controlled breakdown voltage V_c of the spark gap device is selected to have a value between V_s and V_{max}.

Both V_s and V_{max} change as the temperature of the lamp increases during lamp operation. As the lamp heats, the breakdown voltage of the argon gas within the lamp outer envelope decreases. This was an unexpected result because the breakdown voltage should have been independent of pressure at the constant gas density expected in a sealed lamp. The decrease in breakdown voltage was measured in a lamp having an outer envelope filled with argon at 700 torr and a stem like that shown in Fig. 2 but without the glass sleeve 33. At the lamp operating temperature, the internal breakdown voltage will decrease by about 500 volts to 3500 volts. At the same time, the internal pressure of the sodium vapor within the discharge device 10 increases substantially and the starting voltage increases. In fact, the starting voltage may inorease to a value greater than the controlled breakdown voltage V_c of the arc gap device. The breakdown voltage V_c must therefore be selected less than the lowered maximum voltage V_{max} that the lamp can withstand, but it should be higher than V_s so that the lamp can be restarted without having to first cool down completely. A good nominal value for V_c is around 3,000 volts.

The use of the switching device 60 is not limited to reflector lamps. It can also be applied to high pressure sodium lamps having conventional envelopes but which have a rate gas fill rather than a high vacuum. Such lamps might use the rare gas to limit discharge device material evaporation as discussed above. The problem of internal electrical breakdown through the rare gas could also be solved with the switching device as it is in reflector lamps.

Claims

1. In a high pressure sodium discharge reflector lamp, comprising a sealed outer lamp envelope having a reentrant stem and an axis of symmetry through said stem and defining a lamp centerline, a high pressure sodium discharge device comprising an elongate body having a pair of terminals each extending from a respective end of said elongate body for receiving thereacross an electrical potential to energize said discharge device to emit light, and mounting means for mounting said discharge device within said sealed envelope on the lamp centerline and for defining a conductive circuit to said pair of terminals to permit energization of said discharge device, the lamp further having the features;
said sealed outer envelope containing a quantity of rare gas such that the pressure of said rare gas is approximately one atmosphere when the lamp is at its operating temperature; and
said mounting means comprising a pair of upstanding support conductors extending from said stem, one shorter and one longer than the other, and extending generally parallel to said lamp axis, transverse conductive links connected between said support conductors and said discharge device terminals for mounting said discharge device on the lamp centerline and establishing a conductive path for energizing said discharge device, and means for establishing a relative high electrical breakdown voltage between said pair of support conductors to avoid electrical breakdown through said rare gas in said outer envelope when said discharge device is energized during lamp operation.

2. In a high pressure sodium discharge lamp according to Claim 1, one of said support conductors comprising a straight length of wire extending from said stem, and said means for establishing the relative high electrical breakdown voltage comprising a sleeve of non-conductive material covering a substantial length of said one support conductor.

3. In a high pressure sodium discharge lamp according to Claim 2, wherein said sleeve of non-conductive material is a glass sleeve to said stem and extending from said stem with said one support conductor extending through said sleeve and into said stem.

4. In a high pressure sodium discharge lamp according to Claim 1, said transverse conductive links are each comprised of a length of wire having a circular cross and respective end portions wound substantially around one of said terminals and one of said support conductors for defining a connecting link free of protrusions and mounting said discharge device on said support conductors.

5. In a high pressure sodium discharge lamp having an outer envelope, a high pressure sodium discharge device disposed in said outer envelope, and mounting means for mounting said discharge device within said outer envelope and for defining a conductive circuit to said discharge device to permit energization of said discharge device, comprising:
a metallic reflective layer disposed on a portion of said outer envelope for reflecting and imparting directivity to light emitted from said discharge device;
a rare gas atmosphere within said outer envelope having a fill pressure at room temperature of the order of one atmosphere; and
said mounting means having first and second conductors which define said conductive circuit to said discharge device, a first of said conductors to said discharge device, and a second of said conductors following a non-linear path spaced from said first conductor for establishing an electrical breakdown voltage

through said rare gas atmosphere between said conductors above a certain value and spaced from said reflective layer for establishing the electrical breakdown voltage through said rare gas atmosphere between said second conductor and said reflective layer above said certain value.

6. A high pressure sodium discharge lamp according to one or more of the preceding Claims, characterized in that the lamp incorporates means in the outer envelope connected across the conductors and exhibiting a high impedance below a certain applied voltage and a low impedance above said certain applied voltage.

7. A high pressure sodium discharge lamp according to Claim 6, characterized in that the said means comprise a self-restoring threshold switch for establishing a low impedance circuit path between the conductors when the voltage between the conductors exceeds the threshold voltage of the threshold switch, the threshold voltage being greater than the starting voltage of the discharge device and being less than the breakdown voltage of the inert fill gas between the conductors.

8. A high pressure sodium discharge lamp according to any of the foregoing Claims, characterized in that the lamp comprises thermal control means for controlling the relative thermal dissipation of said ends of said discharge device for rendering the operating voltage thereof insensitive to the orientation of the lamp during lamp operation.

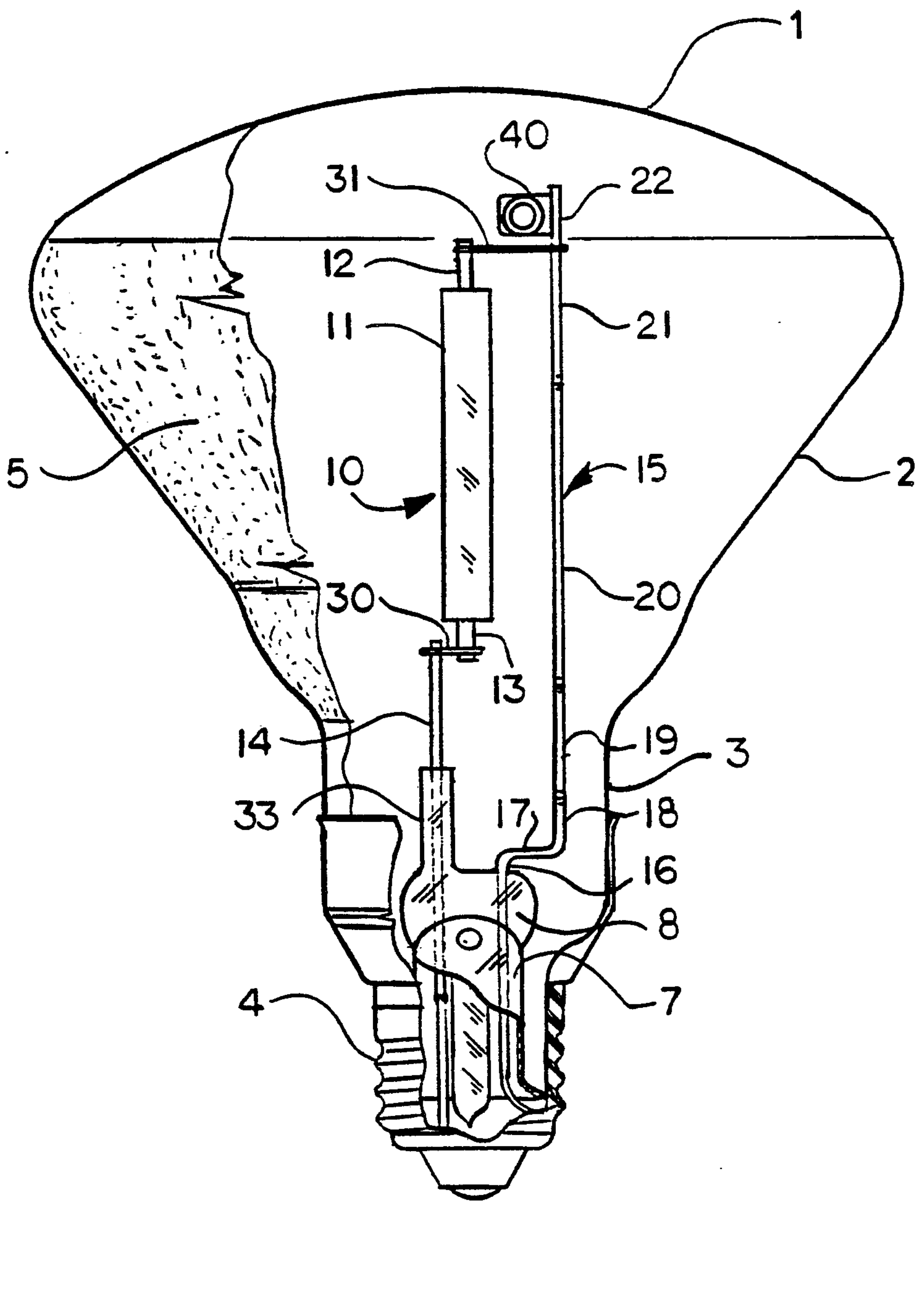

FIG.1

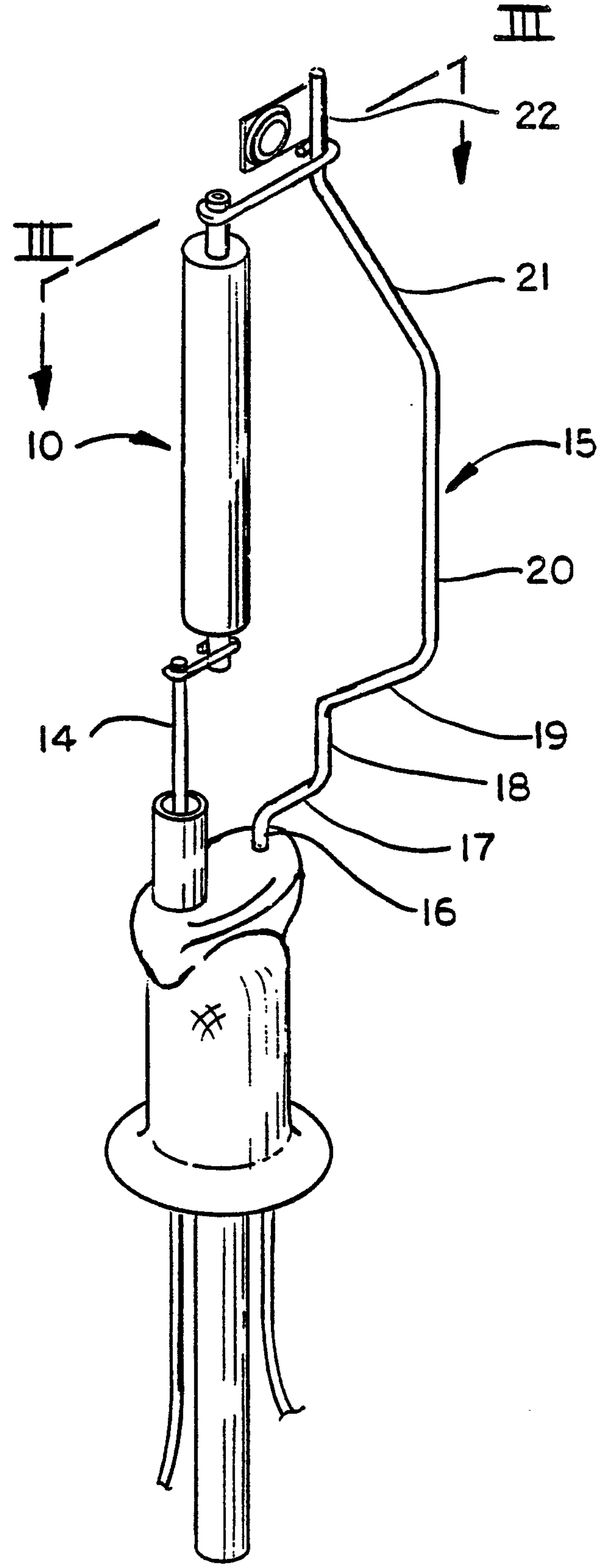

FIG. 2

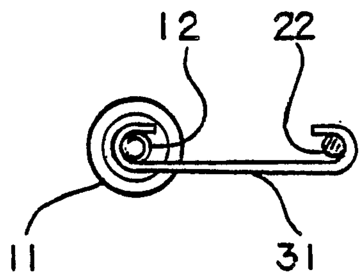

FIG. 3

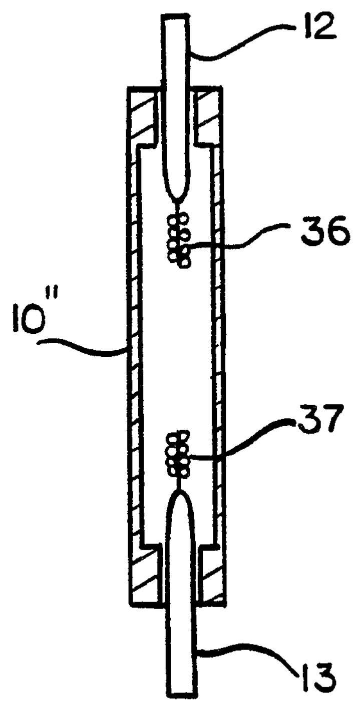

FIG. 5

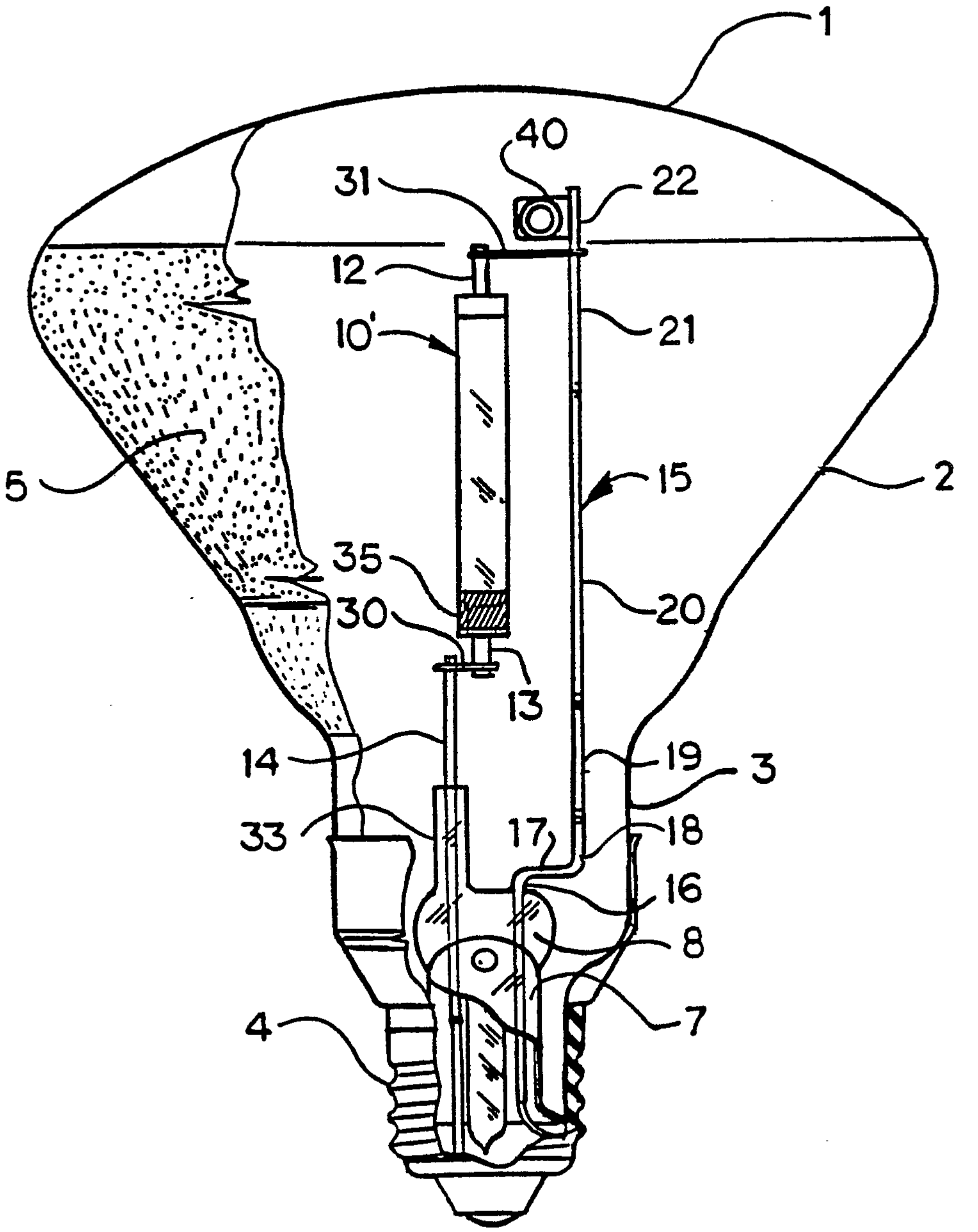

FIG. 4

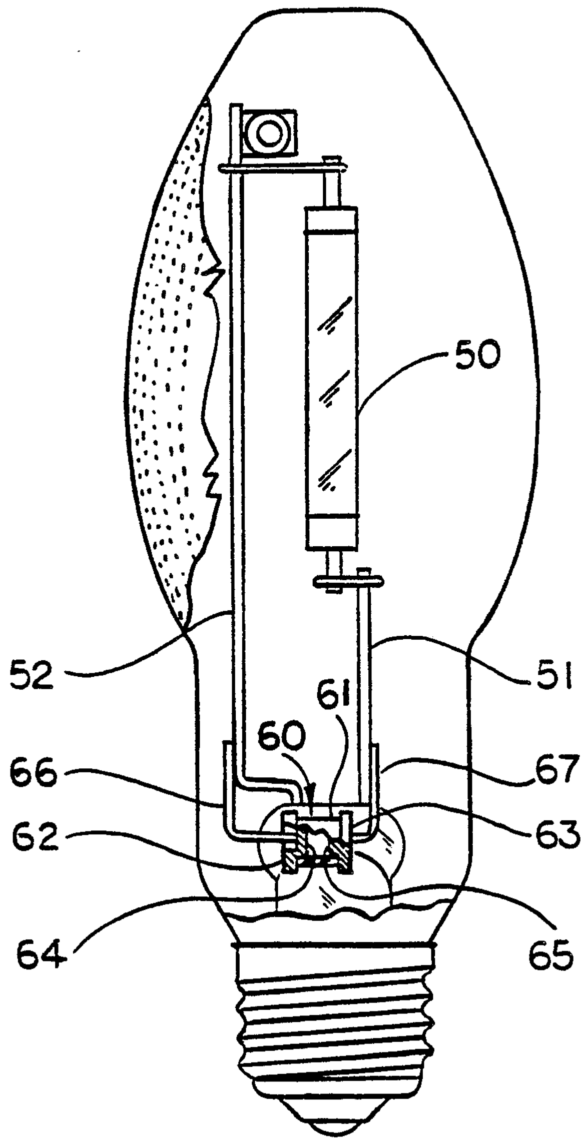

FIG. 6

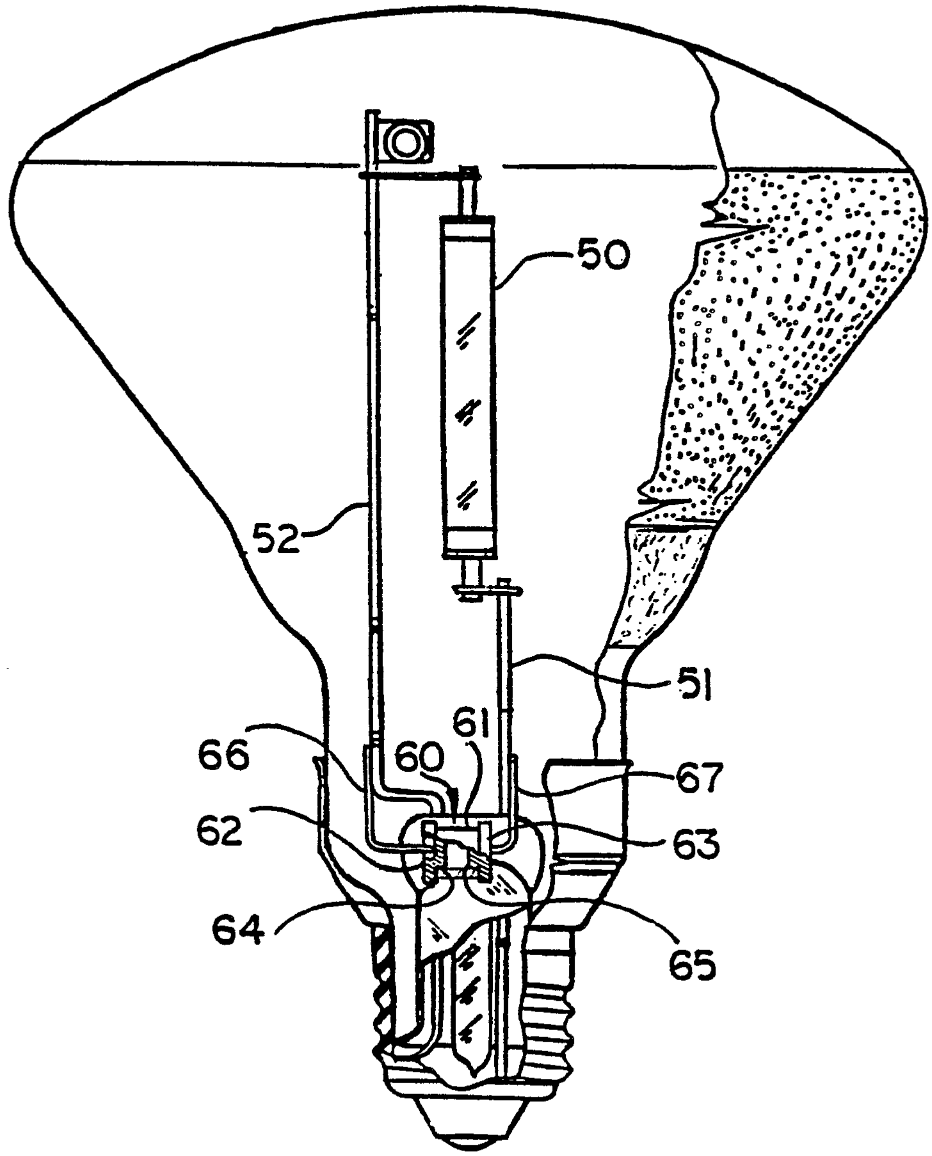

FIG.7

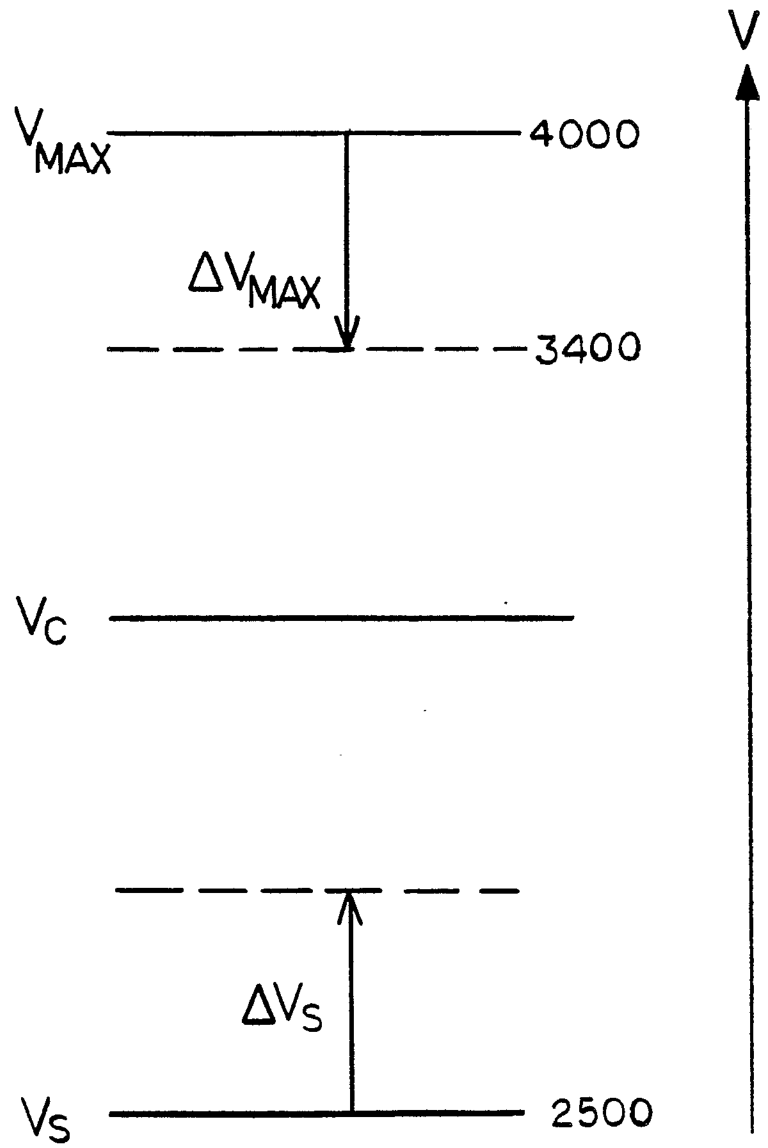

FIG. 8

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 89201603.1

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y,A	US - A - 4 677 343 (HICK) * Fig. 1,2; column 1, line 43 - column 2, line 10; column 2, line 67 - column 3, line 4 *	1	H 01 J 5/48 H 01 J 7/44 H 01 J 61/56 H 01 J 61/22
Y	PATENT ABSTRACTS OF JAPAN, unexamined applications, E field, vol. 7, no. 276, December 9, 1983 THE PATENT OFFICE JAPANESE GOVERNMENT, page 54 E 215 * Kokai-no. 58-155 641 (TOKYO SHIBAURA DENKI) *	1	
X		5	
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			H 01 J 61/00 H 01 J 5/00 H 01 J 7/00 H 01 J 9/00 H 01 J 17/00
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	18-09-1989	BRUNNER

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
	GOVERNMENT, page 4 E 80 * Kokai-no. 56-97 960 (MITSU-BISHI DENKI) * ----		
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)

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