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(54) Title: COMPACT FLUORESCENT LAMP WITH OUTER ENVELOPE

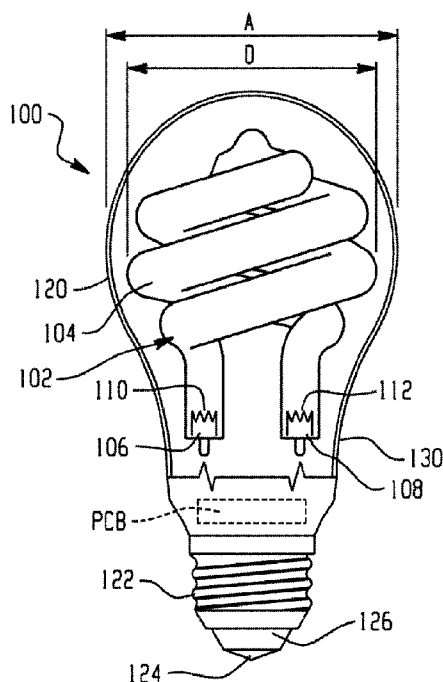


Fig. 1

(57) Abstract: An energy saving lamp (102) includes a discharge tube arrangement or illuminant body formed of at least one discharge tube (104) preferably made of glass, enclosing at least in part a discharge volume filled with a discharge gas, and having a fluorescent phosphor coating disposed on an inner surface of the discharge tube. The discharge tube forms a continuous arc path and is provided with electrodes (110, 112) at each end of the arc path resulting in a volume of the illuminant body A. A ballast circuit controls current provided to the tube and is connected to the electrodes, and is also connected to an associated supply voltage A. A bulb-shaped outer envelope (120) comprises a spherical portion enclosing at least in part the discharge tube arrangement and an elongated end portion enclosing at least in part the ballast circuit to define a resultant envelope volume.



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## COMPACT FLUORESCENT LAMP WITH OUTER ENVELOPE

## BACKGROUND OF THE DISCLOSURE

[0001] This application claims priority from U.S. provisional application Serial No. 61/084,299, filed July 29, 2008. Cross-reference is made to commonly-owned, co-pending applications Serial No. 12/181,406, filed July 29, 2008, entitled "FIXING MECHANISM FOR AN INNER ASSEMBLY TO OUTER BULB" [Attorney Docket No. 232335 (GECZ 2 00904)] and Serial No. 12/181,414, filed July 29, 2008, entitled "HOLDER FOR INTEGRAL COMPACT FLUORESCENT LAMP WITH OUTER BULB" [Attorney Docket No. 232555 (GECZ 2 00905)] and Serial No. 12/181,419, filed July 29, 2008, entitled "ELECTRIC LAMP WITH INNER ASSEMBLY AND OUTER BULB AND METHOD FOR MANUFACTURING" [Attorney Docket No. 227729 (GECZ 2 00941)].

[0002] This disclosure relates to an electric lamp assembly, and more particularly to an electric lamp with an inner assembly including a light source and the associated electronics or control circuit, which can replace conventional, general purpose incandescent lamps. More particularly, the disclosure relates to a low-pressure fluorescent discharge lamp received in an outer envelope that also encloses the associated electronics.

[0003] A majority of known and commercially available low-pressure fluorescent discharge lamps are compact fluorescent lamps (CFL). A CFL lamp is intended to replace an incandescent lamp and is presently used in a wide field of industrial and home applications. A CFL offers the advantages of low-power consumption and long life. On the other hand, a CFL has an elongated discharge path which usually results in an extended length dimension. In an effort to overcome the extended length, multiple interconnected tube embodiments have been employed, as well as helical or coiled tube arrangements.

[0004] More recently, the CFL also includes an outer envelope or bulb that encloses the lamp and the associated electronics therein. Known CFL assemblies of this type may not include a built-in ballast and also suffer from one or more of performance, environmental, and safety issues. Among these issues is a market demand for a high luminous output provided by a small

volume lamp with good lumen per watt efficiency. Another demand of the market is for a uniform luminous output. There is likewise a demand for better efficacy and a fast warm-up, while there is still a need for increased safety (for example, in case the CFL discharge tube breaks during shipment or handling), an environmental demand (to prevent inadvertent release of mercury to the environment or to the customer), as well as a safety demand where there is a need for a safety cover over the inner light source.

[0005] Although selected lamps may address one or selected ones of these issues, heretofore there has not been a lamp assembly that effectively resolves all of these issues simultaneously.

#### SUMMARY OF THE DISCLOSURE

[0006] There is provided an energy saving lamp comprising a discharge tube arrangement or illuminant body formed of at least one discharge tube made of glass, enclosing a discharge volume filled with a discharge gas, and having a fluorescent phosphor coating disposed on an inner surface of the discharge tube. The discharge tube forms a continuous arc path and is provided with electrodes at each end of the arc path resulting in a volume of an illuminant body. A ballast circuit controls current provided to the tube and is connected to the electrodes, and is also connected to an associated supply voltage. A bulb-shaped outer envelope includes a spherical portion enclosing the discharge tube arrangement and an elongated end portion enclosing the ballast circuit to define a resultant envelope volume.

[0007] A shape of the end portion of the outer envelope is approximately circular in cross-section and suitable to hold a base of the lamp where lead-in wires are led through to the base for connecting said lamp to the associated supply voltage through a socket. A preferred ratio between the volume of the illuminant body and the volume of the outer envelope is greater than 0.5.

[0008] A preferred ratio between a diameter of the illuminant body and the diameter of the outer envelope exceeds 0.75.

[0009] A preferred length of the arc tube exceeds 350 millimeters.

[0010] An embodiment of the present disclosure provides good lumen per watt efficiency

[0011] Another feature of the present disclosure is a uniform luminous output.

[0012] Still other aspects of this disclosure improved efficacy and a fast warm-up.

[0013] Yet another feature is the ability to protect the inner illuminant assembly from breakage during handling, to contain any mercury included in the illuminant body, and to serve as a safety cover over the outer envelope.

[0014] Still other benefits and advantages of the present disclosure will become more apparent from reading and understanding the following detailed description.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Figures 1-6 are elevational views, partially in cross-section of preferred embodiments of the present disclosure.

[0016] Figure 7 is a table of the volume data for the six embodiments of Figures 1-6.

[0017] Figure 8 is a lamp illustrating the parameters A, D compiled in the table of Figure 9.

[0018] Figure 9 is a table of the diameter data for the six embodiments of Figures 1-6.

[0019] Figure 10 is a lamp illustrating the parameters A, D, B which are used in part in the table of Figure 11.

[0020] Figure 11 is a table of dimensional data for the six embodiments of Figure 1-6.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] Figures 1-6 are elevational views, partially in cross-section, of preferred compact fluorescent lamp assemblies, each having the same general structure except where noted below and including different wattage ratings, and different dimensional sizes. Each lamp assembly 100 includes a low-pressure, discharge tube arrangement such as a preferred helical, spiral, or

coiled lamp assembly 102 (also referred to as an illuminant body) having a discharge tube 104 with first and second ends 106, 108, respectively. As evident, the ends 104, 106 are preferably disposed at the same end (a lower end of the lamp assembly as illustrated) of the compact fluorescent lamp or CFL 102. In an effort to make the lamp envelope as compact as possible, the discharge tube 104 is preferably wound in a spiral or double helix shape and has a generally snow-cone contour with a maximum diameter at approximately mid-height. Each end 106, 108 of the discharge tube receives a respective electrode 110, 112 for connection with a printed circuit board (PCB) or associated electronics (Figure 1) that is integrated into the lamp assembly.

[0022] An outer envelope 120 has a typical A-line shape or configuration that is generally spherical at the upper closed end and has a narrowing region that merges into a necked-down circular cross-section end. The outer envelope is intended to enclose the discharge tube arrangement 102 while the narrow, lower end receives the PCB or electronics that drive the CFL and is connected to a lamp base, shown here as an externally threaded shell or Edison-type base 122, that is received in a corresponding internally threaded socket (not shown) of an associated fixture (not shown). A contact 124 is preferably provided at a lowermost end of the lamp assembly and is typically spaced from the threaded shell 122 by an insulating material 126.

[0023] An internal volume of the CFL is filled with a conventional discharge gas and, likewise, a fluorescent phosphor coating is disposed on an inner surface of the tube 104. The bulb-shaped outer envelope 120 is connected to the base 122 of the lamp adjacent where lead wires extend through the base so that the lamp is operated by a supply voltage. The electronics then drive the operation of the CFL.

[0024] As noted above, it is desired that a high luminous output be provided in a small volume. Stated another way, the lamp assembly should provide good lumen per watt efficiency. It is also desirable that the lamp assembly have a generally uniform luminous output. Thus, the phosphor coating and outer envelope 120 contribute to the uniform output. A thin glass bulb wall for the discharge vessel also provides for better efficacy and fast warm-up. Further, the outer envelope 120 protects the thin CFL discharge tube 104 from potentially breaking during transportation and handling. Further, the outer envelope serves as a containment vessel to

protect the consumer as well as the environment from potential mercury contamination if the discharge tube arrangement is broken. Likewise, the outer envelope can be provided with an additional safety cover, e.g., a light-transmissive protective coating, for example, that provides further shatter-proof characteristics and containment without adversely impacting the light output, such as a silicon-type coating or cover 130.

[0025] The self-ballasted CFL lamps shown in Figures 1-6 are provided in an outer envelope where a volume of the illuminant body of the CFL is made to be as close as possible to a volume of the outer envelope. Thus, in the table of Figure 7, the volume of the outer envelope (BV) (in  $\text{mm}^3$ ) and the volume of the discharge lamp or wire lamp outline volume (WOV) (also measured in  $\text{mm}^3$ ) are provided for each of the embodiments of Figures 1-6, as well as the ratio of the wire lamp outline volume to the bulb volume (WOV/BV). Preferably, the ratio of each of them is greater than 0.5.

[0026] Similarly, the table of Figure 9 provides maximum diameters of the outer envelope (A) (measured in mm) and the diameters of the illuminant body or CFL (D) (see Figure 8)(also measured in mm) are provided for each of the lamps of Figures 1-6, as well as the ratio of the diameter of the illuminant body to the diameter of the outer envelope (D/A). Preferably, this ratio exceeds 0.75 and as shown in Figure 9 meets or exceeds 0.78, and more generally exceeds 0.80.

[0027] The table of Figure 11 provides a ratio (D/B) of the maximum diameter (D) of the CFL (spiral diameter) (measured in mm) relative to the neck diameter (B) of the outer envelope (bulb neck diameter) (also measured in mm) for the six embodiments of Figures 1- 6 (generally illustrated in Figure 10). In addition, the table of Figure 11 provides the arc tube length of the CFL. Preferably, the length of the arc tube exceeds 350 millimeters. Further, a more uniform luminous output is provided in the self-ballasted CFL with a surrounding outer envelope where the ratio between the maximum overall diameter of the discharge illuminant body (D) and the inner diameter of the glass outer envelope neck portion (B) exceeds 1.1.

[0028] The preferred embodiments of the self-ballasted CFLs provided with an outer envelope preferably having a wall thickness of the glass tube discharge vessel in the range of 0.4 to 0.9 mm, and the inner diameter of the glass tube is preferably in the range of 3-10 mm.

[0029] The structural arrangements provide a high luminous output in a small lamp size due to the advantageous dimensioning of the illuminant body. A more uniform, luminous output is provided by the optimized spiral discharge vessel dimensions. Further, due to the thinner glass bulb wall of the discharge vessel, the lumen per watt efficacy increases relative to known arrangements and the warm-up time of the lamp is also reduced. As noted, the glass outer envelope also protects the thin CFL discharge tube from breaking during transportation and handling. The outer envelope likewise serves containment and protective functions for consumers and the environment at the end of the life of the product so that it is less likely that mercury will not inadvertently be exposed to the environment.

[0030] The energy savings lamp includes a ratio between the volume of the illuminant body and the volume of the outer envelope that is greater than 0.5, a ratio between the diameter of the illuminant body and the outer envelope exceeds 0.75, and the length of the arc tube exceeds 350 mm. Performance, environmental and safety issues are solved by this disclosure and embodied in a single lamp that has high luminous output in a small volume with good lumen per watt efficiency, a uniform luminous output, a thin glass bulb for a discharge vessel which equates to better efficacy and fast warm up of the lamp. Further, the outer envelope protects the thin CFL discharge tube from possible breaking during shipment and handling, and also serves to further protect the consumer and the environment from possible mercury dissemination. The present lamps as shown and described herein have a high luminous output in a small volume with good lumen per watt efficiency. The volume of the illuminant body of the CFL is close to the volume of the illuminant discharge body and the outer envelope as evidenced by the ratio between these volumes being greater than 0.5, the ratio of the diameter of the illuminant discharge body and the outer envelope exceeds 0.75, and the length of the arc tube exceeds 350 mm. Similarly, the uniform luminous output is exhibited by the ratio of the maximum overall diameter of the discharge illuminant body and the inner diameter of the glass outer envelope neck portion exceeding 1.1. Likewise, the providing an outer envelope where the wall thickness



of the glass tube discharge vessel is in the range of 0.4 to 0.9 mm and the inner diameter of the glass tube is in the range of 3-10 mm is representative of a thin glass bulb wall for the discharge vessel.

[0031] The disclosure has been described with reference to preferred embodiments. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations.

We claim:

1. A lamp comprising:
  - a discharge tube arrangement having at least one discharge tube enclosing a discharge volume filled with a discharge gas, and having a fluorescent phosphor coating disposed on an inner surface of the discharge tube;
  - first and second electrodes spaced along a continuous arc path and adjacent first and second ends, respectively, of the discharge tube adjacent each end of the arc path resulting in a volume of an illuminant body;
  - a bulb-shaped outer envelope having a spherical portion enclosing at least part of the discharge tube arrangement and an elongated end portion that together define an outer envelope volume;
  - a preferred ratio between the volume of the illuminant body and the outer envelope volume is greater than about 0.5. and
  - a ratio between a maximum diameter of the illuminant body and a maximum diameter of the outer envelope is greater than approximately 0.75.
2. The lamp of claim 1 wherein a length of the discharge tube exceeds approximately 350 mm.
3. The lamp of claim 1 further comprising a ballast circuit connected to the electrodes for providing current thereto from an associated supply voltage, wherein the elongated end portion of the outer envelope encloses at least part of the ballast circuit.
4. The lamp of claim 1 wherein the elongated end portion of the outer envelope is approximately circular in cross-section and suitable to hold a base of the lamp where lead-in wires are led through to the base for connecting said lamp to the associated supply voltage.
5. The lamp of claim 1 wherein a ratio between a maximum diameter of the illuminant body and an inner diameter of a neck portion of the outer envelope is greater than 1.1.

6. The lamp of claim 1 wherein an inner diameter of the discharge tube is in the range of 3 to 10 mm.

7. The lamp of claim 1 further comprising a safety cover received over the outer envelope.

8. The lamp of claim 1 wherein a wall thickness of the discharge tube is in the range of approximately 0.4 to 0.9 mm.

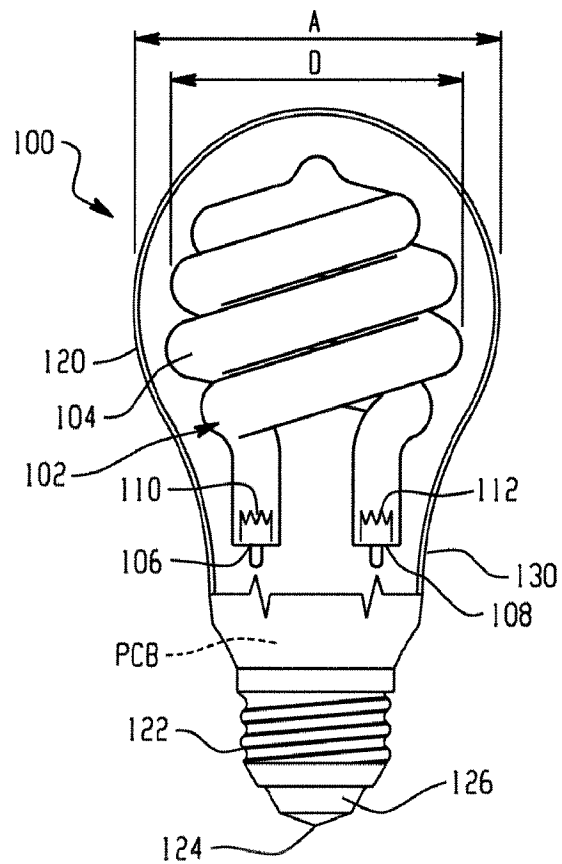
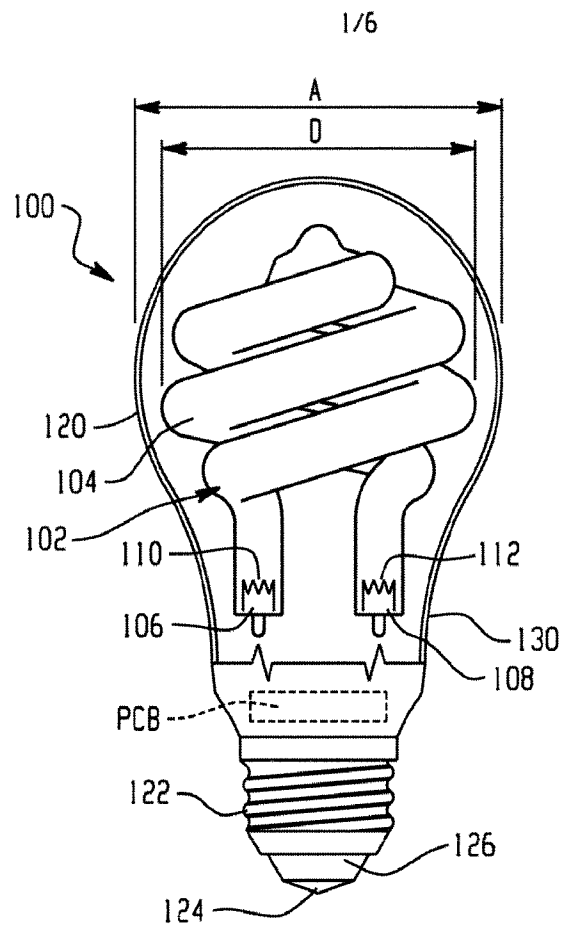
9. A method of forming a compact fluorescent lamp comprising:  
providing a discharge tube arrangement having at least one discharge tube enclosing a discharge volume filled with a discharge gas, and having a fluorescent phosphor coating disposed on an inner surface of the discharge tube;  
introducing first and second electrodes spaced along a continuous arc path and adjacent first and second ends, respectively, of the discharge tube adjacent each end of the arc path resulting in a volume of an illuminant body;  
forming a bulb-shaped outer envelope having a spherical portion enclosing at least a part of the discharge tube arrangement and an elongated end portion that together define an outer envelope volume;  
maintaining a preferred ratio between the volume of the illuminant body and the outer envelope volume greater than about 0.5; and  
supplying a ratio between a maximum diameter of the illuminant body and a maximum diameter of the outer envelope greater than approximately 0.75.

10. The method of claim 9 further comprising providing a length of the discharge tube that exceeds approximately 350 mm.

11. The method of claim 9 further comprising forming an inner diameter of the discharge tube in the range of 3 to 10 mm.

12. The method of claim 9 wherein a ratio between a maximum diameter of the illuminant body and an inner diameter of a neck portion of the outer envelope is greater than 1.1.

13. The method of claim 9 wherein a wall thickness of the discharge tube is in the range of approximately 0.4 to 0.9 mm.



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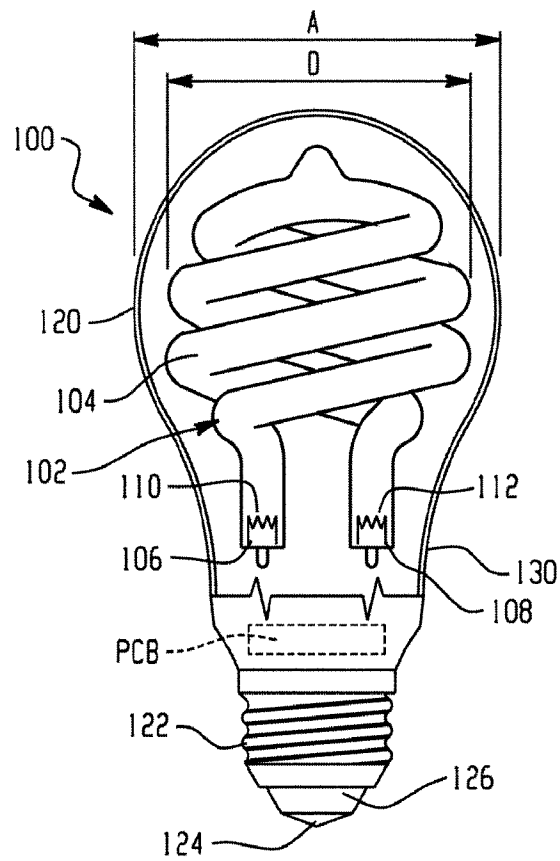


Fig. 3

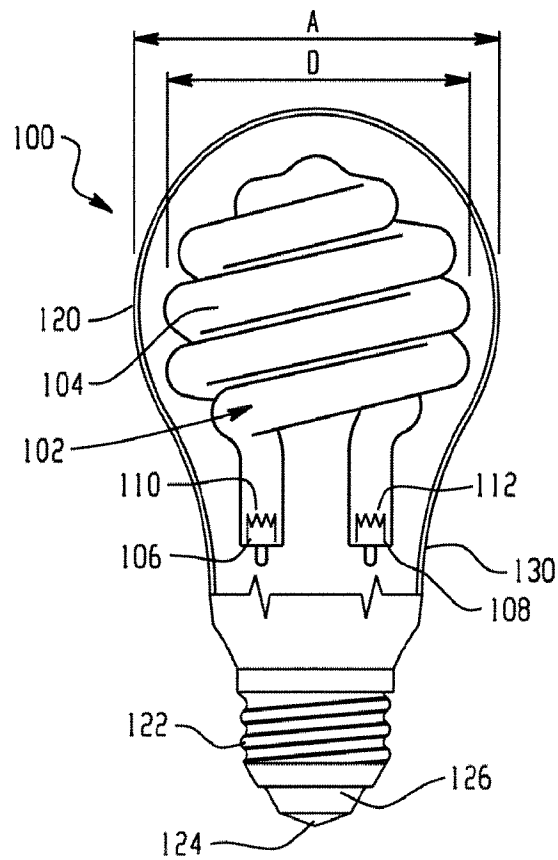


Fig. 4

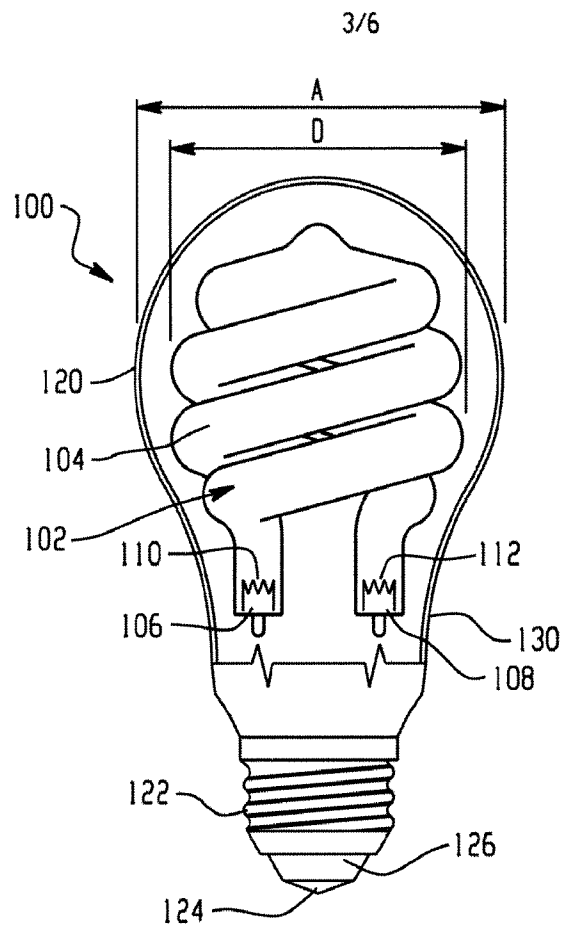


Fig. 5

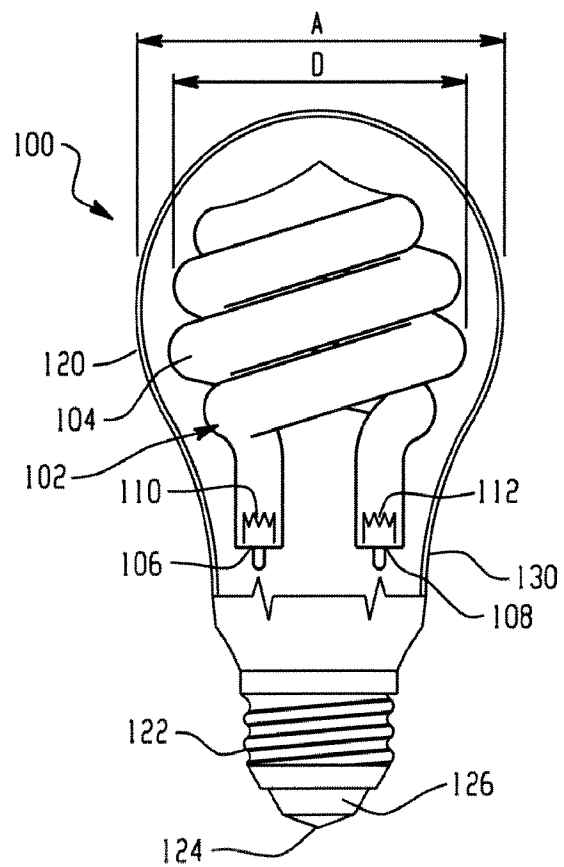


Fig. 6

|        |            | BV = BULB<br>VOLUME (mm <sup>3</sup> ) | WOV = WIRELAMP<br>OUTLINE<br>VOLUME (mm <sup>3</sup> ) | WOV/BV |
|--------|------------|----------------------------------------|--------------------------------------------------------|--------|
| FIG. 1 | T2 10W/A19 | 149641                                 | 82309                                                  | 0.55   |
| FIG. 2 | T2 15W/A19 | 149641                                 | 82309                                                  | 0.55   |
| FIG. 3 | T2 15W/A21 | 199261                                 | 110317                                                 | 0.55   |
| FIG. 4 | T2 20W/A21 | 199261                                 | 110317                                                 | 0.55   |
| FIG. 5 | T3 15W/A21 | 199261                                 | 100990                                                 | 0.51   |
| FIG. 6 | T3 20W/A21 | 199261                                 | 115089                                                 | 0.58   |

Fig. 7



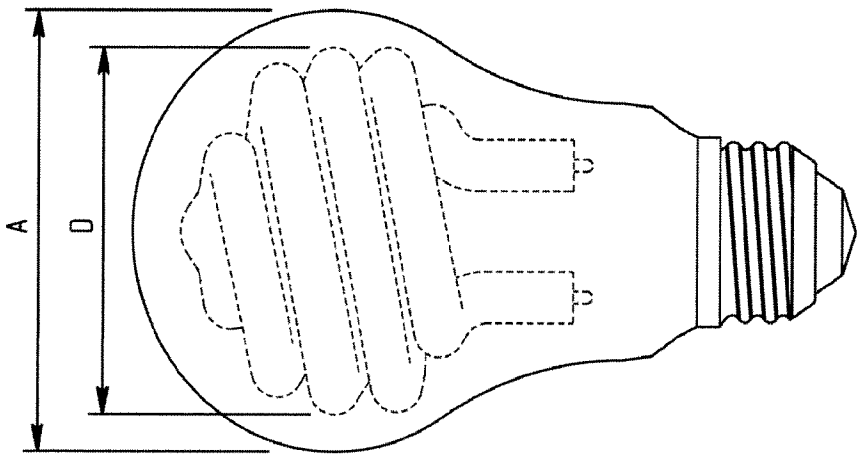


Fig. 8

|        |            | A ( mm ) | D ( mm ) | D/A  |
|--------|------------|----------|----------|------|
| FIG. 1 | T2 10W/A19 | 60       | 52       | 0.87 |
| FIG. 2 | T2 15W/A19 | 60       | 52       | 0.87 |
| FIG. 3 | T2 15W/A21 | 67       | 56       | 0.84 |
| FIG. 4 | T2 20W/A21 | 67       | 56       | 0.84 |
| FIG. 5 | T3 15W/A21 | 67       | 52       | 0.78 |
| FIG. 6 | T3 20W/A21 | 67       | 58       | 0.87 |

Fig. 9

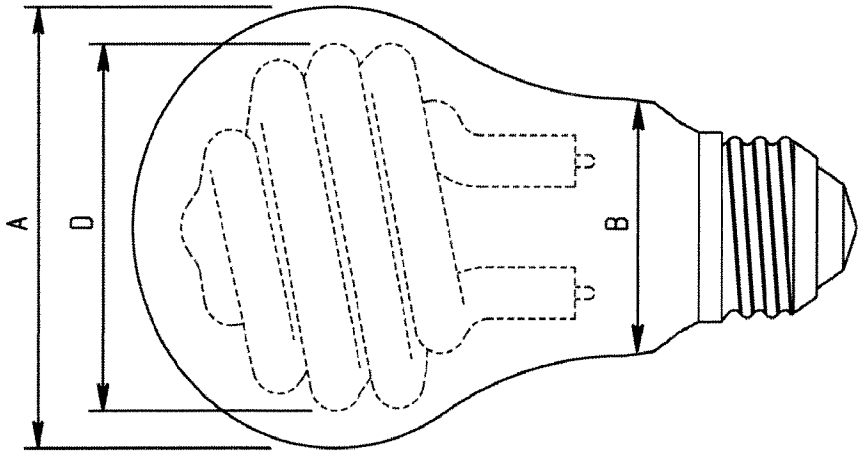


Fig. 10

|        |            | SPIRAL DIA/<br>BULB NECK DIA | ARC TUBE LENGTH |
|--------|------------|------------------------------|-----------------|
| FIG. 1 | T2 10W/A19 | 1.63                         | 411             |
| FIG. 2 | T2 15W/A19 | 1.63                         | 456             |
| FIG. 3 | T2 15W/A21 | 1.75                         | 545             |
| FIG. 4 | T2 20W/A21 | 1.75                         | 612             |
| FIG. 5 | T3 15W/A21 | 1.63                         | 467             |
| FIG. 6 | T3 20W/A21 | 1.81                         | 585             |

Fig. 11

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2009/051915

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H01J 61/30 (2009.01)

USPC - 313/493

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - H01J 61/30 (2009.01)

USPC - 313/493

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

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

PatBase, Google Patents

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|------------------------------------------------------------------------------------|-----------------------|
| Y         | US 6,064,155 A (MAYA et al) 16 May 2000 (16.05.2000) entire document               | 1-13                  |
| Y         | US 5,568,008 A (NARITA) 22 October 1996 (22.10.1996) entire document               | 1-13                  |
| Y         | US 5,552,666 A (SHEA et al) 03 September 1996 (03.09.1996) entire document         | 7                     |

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Date of the actual completion of the international search

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Date of mailing of the international search report

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