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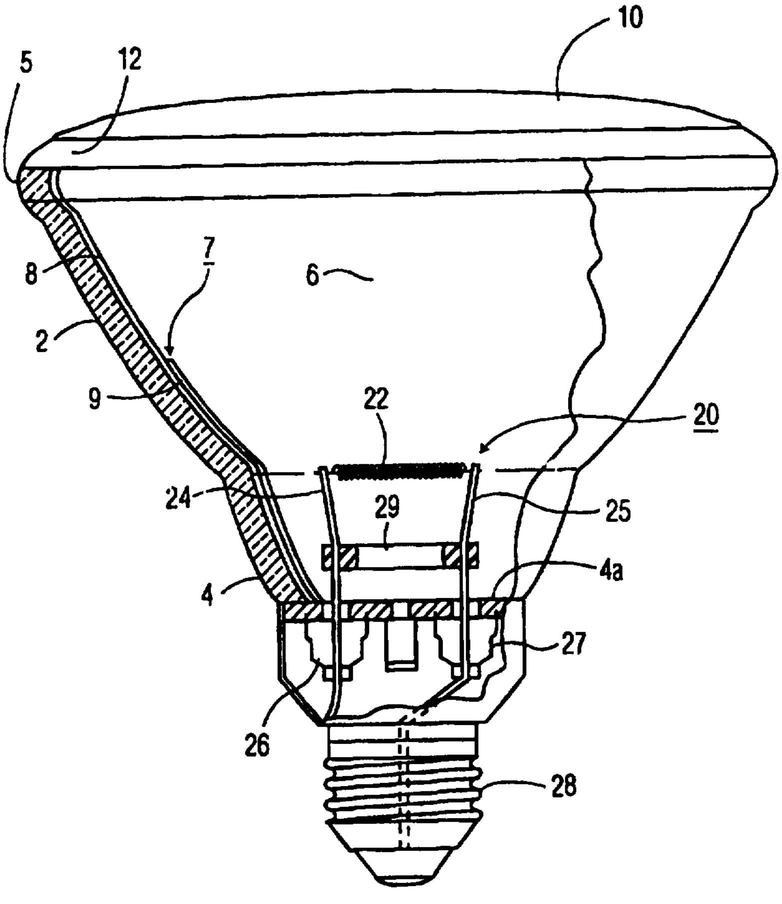
(54) Title: REFLECTOR LAMP

(57) Abstract

A reflector lamp having a lens (10) of vitreous material secured to a reflector body (2) of vitreous material. An inner reflector surface (6) of the reflector body (2) includes a reflective coating (7) having a first coating portion (8) extending from the rim (5) of the reflector body (2) and a second coating portion (9) extending from a location spaced from the rim (5) towards a basal end (4a) of the reflector body. The second coating portion (9) is a layer of heat-treated silver having a uniform, whitish non-metallic appearance and being diffusely reflective. The first coating portion is a layer of material other than silver, such as aluminum, having a high resistance to damage by high heat.



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Reflector lamp

The invention relates to a reflector lamp comprising

- a reflector body of vitreous material having a longitudinal axis, a basal portion, a rim which defines a light-emitting opening of said reflector body, and an inner reflector surface which extends from the basal portion to the rim of the reflector,
- a lens of vitreous material secured to said rim,
- a light source arranged within said reflector body, and
- a reflective coating on said inner reflector surface,

the reflective coating comprising a first coating portion extending from said rim towards said basal portion and a second coating portion which extends from an axial position spaced from said rim to said basal portion, and the second coating portion comprising silver and the first coating portion consisting essentially of a material other than silver.

Such a lamp is described in the patent application of earlier date WO 96/08035-A1.

In reflector lamps which are currently on the market, so called PAR-lamps, and which are known from e.g. US-A-3,010,045, the reflective coating consists of aluminum and the light source is typically an incandescent filament or halogen capsule, i.e. an envelope having an incandescent body and a halogen containing gas therein. The lens and the reflector body are typically a borosilicate hard glass and are generally fused to each other using a flame sealing process. As used herein, "fused" refers to a sealed joint between the reflector body and the lens in which the vitreous material of each part is fused to the other by a high temperature process such a flame sealing. Alternatively, for example, a joint where the two parts are bonded together with an adhesive, such as epoxy, also, gas-tight seals using a glass frit may be made.

As part of a worldwide movement towards more energy efficient lighting, recent government legislation in the United States (commonly referred to as the national Energy Policy Act "EPACT") has mandated lamp efficacy values for many types of commonly used lamps including PAR lamps. These minimum efficacy values will become effective in 1995 and only products meeting these efficacy levels will be allowed to be sold in the United States. The efficacy values for PAR-38 incandescent lamps have been established for various wattage ranges. For example, lamps of 51-66 W must achieve 11 lumens per Watt, lamps of 67-85 W must achieve 12.5 lm/W, lamps of 86-115 W must achieve 14 lm/W and lamps in the range of 116-155 W must achieve 14.5 lm/W.

PAR 38 lamps currently on the market with a reflective coating of aluminum and an incandescent filament have efficacies which will fail to meet the EPACT minimum efficacy standards. For example, the typical 150 W PAR 38 lamp provides only about 10-12 lm/W (initial) and a 2000 hour life. It is possible to design a filament for a convential aluminized reflector body which would meet the EPACT standards. However, such a filament would result in a greatly reduced lamp life (on the order of, for example, 800-1200 hours) which would not be commercially acceptable in view of the 1800-2000 hour lamp lives now available in conventional PAR lamps.

In the lamp described in the opening paragraph a second coating is present which comprises silver, because of the reflectivity of silver being higher than that of aluminium. However, the second coating is confined to an area of the reflector inner surface which is away from the rim of the reflector, because a silver coating near the rim would become considerably damaged during the heating stages used to connect the lenses to the reflector body. The damaged coating has a greatly reduced reflectivity, is a source of light scattering, and is cosmetically unsightly for consumers because it can be seen from the exterior of the reflector through the lens.

The higher reflectivity of silver is employed in the lamp of the opening paragraph to enhance luminous efficacy by using it in the critical reflecting areas of the basal portion behind the light source and the portions laterally surrounding the light source while its undesirable characteristic of susceptibility to damage during manufacturing is avoided by spacing it from the rim area which is subject to high heat. A more heat resistant, but less reflective metal, such as aluminum, is used for reflection in the high heat rim area. Higher efficacies could be achieved with this arrangement than when the silver covered 100% of the surface area of the reflector body, even when silver near the rim was over a layer of aluminum. The highest efficacies were achieved when the silver covered between about 40% and 65% of the area of the reflector surface.

It is favorable when the first reflective material is aluminum and extends as a first coating layer completely between the rim and the basal portion and the silver material extends as a second coating layer disposed on the first, aluminum layer. This simplifies lamp manufacturing by employing a fully aluminized reflector which is already used in the lamp manufacturing process.

The silver layer of the known lamp has a highly reflective, mirror-like appearance, thus constituting a specular reflector surface. However, experiments have revealed that even with the silver layer terminating at a distance from the rim when it covers approximately 40% - 65 % of the surface from the basal end of the reflector body, that the silver layer may still have discolored parts depending, among others, on the sealing process and equipment used and the size of the reflector body. Essentially, various variables in the lamp making parts, equipment and process used for different lamps and by different lamp manufacturers may result in temperatures during sealing which result in erratic discoloration or hazing over parts of the silver layer. Consequently, the cosmetic appearance of the reflective surface, when viewed through the lens, and performance will be worse than with lamps in which no discoloration of the silver layer is present.

It is an object of the invention to provide a reflector lamp of the kind described in the opening paragraph in which the second reflective coating has a substantial uniform reflectivity and appearance.

According to the invention, the second coating portion is diffusely reflecting and has a whitish, non-metallic appearance. This is obtained in a simple manner by heating the reflector body at a controlled temperature in an oven after deposition of the silver material on the reflector body and prior to securing the lens to the rim of the reflector body. The controlled oven environment provides a uniform, reflective surface for the second layer which remains unchanged during the following lens securing, e.g. fusing, process. As compared to lamps having a corresponding second layer of specular silver, the diffusely reflecting layer provides a beam having a lower maximum beam candlepower and a corresponding broadening of the beam. This holds true for a comparison with a corresponding lamp having a conventional full aluminum reflector surface as well. The heat-treated silver provides a luminous efficacy which is less than a corresponding lamp with the specular silver layer produces but which is significantly more than a corresponding lamp with the conventional full-aluminum only reflector surface provides. Accordingly, a partial, diffusely reflecting second layer is also an attractive device for increasing the luminous efficacy of a reflector lamp without adversely affecting lamp life.

These and other advantageous features of the invention which further contribute to the efficacy of the reflector lamp will become apparent with reference to the following drawings and detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a reflector lamp according to the invention, partly broken away and partly in cross-section.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a PAR-type reflector lamp having a reflector body 2 and lens 10 of vitreous material, in this case borosilicate hardglass. The reflector body includes a basal portion 4, a rim 5 which defines a light-emitting opening of the reflector body, and an inner reflector surface 6 which extends from the neck portion to the rim of the reflector. In the lamp shown, the inner reflector surface is parabolic. A corresponding rim 12 of the lens is fused to the rim 5 of the reflector in a gas-tight manner.

A light source generally denoted as 20 is arranged within the reflector body. The light source 20 includes an incandescent filament 22 supported by conductive supports 24,25 which are braced together with an insulative bridge 29. The supports are brazed to respective ferrules 26, 27 and connected to respective electrical contacts on a screw-type base 28 in a conventional fashion.

The sealed space enclosed by the reflector body and lens includes a gas fill consisting of 80% krypton and 20% nitrogen at a pressure of about 1 atmosphere.

The inner reflector surface 6 includes a reflective coating generally denoted as 7 which extends from the surface 4a of the basal portion near the ferrules 26, 27 to the rim 5 of the reflector for directing light emitted by the filament out through the lens 10 with a desired beam pattern. In commercially available PAR lamps, the reflective coating is typically a single layer of aluminum, which is deposited by well known chemical or vapor deposition techniques with a thickness of about (0.1 - 0.3μm).

In the lamp shown in Figure 1, aluminum is coated in a first layer 8 which extends over the entire reflector surface and a second layer 9 of silver is coated over the aluminum. This has the advantage that a reflector body having a full aluminum layer, which is already used in the production of conventional PAR lamps, is utilized, which then merely must have its portion remote from the rim coated with a layer of silver. Thus, minimal changes in production are necessary. From the exterior, the fully coated aluminum reflector has a uniform appearance, and is exactly the same as the conventional lamp, which is important for consumer acceptance.

After depositing the silver in the region shown in Figure 1, the reflector body was heated to a temperature of 450°C for five minutes in an oven in the presence of air. This caused the silver layer to have a whitish, non-metallic, diffusely reflective appearance rather than the initial metallic, specular appearance. The oven-baking had no effect on the aluminum layer. The appearance of the heat-treated silver layer was unaffected by the following flame-sealing process used for fusing the lens to the reflector body.

Table I shows the test results for a comparison test between lamps having (i) an all aluminum reflector surface, (ii) heat-treated silver/aluminium reflector surface, and (iii) a specular silver/aluminium reflector surface. Each of the lamps employed a PAR 38 reflector body, 85W coils and a fill gas of 90% argon/10% nitrogen at 0.8 bar.

TABLE 1

Coating	Heat treated	Sample size	Efficacy (lm/W)
Al	No	10	12.15
Al/Ag	Yes	8	12.50
Al/Ag	No	8	13.48

While the corresponding efficacy was higher for the samples with the specular silver layer than with the heat-treated silver layer, the samples with the heat-treated silver layer showed substantial gains in efficacy over the conventional (aluminum only) lamps thereby meeting the EPACT requirement, even although the lamps had a nominal life of 2150 hours and a gas pressure of only 0.8 bar.

The advantages of the two-material reflector surface for an e.g. fused lens design are applicable to lamps with other light sources as well. Thus, reflector lamps in which the light source is a halogen capsule or an HID arc tube, such as a metal halide or high pressure sodium arc tube, would likewise have corresponding efficacy increases with this type of reflective surface. Additionally, the percentage of the area of the reflector surface which is silvered may be varied.

While there has been described what are considered to be the preferred features of the invention, those of ordinary skill in the art will appreciate that various modifications are possible within the scope of the appended claims. For example, although aluminum was found to provide the best performance in the lens-rim seal area, other materials such as aluminum alloys may be used which have similar resistance to break down in this high-temperature region during manufacture. Accordingly, the description is considered to be illustrative only and not limiting.

WHAT IS CLAIMED IS:

1. A reflector lamp, comprising:

- a reflector body (2) of vitreous material having a longitudinal axis, a basal portion (4), a rim (5) which defines a light-emitting opening of said reflector body, and an inner reflector surface (6) which extends from the basal portion (4) to the rim (5) of the reflector body (2),

- a lens (10) of vitreous material secured to said rim (5),

- a light source (20) arranged within said reflector body (2) and

- a reflective coating (7) on said inner reflector surface (6),

the reflective coating (7) comprising a first coating portion (8) extending from said rim (5) towards said basal portion (4) and a second coating portion (9) which extends from an axial position spaced from said rim (5) to said basal portion (4), and the second coating portion (9) comprising silver and the first coating portion (8) consisting essentially of a material other than silver, characterized in that the second coating portion (9) is diffusely reflecting and has a whitish, non metallic appearance.

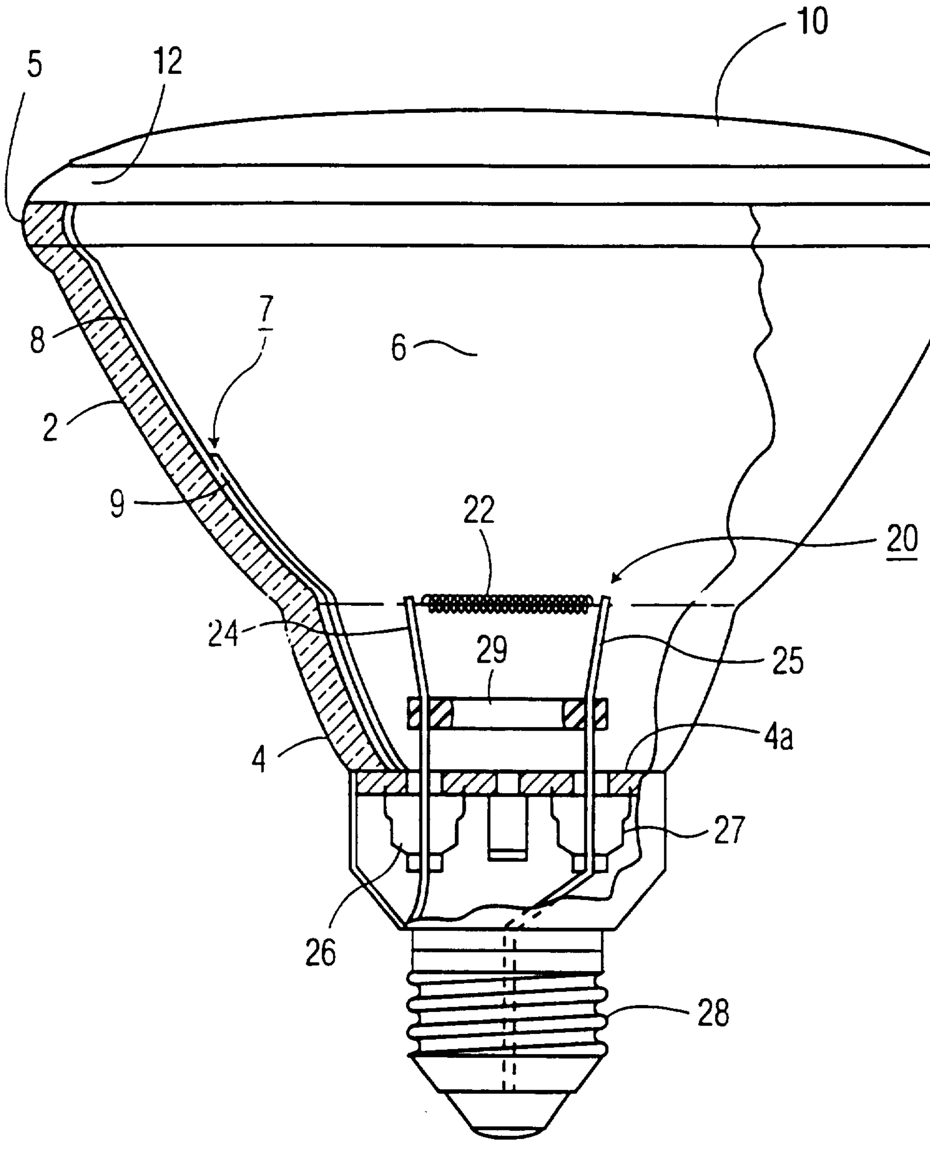
2. A reflector lamp according to claim 1, wherein said first coating portion (8) is part of a first layer which extends completely between said rim (5) and said basal portion (6) and said second coating portion (9) is layer disposed on said first layer.

3. A reflector lamp according to claim 2, wherein said first layer consists essentially of aluminum.

4. A reflector lamp according to claim 3, wherein said light source (20) is an incandescent filament and the space enclosed by said reflector body (2) and said lens (10) includes a gas fill consisting essentially of krypton and nitrogen.

5. A reflector lamp according to claim 4, wherein said second coating portion (9) covers between 40% and 65% of the area of the reflector surface.

6. A reflector lamp according to claim 1, wherein said first coating portion (8) consists essentially of aluminum.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