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(54) **Bonded beam lamp.**

(57) An electric lamp having an envelope, formed from a lens and a reflector that are sealed together by adhesive means, a light source and a base. The adhesive means has a curing temperature that is equal to or higher than the operating temperature of the lamp and a higher index of thermal expansion than the lens and reflector material. The adhesive means includes an epoxy, that is either heat or ultraviolet curable, which is disposed on the sealing surfaces of the glass lens and reflector. Sealing in this fashion obviates the need for flame sealing the glass lens and reflector together and results in a lamp that is substantially free from thermally induced strains in either the lens or the reflector.

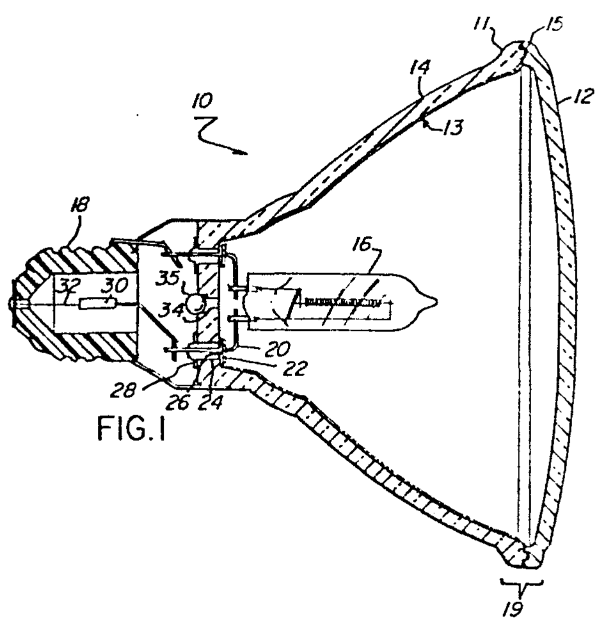

FIG.1

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BONDED BEAM LAMP

CROSS REFERENCE TO COPENDING APPLICATION

In Serial No. 524,507, entitled "Par Spot Lamp" and filed August 18, 1983 (William Thiry et al), there is described a spot lamp having a curved lens member, the inner surface of which has a series of radially disposed flutes formed therein defining a fluted portion which surrounds a centrally disposed stippled portion. The aforementioned application was assigned to the same assignee as the instant invention.

TECHNICAL FIELD

The present invention relates in general to incandescent light sources and particularly bonded beam lamps, having two-piece envelopes, comprising a reflector and lens assembled by adhesive means. The reflector has an internal reflective coating for reflecting and directing light, originating from a light source located within the envelope, towards a cooperating lens through which the light is transmitted.

BACKGROUND

It is well known in the art to utilize PAR (parabolic aluminized reflector) or ER (eliptical reflector) lamps for general spot or flood lighting applications. In particular, PAR and ER lamps have become exceptionally popular for short to medium distance outdoor uses as well as indoor for display, decoration, accent, inspection and downlighting applications. Such lamps are manufactured and sold by the assignee of the instant invention. Typically, these lamps are of hardglass and include a medium skirt (screw-type) or side prong base at the rear thereof for connecting the lamp to the desired power source.

The production of such assembled substantially circular glass reflectors and lenses, however, can present numerous problems. For example, stresses created in the glass lenses and reflectors during assembly by fusion sealing (i.e., flame sealing) can cause cracking thereof. The process of flame sealing is not only expensive but it requires the use of difficult-to-operate equipment. The thermally induced stress points can be the origin point of reflector or lens cracking and subsequent non-containment upon fracture of a light source capsule located within the lamp. These problems are particularly evident in outside applications where the PAR or ER lamp may be subjected to extreme thermal gradients. Experience gained in the testing involved with automobile headlight design has demonstrated that the probability of such thermally induced stresses can be significantly reduced by using an adhesive, rather than flame sealing, to seal the glass reflector and lens together.

In the design of automobile headlights, the quality of the lens-reflector seal depends largely on properly combining the index of thermal expansion of the lens and reflector material with the index of thermal expansion of the adhesive to be used. The typical indices of thermal expansion for hardglass used in headlights, such as borosilicate, and a suitable adhesive for bonding lamp glassware, such as an epoxy polymer which has been flexibilized, can differ by a factor of about 10. The glass-adhesive seal, when exposed to a decreasing ambient temperature, can have glass portions thereof contracting at a much different rate than the adhesive portions thereof. Such variations in contraction cause stresses that will ultimately lead to weakening of the lens to reflector seal or cracking of the glass. Likewise, in other lamps where a lens and reflector must be joined to form a sealed envelope, the proper combination of indices of thermal expansion of the lamp envelope material and adhesive for the lens-reflector seal is important in order to obtain a strong long-lasting seal.

It is believed, therefore, that there is a need for a lamp that can be assembled by a method that substantially eliminates thermally induced strains in either the lens or the reflector, unlike the traditional flame sealing technique. Such a lamp would be deemed an even further advancement if a higher wattage capsule could be used, without the concern that the additional heat generated would cause a strain induced failure.

DISCLOSURE OF THE INVENTION

Therefore, it is a primary object of this invention to enhance the art of incandescent lamps and particularly bonded beam lamps, operating at higher wattages, that are subjected to extreme thermal gradients.

It is another object of this invention to provide a bonded beam lamp that may be used more successfully in severe outdoor applications without the concern that an abrupt temperature change will cause a lamp envelope failure.

It is still another object of this invention to provide a bonded beam lamp which will successfully contain glass fragments resulting from the fracture of a light source capsule located within the lamp.

In accordance with one aspect of the instant invention, there is provided an electric lamp comprising an envelope having a reflector and a lens made of substantially the same material with a predetermined index of thermal expansion, a light source disposed within the envelope and substantially surrounded by the reflector, and adhesive means disposed between and sealing the lens and reflector together, the adhesive means having a curing temperature that is equal to or higher than the operating temperature of the lamp and a higher index of thermal expansion than the lens and reflector material.

In accordance with another aspect of the present invention, there is provided a method of making an electric lamp, the lamp having an envelope formed from a lens and a reflector, the lens and reflector having sealing surfaces on the lens and reflector peripheries, the method comprising the steps of: aluminizing the reflector, mounting a light source within the reflector, disposing adhesive means on the sealing surface of the lens and joining the lens sealing surface with the reflector sealing surface, the adhesive means having a curing temperature that is equal to or higher than the operating temperature of the lamp and a higher index of thermal expansion than the material forming the lens and reflector, curing the adhesive means to a temperature in the range of about 148° Celsius to 190° Celsius for a period of time in the range of about 5 to 40 minutes time.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view, partly in section, of an electric lamp constructed in accordance with the principles of this invention; and

FIG. 2 is a fragmentary, cross-sectional view of the lens and reflector sealing surfaces in accordance with the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

For a better understanding of the present invention together with other and further objects, advantages and capabilities thereof, reference is made to the following disclosure and appended claims in connection with the above-described drawings.

With reference now to the drawings, there is shown in FIG. 1 an electric lamp 10 made in accordance with the teachings of the present invention. Electric lamp 10 includes an envelope 11, formed from a lens 12 and a cooperating reflector 14, a light source 16 and a base 18. Both lens 12 and reflector 14 are joined by adhesive means 15 to form a lens-reflector seal 19 for lamp 10. Lens 12 and reflector 14 can be formed by pressing hardglass in a mold followed by an annealing process. Lens 12 typically has a slightly convex outer face and an optical prescription provided, for example, by a series of radially disposed flutes formed on the inner surface thereof defining a fluted portion which surrounds a centrally disposed stippled portion, as described in the aforementioned application having U.S. Serial No. 524,507. Additionally, reflector 14 has a concave inner surface 13 that includes a light reflective coating typically comprised of aluminum or silver. Reflector 14 is preferably a parabolic reflector but it can also be an eliptical reflector. Lens 12 and reflector 14 preferably have substantially circular peripheries and sealing surfaces located approximately about these peripheries, respectively.

As previously discussed, flame sealing, produced, for example, by a flame trained on the glass reflector and lens sealing surfaces, can create unacceptable stress patterns in envelope 11. In particular, stresses tend to concentrate about the lens-reflector seal 19, resulting in cracks about that area. The stresses created by flame sealing can be substantially eliminated by interposing adhesive means 15 between the aforementioned peripheral sealing surfaces to seal lens 12 to reflector 14. Acceptable adhesives for the use indicated above are those having a curing temperature that is equal to or higher than the operating temperature of the lamp and a higher index of thermal expansion than the lens and reflector material. An example of such an adhesive is "UNISET 3002-14", a heat curable epoxy sold by the Amicon Corp. of Lexington, Massachusetts.

Electric lamp 10 includes a tungsten-halogen capsule 16 having an envelope containing an inert gas fill and a halogen disposed within. Capsule 16 is disposed within and is substantially surrounded by reflector 14 as well as being substantially perpendicular to lens 12. Capsule 16 is attached to and supported by mount 20. Reflector 14 has two ferrule holes 22 through which the capsule-mount assembly will be inserted and secured into place by an eyelet-epoxy-washer combination. Each lead of mount 20 is secured in each ferrule 22 by an eyelet 24, epoxy 26 and washer 28. Lamp 10 also includes a diode 30 and a fuse wire 32 coupled in series with capsule 16 and base 18. Envelope 11 of lamp 10 also includes an exhaust hole tube 34 and a small steel ball bearing 35 that serves as a plug.

Envelope 11, as illustrated in FIG. 1, is one example of a lamp envelope that is also capable of containing glass fragments resulting from a possible, but unlikely fracture of capsule 16. Test results have shown that out of 60 lamp envelopes formed by the method described here, all of the lamps successfully contained glass fragments resulting from intentionally induced capsule failures. Of the 50 lamps made by the flame sealing technique, 3 lamps failed to contain after intentional inducement of capsule failure. Therefore, the above described sealing technique results in a lamp envelope that will reliably contain glass fragments from a possible, but unlikely fracture of capsule 16.

Referring now to FIG. 2, there is illustrated a fragmentary, cross-sectional view of the lens-reflector seal 19 having a lens sealing, channel-like surface A and a reflector sealing surface B that are located about the peripheries of lens 12 and reflector 14, respectively. During assembly of electric lamp 10, adhesive means 15 is placed between sealing surfaces A and B. Sealing surfaces A and B are joined when lens 12 and reflector 14 are pressed together. Lamp 10 is then subjected to a heat curing temperature in the range of about 148° Celsius to 190° Celsuis for about 5 to 40 minutes in order to cure adhesive means 15.

Contact between sealing surfaces A and B can degrade quickly with time upon improperly combining the different indices of thermal expansion of glass and adhesive means used. For example, the index of thermal expansion for borosilicate glass, conventionally used in sealed beam automotive headlights, typically is about 40 X 10^{-7}cm/cm/°C (i.e., cm = centimeter; °C = Celsius). Whereas the index of thermal expansion of a typically flexibilized epoxy, suitable for sealing headlight glassware, typically is about 40 X 10^{-6}cm/cm/°C. That is, the indices of thermal expansion of glass and adhesive means in a sealed beam headlight can differ, by a factor of about 10. Therefore, temperature changes, in particular decreasing temperatures, produce different rates of contraction for the glass and interposed adhesive means creating more stress between the sealing surfaces thereby adversely affecting the glass lens to glass reflector contact along the outermost sealing surfaces where adhesive means has been pressed away.

The sealing and stress problems found in automotive headlights, due to the differing rates of contraction for the lens and reflector material and interposed adhesive means, also exist in PAR and ER lamps. In addition, the sealing problem in PAR and ER lamps is compounded by their higher operating temperature (140° Celsius - 150° Celsius) as compared to headlights (about 120° Celsius), which in turn causes the failure of most adhesives having low tolerances to high temperatures. Adhesive means 15, of the present invention, serves to alleviate somewhat the stresses between sealing surfaces A and B due to its ability to withstand the high compressive stress without breakdown at high operating temperatures of the lamp, and therefore provide an operative lamp for an environment that varies frequently in temperature.

The present invention significantly reduces thermally induced stresses by eliminating flame sealing as a method of creating a lens to reflector seal. Adhesive means 15, used to join lens 12 and reflector 14 together, must have a curing temperature that is equal to or higher than the operating temperature of lamp 10 and it must have a higher index of thermal expansion than the material that forms lens 12 and reflector 14. Since the normal operating temperature of a lamp such as lamp 10 is usually about 140 to 150° Celsius, the adhesive means used here will provide for a strong seal at such high temperatures due to its own high curing temperature.

The material used to form lens 12 and reflector 14 is usually hardglass, and the predetermined index of thermal expansion for such a material is about 40 X 10^{-7}cm/cm/°C. Adhesive means 15 of the present invention includes an epoxy having a curing temperature that is in the range of about 148° Celsius to 190° Celsius with an index of thermal expansion in the range of about 75 - 300 X 10^{-7}cm/cm/°C. The curing time of the epoxy is about 5 to 40 minutes. The epoxy currently in use has an index of thermal expansion of about 150 X 10^{7}cm/cm/°C, a curing temperature of about 160° Celsius and a curing time of about 5 minutes. In addition, adhesive means 15 may also include ultraviolet cured epoxies that have similar expansion and temperature characteristics as the acceptable heat cured epoxies described earlier.

Since the epoxy used here has an index of expansion greater than the hardglass forming the lens and reflector, a stronger seal will result due to a compressive stress being formed around the lens-reflector seal when the lamp is placed in an environment with a temperature below that which it was cured. This would occur during most, if not all, operating conditions with the lamp on or off. In addition, the need for a specialized shape or form for sealing surfaces A and B of lens 12 and reflector 14 is obviated by the use of the sealing techniques taught by the present invention. In one embodiment of the present invention, the lens sealing surface A has a channel or recessed portion and reflector sealing surface B has a flange, thereby creating a self-aligning relationship when the lens 12 and reflector 14 are sealed together by adhesive means 15 (see FIG. 2).

To assemble lamp 10, reflector 14 is first of all aluminized by placing a light reflective coating on the inner surface 13 of reflector 14, typically comprised of aluminum or silver. Reflector 14 is aluminized in such a way as to provide an aluminum-free area near the reflector base where ferrule holes 22 are located. Eyelets 24 are then placed in ferrules 22 and a small amount of thermally cured epoxy 26 is injected around eyelets 24. Washers 28 are then placed about eyelets 24 whereupon eyelets 24 are staked. Capsule 16, which is attached to mount 20, is then inserted into ferrules 22 and then supported by the eyelet-epoxy-washer combination. The capsule-mount assembly is then soldered into place. Adhesive means 15, which is preferably a thermally cured epoxy, is then applied to lens 12 which is then joined with reflector 14, such that a self-aligning relationship is created. The lens-reflector assembly is then placed in an oven and brought to and kept at the requisite curing temperature (about 160° Celsius) until such time as the epoxy is cured (about 5 to 40 minutes). Lamp 10 is then subjected to a brief nitrogen flush through exhaust tube hole 34 located in reflector 14. Exhaust tube hole 34 is thereafter plugged by using small steel ball bearing 35 and an ultraviolet cured epoxy. The diode-fuse assembly and base 18 are then soldered into place.

Thus, there has been shown and described an improved electric lamp and method of making such a lamp which substantially reduces or eliminates thermally induced strains in either the lens or the reflector once they have been joined together, unlike the traditional flame sealing technique. The advantages of a strain-free PAR or ER lamp include the following: a higher wattage tungsten-halogen capsule may be used without the concern that the additional heat generated will cause a strain induced failure; the lamp may be used more successfully in severe outdoor applications without the concern that a thermal shock will cause a lamp envelope failure; and envelope failures due to a fracture of a tungsten-halogen capsule will be substantially eliminated in bonded beam lamps . The above described invention may be utilized wherever the flame sealing technique is used in a lamp to seal two corresponding and opposing members together to form a single member.

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

CLAIMS

WHAT IS CLAIMED IS:

1. An electric lamp comprising:

an envelope having a reflector and a lens made of substantially the same material with a predetermined index of thermal expansion;

a light source disposed within said envelope and substantially surrounded by said reflector; and

adhesive means disposed between and sealing said lens and reflector together, said adhesive means having a curing temperature that is equal to or higher than the operating temperature of said lamp and a higher index of thermal expansion than said lens and reflector material.

2. The electric lamp according to Claim 1 wherein said reflector is an aluminized parabolic reflector.

3. The electric lamp according to Claim 1 wherein said reflector is an eliptical reflector.

4. The electric lamp according to Claim 1 wherein said adhesive means includes an epoxy having a curing temperature in the range of about 148° Celsius to 190° Celsius and an index of thermal expansion in the range of about $75 - 300 \times 10^{-7}$ cm/cm/°Celsius.

5. The electric lamp according to Claim 4 wherein said epoxy has a curing time in the range of about 5 to 40 minutes.

6. The electric lamp according to Claim 4 wherein said epoxy has a curing temperature of about 160° Celsius, a curing time of about 5 minutes and an index of thermal expansion of about 150 X 10^{-7}cm/cm/°Celsius.

7. The electric lamp according to Claim 1 wherein said lens and reflector have sealing surfaces located about the lens and reflector peripheries, said lens sealing surface having a recessed portion and said reflector sealing surface having a flange to create a self-aligning relationship when said lens and reflector are sealed together by said adhesive means.

8. The electric lamp according to Claim 1 wherein said light source includes a tungsten-halogen capsule mounted within said reflector, said reflector having ferrules through which said capsule is mounted using a combination of an eyelet, a washer and an epoxy.

9. A method of making an electric lamp, said lamp having an envelope formed from a lens and a reflector, said lens and reflector having sealing surfaces on the lens and reflector peripheries, said method comprising the steps of:

aluminizing said reflector;

mounting a light source within said reflector;

disposing adhesive means on said sealing surface of said lens and joining said lens sealing surface with said reflector sealing surface, said adhesive means having a curing temperature that is equal to or higher than the operating temperature of said lamp and a higher index of thermal expansion than the material forming said lens and reflector; and

curing said adhesive means to a temperature in the range of about 148° Celsius to 190° Celsius for a period of time in the range of about 5 to 40 minutes time.

10. The method according to Claim 9 wherein said adhesive means includes an epoxy having an index of thermal expansion in the range of about 75 - 300 X 10^{7}/cm/cm/°Celsius.

11. The method according to Claim 10 wherein said epoxy has a curing temperature of about 160° Celsius, a curing time of about 5 minutes and an index of thermal expansion of about 150 X 10^{-7}cm/cm/°Celsius.

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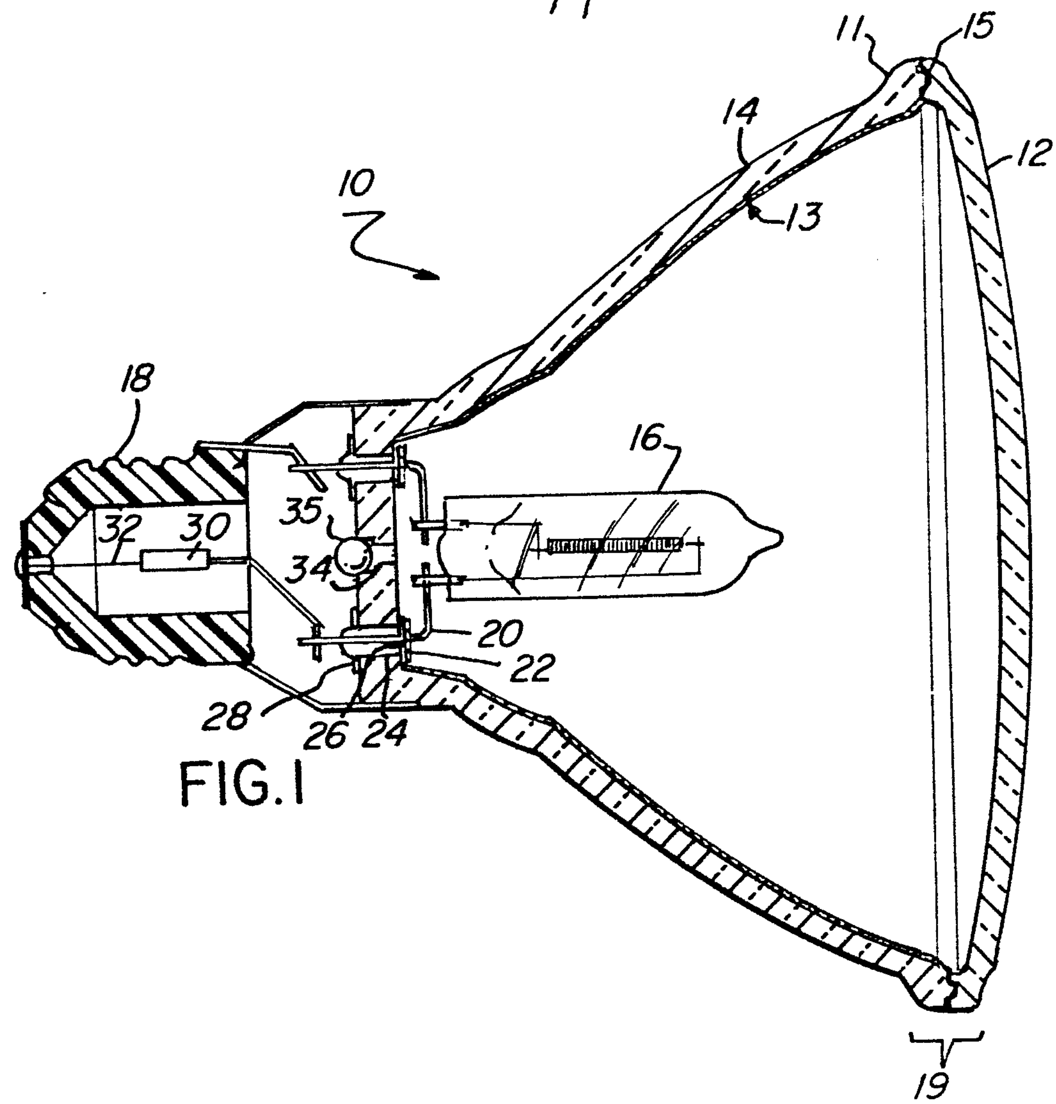

FIG.1

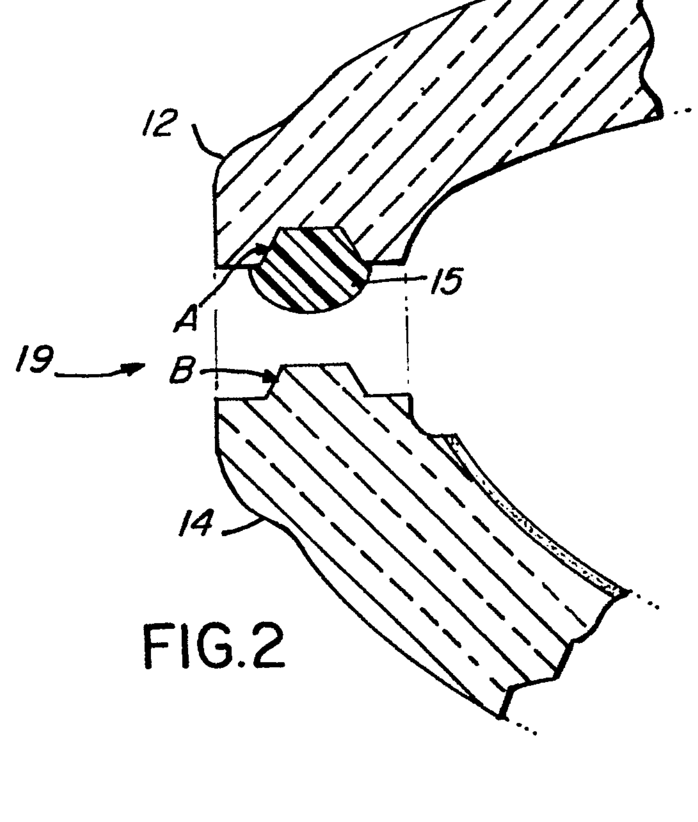

FIG.2