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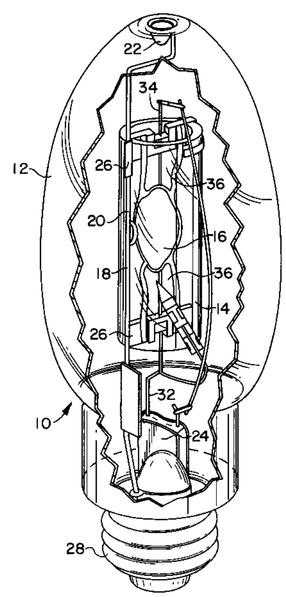
(54) **Metal halide arc lamp having glass containment shroud.**

(57) A double-enveloped lamp assembly (10) includes a light-source capsule (16), which is substantially surrounded by a light-transmissive shroud (14) made of glass, preferably aluminosilicate glass. In a preferred embodiment, the lamp assembly (10) is a metal halide arc discharge lamp, and the shroud (14) is a cylindrical, open-ended tube. For metal halide lamps having a power rating of 150 watts or less, the shroud (14) preferably has a wall thickness of one millimeter. The thin wall glass shroud meets or exceeds containment performance requirements.



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Field of the Invention

This invention relates to electric lamps wherein a light-source capsule is mounted within an outer envelope and, more particularly, to a glass shroud for containing fragments of the light-source capsule in the event that the capsule bursts.

Background of Invention

Double-enveloped lamps, such as metal halide arc lamps, include a light-source capsule, such as an arc tube, and a sealed outer envelope surrounding the light-source capsule. The arc tube typically operates at high temperature and high pressure. In such lamps, there is a small probability that the light-source capsule will burst. When this occurs, hot fragments of fused quartz from the arc tube are forceably propelled against the outer envelope. If the outer envelope also shatters, there is a potential safety hazard to persons or property in the immediate surroundings. A failure of the outer envelope is known as a containment failure.

United States Patent No. 5,122,706, issued June 16, 1992 to Parrott et al., discloses a metal halide arc lamp wherein a generally cylindrical fused quartz shroud encircles an arc tube. Typically, the shroud is made of fused quartz and is at least about 2.0 mm (0.098 inches) thick. The shroud may be open at both ends, or may be open at one end and have a domed configuration at the other end. The shroud is typically mounted within the lamp by clips or straps attached to a frame member. Fused quartz has been used to fabricate prior art shrouds because it is a reliable material which has a very low water content and is resistant to high operating temperatures. Furthermore, the arc tube which the shroud surrounds is usually fused quartz.

Shrouds for metal halide arc discharge lamps are also disclosed in U.S. Patent Nos. 5,023,505, issued June 11, 1991 to Ratliff et al.; 4,812,714, issued March 14, 1989 to Keeffe et al.; 4,888,517, issued December 19, 1989 to Keeffe et al.; 4,791,334, issued December 13, 1988 to Keeffe et al.; 4,721,876, issued January 26, 1988 to White et al.; 4,709,184, issued November 24, 1987 to Keeffe et al.; 4,625,141, issued November 25, 1986 to Keeffe et al.; 4,620,125, issued October 28, 1986 to Keeffe et al.; and 4,499,396, issued February 12, 1985 to Fohl et al. It is also known to reinforce a shroud by using a mesh of substantially non-conducting fiber, as disclosed in U.S. Patent No. 4,942,330, issued July 17, 1990 to Karlotski et al.

In addition to containment, the shroud has other beneficial effects on lamp operation. In lamps with a gas filled outer envelope, the shroud reduces convective heat losses from the arc tube and thereby improves the luminous output and the color temperature of the lamp. In lamps with an evacuated outer envelope, the shroud helps to equalize the temperature of the arc tube.

It would be desirable to replace the fused quartz shroud with a different material which could be easily manufactured, which would provide the benefits of a fused quartz shroud, but which would require less material.

Accordingly, it is an object of the present invention to provide an improved shroud for containing an arc tube in the event that the arc tube bursts.

It is another object of the present invention to provide a shroud which is lighter in weight than the fused quartz shroud, but which will contain fragments of a burst light-source capsule.

Summary of the Invention

Accordingly, these and other objects and advantages are achieved in a double-enveloped lamp assembly which includes a light-source capsule enclosed in a sealed, light-transmissive outer envelope. A containment means is mounted within the outer envelope and substantially surrounds the light-source capsule. The containment means comprises a shroud made of a glass which has a strain point greater than the operating temperature of the shroud. The strain point is defined as the temperature at which stress in the glass is substantially removed in about four hours when the glass is maintained at that temperature.

The lamp assembly is typically a metal halide arc lamp, and the light-source capsule comprises a metal halide arc tube. The glass is preferably an aluminosilicate glass which has a strain point of about 600°C or greater. The aluminosilicate glass preferably has a low water content in order to minimize outgassing of water vapor when the lamp is at operating temperature. The shroud preferably comprises an open-ended cylindrical tube, and for lamps with a power rating of about 150 watts or less, the wall thickness is about 1 mm.

Brief Description of the Drawing

For a better understanding of the present invention together with other and further objects, advantages, and capabilities thereof, reference is made to the accompanying drawing which is incorporated herein by reference and which is a partially cut-away, side view of a double-enveloped lamp assembly according to the present invention.

Description of the Preferred Embodiments

A metal halide arc discharge lamp 10 is shown in the drawing. A sealed outer envelope 12 (also called an outer jacket) encloses a generally cylindrical shroud 14. The shroud 14 surrounds an arc tube 16 which encloses two electrodes (not shown) and a fill material for supporting an arc discharge. Suitable fill materials are well known to those skilled in the art. Each electrode is coupled through a press seal 36 that hermetically seals the arc tube 16. Electrical energy is coupled from a lamp base 28 through a lamp stem 24 and electrical leads 32 and 34 to the electrodes in the arc tube 16.

A mounting assembly 18 mechanically supports the arc tube 16 and the shroud 14. The assembly 18 includes a support rod 20 which is coupled to the stem 24 and to a dimple 22 in the upper end of the envelope 12. The rod 20 is coupled to the shroud 14 with a pair of clips 26. The structure of the lamp is described in more detail in U.S. Patent No. 5,122,706 which is hereby incorporated by reference. In that patent, the shroud is fabricated of fused quartz and has a thickness of 2.0 mm or 2.5 mm, depending on the embodiment.

The shroud 14 according to the present invention is made of glass, preferably an aluminosilicate glass. Corning 1724 is generally preferred, but other glasses such as GE 177, GE 179, GE 180, Schott 8252, or Schott 8253 can be used. The shroud 14 is typically formed as a cylindrical tube open at both ends. In other embodiments, the shroud is closed at one end by a dome shaped portion. The glass shroud preferably has a wall thickness of 2 mm or less, and in a preferred embodiment has a wall thickness of 1 mm (0.039 inches) when it is used in metal halide arc lamps in a range of 75 watts to 150 watts. The glass shroud has the ability to contain fragments of the arc tube, if it bursts, at least as well as a fused quartz shroud with a substantially thicker wall. In the preferred embodiment for metal halide lamps in the above wattage range, the shroud has an inner diameter of 20 mm and an outer diameter of 22 mm, and the length of the shroud ranges from about 46 mm to 56 mm. Other lengths and wall thicknesses can be used in different lamps.

The aluminosilicate glass shroud material preferably has a $Si0_2$ content of 57% to 63%, and an Al_20_3 content of 14% to 17%. The remainder can include one or more of the following compounds in differing quantities: B_2O_3, Mg0, Ca0, Ba0, Sr0, $Zr0_2$, Sb_20_3, and P_20_5; and may include certain impurities.

A suitable glass should have a strain point which is greater than the temperature of the shroud when the lamp is operating. The strain point, which is defined by the American Society for Testing of Materials standard terminology of glass and glass products (C162), is the temperature at which a stress, such as tension or compression, can be substantially relieved in a matter of hours. Typically, the shroud temperature is about 500°C during operation. Assuming a 100°C safety margin, the strain point should be at least 600°C. The safety margin is maintained to insure that the strain pattern in the shroud does not change with lamp operating life. The glass should also have high resistivity to maintain an electrical charge on the shroud. The charge inhibits sodium loss from the arc tube.

The glass should be dry (have a low water content) so that there is minimal outgassing of water vapor and other gasses, when the lamp is at operating temperature. A measure of the water content is known as beta, which is a measure of the infrared absorption of light in the material due to structurally bonded water. Beta is commonly measured at the absorption peak found at 2.7 - 2.9 microns, and is normalized to a 1 mm path length. Consequently, beta values are expressed in mm^{-1}. A lower value of the beta indicates that a glass is dryer than another glass with a higher beta. The specified measurement wavelength varies for different types of materials, so the beta for an aluminosilicate glass is not directly comparable to the beta for fused quartz. The preferred Corning 1724 glass has a beta of 0.31 mm^{-1}. Other types of glass have a lower beta, e.g., the beta for GE 180 is 0.22 mm^{-1}. In general, the value of beta for the glass shroud is preferably less than about 0.4 mm^{-1}.

Referring to Table I below, containment tests were performed on glass and fused quartz shrouds and the results were compared. The test was similar to the Underwriters Laboratories Standard UL1572-57A, which describes containment criteria for a fixture. In these tests, a 100 watt metal halide arc lamp with a Corning 1724 glass shroud was mounted in a ceramic socket rated for 400 V pulses. A layer of dry, absorbent cotton was positioned about twelve inches below the lamp. The arc tube was exploded by charging a 30 microfarad capacitor connected to the arc tube to between 1500 and 2000 volts. If the cotton was scorched or if it was ignited by the fragments when the arc tube capsule exploded, the result was considered a containment failure.

TABLE I

0.098" walled Fused Quartz (2.5 mm)		
	Percentage	Quantity
Contained, with no outer jacket cracks	65%	88
Contained, with cracked outer jacket	30%	40
Contained, with small hole in outer jacket	5%	7
Did Not Contain	0%	0
0.039" walled Fused Quartz (1.0 mm)		
Contained, with no outer jacket cracks	23%	12
Contained, with cracked outer jacket	42%	22
Contained, with small hole in outer jacket	8%	4
Did Not Contain	27%	14
0.079" Aluminosilicate Glass (2.0 mm)		
Contained, with no outer jacket cracks	91%	29
Contained, with cracked outer jacket	9%	3
Contained, with small hole in outer jacket	0%	0
Did Not Contain	0%	0
0.049" Aluminosilicate Glass (1.25 mm)		
Contained, with no outer jacket cracks	71%	20
Contained, with cracked outer jacket	29%	8
Contained, with small hole in outer jacket	0%	0
Did Not Contain	0%	0
0.039" Aluminosilicate Glass (1.0 mm)		
Contained, with no outer jacket cracks	71%	52
Contained, with cracked outer jacket	29%	21
Contained, with small hole in outer jacket	0%	0
Did Not Contain	0%	0

The 2.5 mm fused quartz shrouds contained in every instance, but in a number of cases, a small hole was formed in the envelope. The 1.0 mm fused quartz shroud did not contain in 27% of the cases -- an unacceptable result. A surprising result was that the aluminosilicate glass shrouds with thicknesses of 2.0 mm, 1.25 mm, and 1.0 mm contained in every instance. In no case was even a small hole formed in the outer envelope.

Referring to Table II below, fused quartz shrouds and glass (Corning 1724) shrouds were tested and compared for impact resistance. The test shroud was clamped against a wall. A weighted pendulum was raised to a specified angle above the sample and was dropped so that the weight would strike the shroud at about the middle of its length. If the sample did not break, the pendulum was raised by an additional 5° and was dropped again. The angle was increased until the sample shattered. Note that the angles are relative and are measured by the pendulum device, and are not absolute with respect to a horizontal or vertical plane. As shown in Table II, the 1.0 mm fused quartz shrouds required pendulum angles of 60° and 75° to shatter, while the glass shrouds with the same thickness required pendulum angles of 115° and 85° to shatter. This test demonstrates that the aluminosilicate glass is more impact resistant than the fused quartz of the same thickness. Since the aluminosilicate glass is more impact resistant, less material can be used in the shroud.

TABLE II

0.039" Fused Quartz Tube	
Sample #1 required Sample #2 required	60° to shatter* 75° to shatter*
0.039" Aluminosilicate Glass Tube	
Sample #1 required Sample #2 required	115° to shatter* 85° to shatter*
0.049" Aluminosilicate Glass Tube	
Sample #1 required Sample #2 required	145° to shatter* 175° to shatter*

*The angle, in degrees, is not the angle above horizontal, but is the angle recorded from the impact device.

Other types of glass may also be used to fabricate the shroud. For example, a heat treated, dry glass, such as VYCOR (available from Corning) can be used. This glass contains about 96% $Si0_2$, the remainder including boron, alumina, and alkali. It has a strain point of about 890°C and a beta which is less than 0.4.

By using conventionally melted glass instead of fused quartz to manufacture the shroud, the amount of material, the weight, and the cost are all reduced without reducing containment performance. The tests described above show that a glass shroud contains as well as a fused quartz shroud having a wall thickness that is two and one half times greater. The lighter weight of the glass shroud reduces shipping costs and potential damage during shipment and handling.

While there have been shown and described what are at present considered the preferred embodiments of the present invention, it will be obvious to those skilled in the art that various changes and modification may be made therein without departing from the scope of the invention as defined by the appended claims.

Claims

1. A metal halide arc lamp assembly comprising:
a sealed, light-transmissive outer envelope;
a metal halide arc tube mounted within the outer envelope;
a light-transmissive aluminosilicate glass shroud mounted within the outer envelope and substantially surrounding said arc tube; and
means for supplying electrical energy to said arc tube.

2. A metal halide arc lamp assembly as defined in claim 1 wherein said glass shroud has a strain point temperature greater than the operating temperature of said glass shroud in said lamp assembly.

3. A metal halide arc lamp assembly as defined in claim 2 wherein said glass shroud has a low water content.

4. A metal halide arc lamp assembly as defined in claim 1 wherein said arc tube has a power rating of 150 watts or less, and said glass shroud has a wall thickness of about 1 mm.

5. A metal halide arc lamp assembly as defined in claim 4 wherein said glass shroud comprises an open-ended, cylindrical tube.

6. A metal halide arc lamp assembly as defined in claim 1 wherein said glass shroud is selected to have a strain point temperature of about 600°C or greater.

7. A double-enveloped lamp assembly comprising:
a sealed, light-transmissive outer envelope;
a light-source capsule mounted within the outer envelope;
containment means, mounted within the outer envelope and substantially surrounding said light-

source capsule, for containing fragments of the light-source capsule in the event that the light-source capsule bursts, said containment means comprising a shroud fabricated of a glass having a strain point temperature that is greater than the operating temperature of the shroud in said lamp assembly; and
means for supplying electrical energy to said light-source capsule.

8. A double-enveloped lamp assembly as defined in claim 7 wherein said shroud is fabricated of an aluminosilicate glass.

9. A double-enveloped lamp assembly as defined in claim 7 wherein said glass shroud has a low water content.

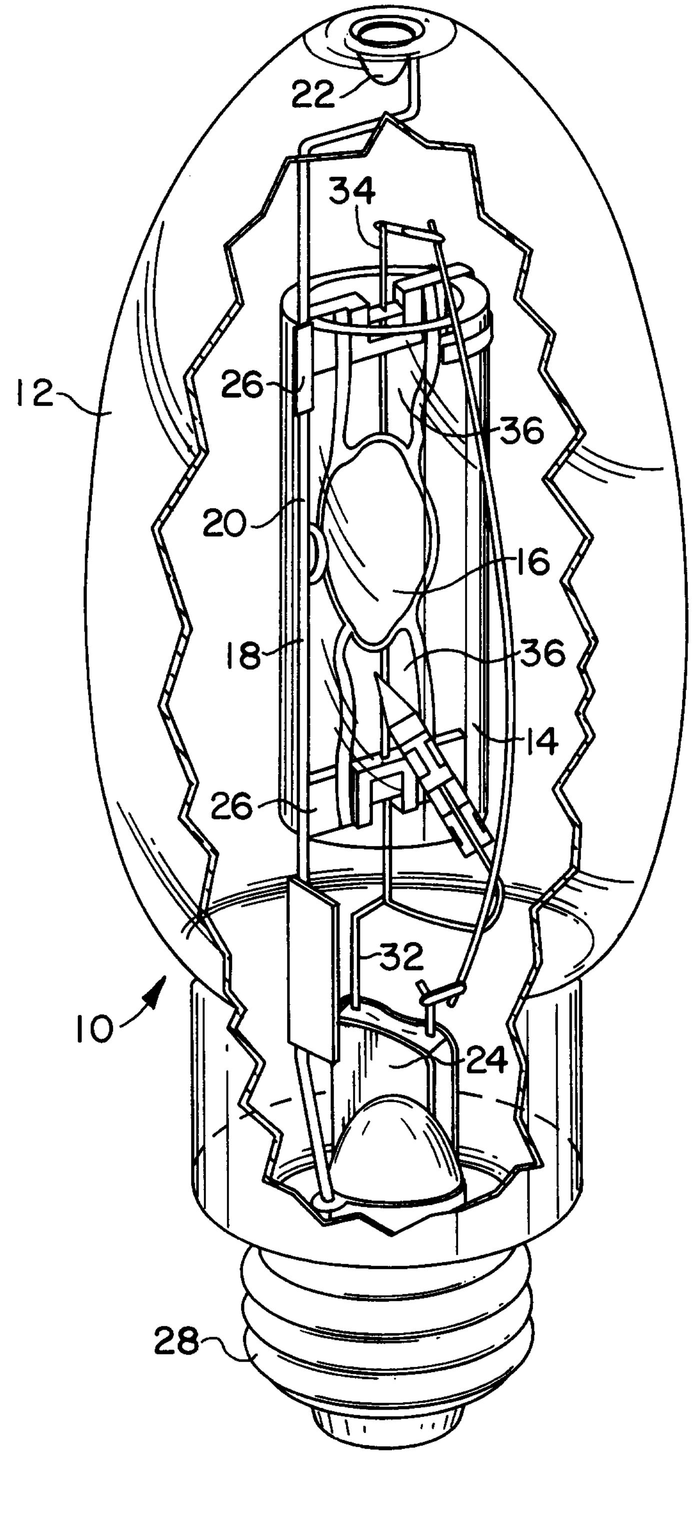
10. A double-enveloped lamp assembly as defined in claim 7 wherein said light-source capsule has a power rating of 150 watts or less, and said glass shroud has a wall thickness of about 1 mm.

11. A double-enveloped lamp assembly as defined in claim 10 wherein said glass shroud comprises an open-ended, cylindrical tube.

12. A double-enveloped lamp assembly as defined in claim 7 wherein said glass shroud is selected to have a strain point temperature of about 600 °C or greater.

13. A double-enveloped lamp assembly as defined in claim 11 wherein said light-source capsule comprises a metal halide arc tube.

14. A double-enveloped lamp assembly as defined in claim 12 wherein said glass comprises a borosilicate glass containing about 96% SiO_2 with the remainder including at least one of boron, alumina, and alkali.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EUROPEAN SEARCH REPORT

Application Number
EP 94 10 4328

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.5)
X Y A	EP-A-0 416 705 (N.V. PHILIPS' GLOEILAMPENFABRIEKEN) * abstract * * page 2, line 43 - line 45 * * page 2, line 52 - page 3, line 4 * * page 3, line 21 - line 23 *	1 1,2,6-9, 12,14 5,11,13	H01J61/50 H01J61/04 H01J61/34 H01J61/82
Y	EP-A-0 019 850 (TOKYO SHIBAURA DENKI KABUSHIKI KAISHA) * abstract * * page 3, line 17 - line 23 * * page 5, line 25 - line 29 *	1,2,6-8, 12	
Y A	EP-A-0 181 690 (CORNING GLASS WORKS) * page 1, line 16 - line 28 * * page 2, last paragraph * * page 3, line 30 - page 4, line 1 * * page 4, line 8 - line 12 *	7,9,12, 14 2,3,6	TECHNICAL FIELDS SEARCHED (Int.Cl.5) H01J
D,A	EP-A-0 173 235 (GTE PRODUCTS CORPORATION) * claim 4 *	1,4,5,7, 10,11,13	
D,A	EP-A-0 361 530 (GTE PRODUCTS CORPORATION) * page 4, line 8 - line 9 *	1,4,5,7, 10,11,13	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 June 1994	Martín Vicente, M

CATEGORY OF CITED DOCUMENTS

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