



(12) **United States Patent**
Lumetta

(10) **Patent No.:** **US 10,364,970 B2**
(45) **Date of Patent:** ***Jul. 30, 2019**

(54) **LED LIGHTING ASSEMBLY HAVING ELECTRICALLY CONDUCTIVE HEAT SINK FOR PROVIDING POWER DIRECTLY TO AN LED LIGHT SOURCE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/973,201**

(22) Filed: **Dec. 17, 2015**

(65) **Prior Publication Data**

US 2016/0102852 A1 Apr. 14, 2016

Related U.S. Application Data

(63) Continuation of application No. 13/559,009, filed on Jul. 26, 2012, now Pat. No. 9,217,563.

(60) Provisional application No. 61/511,735, filed on Jul. 26, 2011.

(51) **Int. Cl.**

- F21V 23/00** (2015.01)
- F21V 29/00** (2015.01)
- F21V 29/71** (2015.01)
- F21V 29/70** (2015.01)
- F21V 23/06** (2006.01)
- F21K 9/23** (2016.01)
- F21K 9/238** (2016.01)
- F21K 9/90** (2016.01)
- F21Y 115/10** (2016.01)

(52) **U.S. Cl.**

CPC **F21V 23/001** (2013.01); **F21K 9/23** (2016.08); **F21K 9/238** (2016.08); **F21V 23/006** (2013.01); **F21V 23/06** (2013.01); **F21V 29/20** (2013.01); **F21V 29/70** (2015.01); **F21V 29/713** (2015.01); **F21K 9/90** (2013.01); **F21Y 2115/10** (2016.08); **Y10T 29/49002** (2015.01); **Y10T 29/4913** (2015.01)

(58) **Field of Classification Search**

CPC F21V 29/26; F21V 29/262; F21V 29/265; F21K 9/10; F21K 9/13; F21K 9/1355; F21K 9/137; F21K 9/23; F21K 9/232; F21K 9/233; F21K 9/238; F21Y 2115/10
 USPC 362/373, 249.02, 294, 547
 See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

- 4,267,559 A 5/1981 Johnson et al.
- 5,939,835 A * 8/1999 Takeda H05B 41/02 307/10.1
- 5,942,907 A * 8/1999 Chiang G01R 31/2886 324/750.09
- 6,712,486 B1 * 3/2004 Popovich A47C 7/725 362/241

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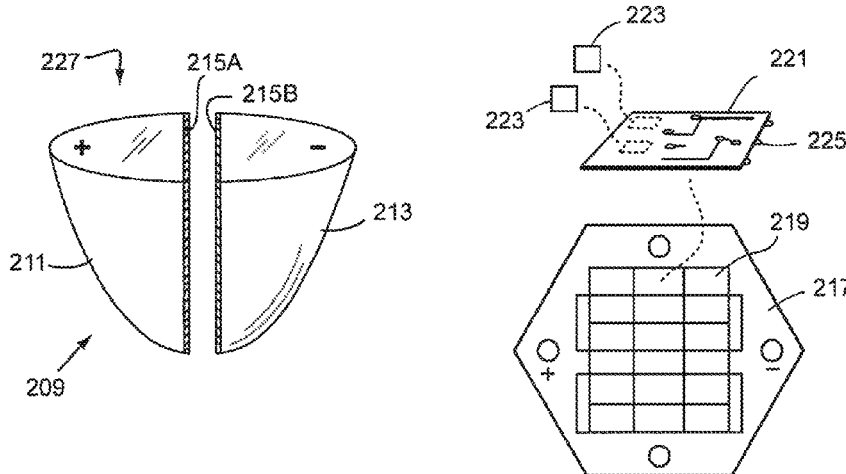
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(57) **ABSTRACT**

A light emitting diode (LED) lighting assembly (200) includes an LED lighting source (223) and a heat sink assembly (209) that is configured between a power source and the LED light source (223) that works as an electrical conductor for the LED light source (223) and for removing heat generated by the LED light source (223).

24 Claims, 2 Drawing Sheets



(56)

References Cited

U.S. PATENT DOCUMENTS

6,943,057	B1 *	9/2005	Shim	H01L 21/50 257/686
6,991,952	B2 *	1/2006	Mizuno	H01S 5/0224 438/115
7,708,452	B2 *	5/2010	Maxik	H05K 1/189 362/650
7,872,273	B2	1/2011	Lin et al.	
7,994,526	B2 *	8/2011	Han	H01L 25/0753 257/98
8,334,656	B2 *	12/2012	Weiss	H05B 37/0245 315/291
8,366,296	B2 *	2/2013	Newman	F21S 8/033 362/249.02
8,513,866	B2 *	8/2013	Breidenassel	F21K 9/1355 313/46
8,525,396	B2	9/2013	Shum et al.	
8,529,095	B2	9/2013	Konaka	
8,540,401	B2	9/2013	Simon et al.	
8,593,044	B2 *	11/2013	Grajcar	F21V 19/0055 313/113
9,217,569	B2 *	12/2015	Prade	F23R 3/14
9,335,036	B2 *	5/2016	Myers	F21S 8/04
2008/0310162	A1 *	12/2008	Thomas	F21V 15/01 362/249.01
2010/0213808	A1	8/2010	Shi	
2013/0027921	A1	1/2013	Lumetta	

* cited by examiner

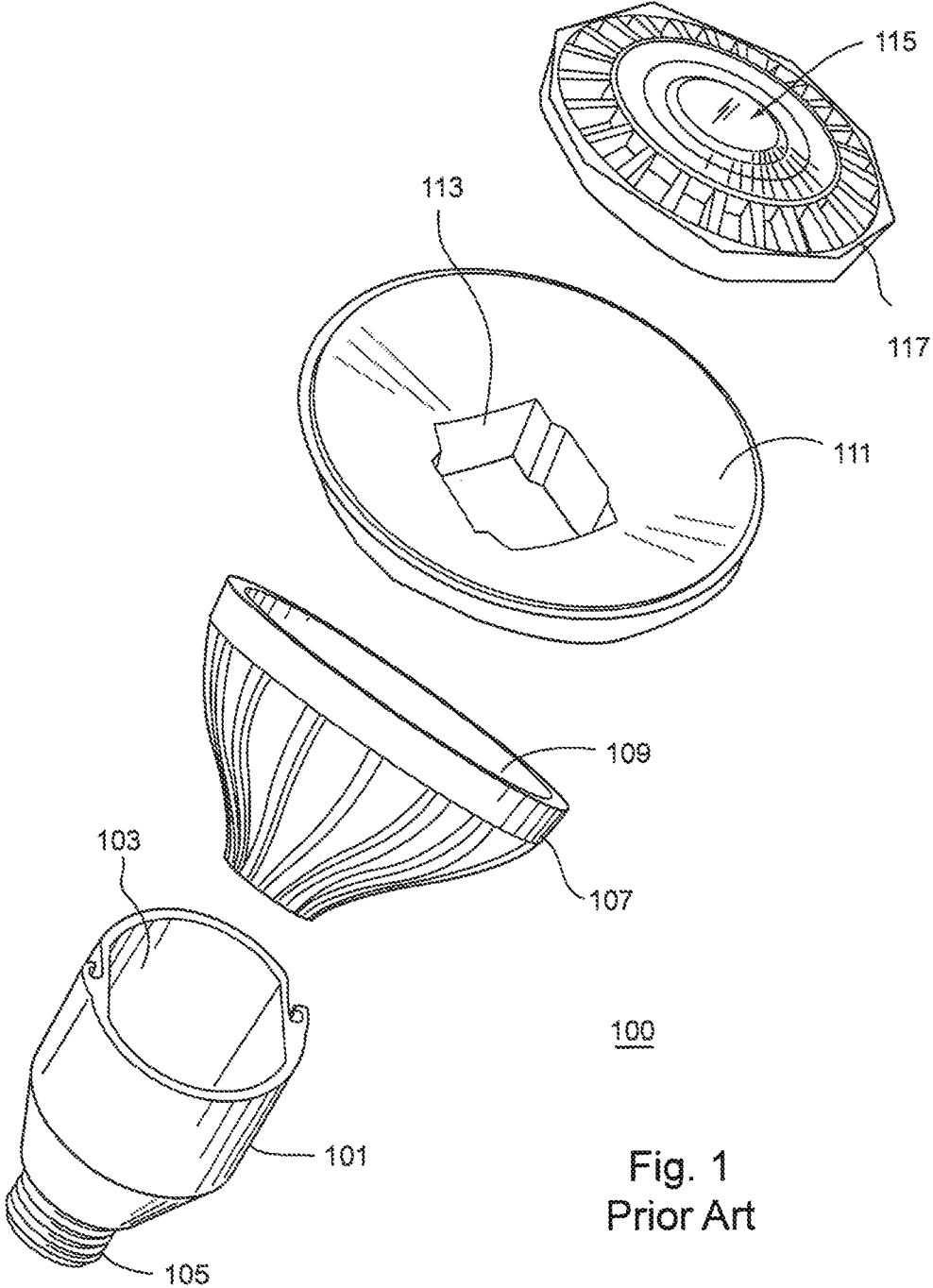


Fig. 1
Prior Art

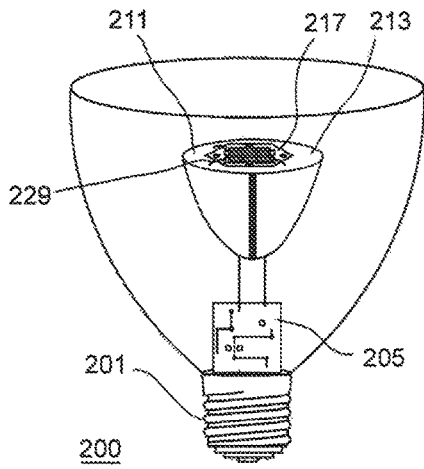


Fig. 2

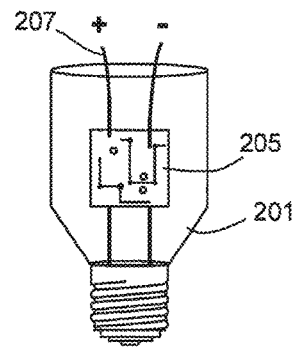


Fig. 2A

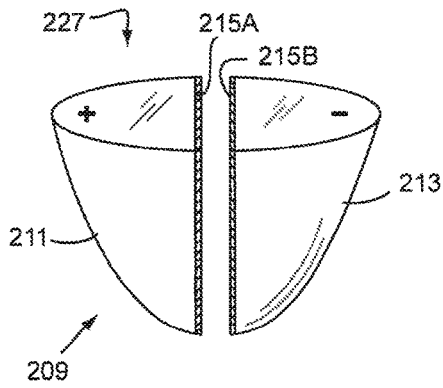


Fig. 2B

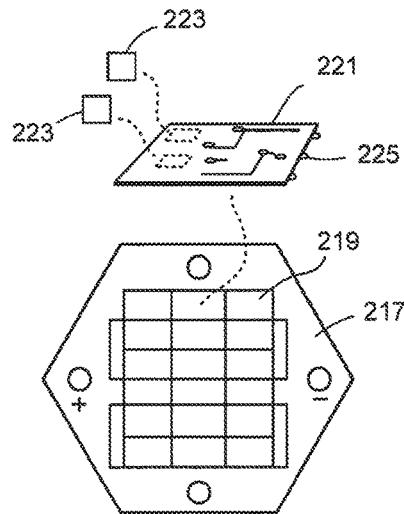


Fig. 2C

**LED LIGHTING ASSEMBLY HAVING
ELECTRICALLY CONDUCTIVE HEAT SINK
FOR PROVIDING POWER DIRECTLY TO AN
LED LIGHT SOURCE**

CROSS REFERENCE TO RELATED
APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 13/559,009 filed on Jul. 26, 2012, which claims priority to and the benefit of U.S. provisional patent application No. 61/511,735 filed on Jul. 26, 2011, entitled "LED LIGHTING ASSEMBLY HAVING ELECTRICALLY CONDUCTIVE HEAT SINK FOR PROVIDING POWER DIRECTLY TO AN LED LIGHT SOURCE," the entire contents of which are incorporated by reference.

FIELD OF THE INVENTION

The present invention relates generally to a light emitting diode (LED) lighting and more particularly to an LED lighting assembly having a heat sink for providing power to one or more LED light sources.

BACKGROUND OF THE INVENTION

High intensity spot and flood lamps, also known as luminaries, using light emitting diodes (LEDs) are now widely used in many different lighting applications. Like its incandescent and fluorescent counterparts, this type of high intensity lighting can efficiently illuminate objects and are used in landscaping, security, industrial, hospitality, household and entertainment settings. As compared to a conventional incandescent bulb, LEDs have a long life span and an excellent anti-shock performance in high power applications. Moreover, high luminance LED lighting can be more easily manufactured in many differing shapes, sizes, brightness and efficiency levels to fit a specific need. LED luminaries are more commonly available in all form factors ranging from the standard A19 household bulb to R150 bulbs used in street light and industrial locations.

One drawback in using high-luminance LED lighting is that it emits a high amount of heat. When used in large groups in a limited space, there are often difficulties in designing and applying the LED as a light source. Since the LED is a semiconductor device, if the heat dissipation efficiency of the luminary is low, the life span of the LEDs will be shortened. Obviously, this is undesirable since shortening the LEDs life would defeat one of its primary benefits of using this type of light source. In order to maintain the life of the LED at expected levels, the LED die is generally kept below approximately 125 degrees Celsius. Thus, designing an LED luminary so that the LED die is maintained at a low temperature can be very challenging.

As seen in U.S. Patent Publication No. 2010/0213808 to Shi, heat pipes are often mounted at the sides of the LED die. The heat pipes and LED both connect to an aluminum substrate at the back of the light so that heat generated from the LEDs can more easily be dissipated. Since the heat is transferred through the heat pipes, this heated air within the pipes can then be further transferred to a heat dissipation cover. Although this type of secondary heat dissipation works to dissipate heat to the external air, there are also more effective ways in lowering heat generated by the LEDs to an acceptable level.

Further, prior art FIG. 1 illustrates an parabolic aluminumized reflector (PAR) style bulb assembly 100 using LEDs

where the bulb assembly has a potted base 101 that works to house an LED power supply driver 103. The base 101 includes a socket 105 that is used to connect within a threaded female AC connection for supplying power to the driver 103. A heat sink base 105 is attached to conical housing 107, which has a substantially truncated conical shape. The conical housing 107 is open at both ends and has a wide opening at its top end 109 for allowing insertion of a heat sink disk 111. The disk 111 includes one or more holes 113 substantially at its center for allowing wire conductors (not shown) originating at driver 103 to extend therethrough. These wire conductors pass through the disk 111 and are used to power an LED light source 115. The LED light source 115 is positioned centrally within a circular housing 117 and includes one or more LED die (not shown) that are used for connecting a plurality of LED semiconductor devices. When assembled, the circular housing 117 is mechanically connected with both the conical housing 107 and heat sink disk 111 for thermally conducting heat away from the LED light source 115. When used outdoors, these heat sink components may also be hermetically sealed for preventing moisture or other contamination from entering the inside of the heat sink assembly.

A problem associated with this type of LED lighting assembly is the complex mechanical nature of housing having various components and pieces that must be separately manufactured and assembled. Those skilled in the art will recognize that other more efficient lighting designs are possible for more effectively removing heat while still maintaining a low manufacturing cost.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying figures, where like reference numerals refer to identical or functionally similar elements throughout the separate views and which together with the detailed description below are incorporated in and form part of the specification, serve to further illustrate various embodiments and to explain various principles and advantages all in accordance with the present invention.

FIG. 1 illustrates an exploded view of a heat sink assembly used in the prior art.

FIGS. 2, 2A, 2B and 2C illustrate an LED lighting assembly having a heat sink for providing power to the LED light source in accordance with an embodiment of the invention.

Skilled artisans will appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated relative to other elements to help to improve understanding of embodiments of the present invention.

DETAILED DESCRIPTION

Before describing in detail embodiments that are in accordance with the present invention, it should be observed that the embodiments reside primarily in combinations of method steps and apparatus components related to an LED lighting assembly having a conductive heat sink for acting an electrical conductor for providing power to an LED light source. Accordingly, the apparatus components and method steps have been represented where appropriate by conventional symbols in the drawings, showing only those specific details that are pertinent to understanding the embodiments of the present invention so as not to obscure the disclosure

with details that will be readily apparent to those of ordinary skill in the art having the benefit of the description herein.

In this document, relational terms such as first and second, top and bottom, and the like may be used solely to distinguish one entity or action from another entity or action without necessarily requiring or implying any actual such relationship or order between such entities or actions. The terms “comprises,” “comprising,” or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element preceded by “comprises . . . a” does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that comprises the element.

FIGS. 2, 2A, 2B and 2C illustrate a new LED lighting assembly using a heat sink for providing power to one or more LED light sources in accordance with an embodiment of the invention. The LED lighting assembly 200 includes a potted base 201 having a threaded lamp connector 203 that is used for supplying AC power to a power supply driver 205. The driver 205 is typically mounted on a printed circuit (PC) board and is housed within the base 201. The driver 205 includes one or more electrical components mounted thereon for converting an AC line voltage, supplied through the threaded lamp connector 203, to DC power at some predetermined voltage and current. The driver 205 also includes one or more electrical conductors 107 extending therefrom for supplying the DC output power. The electrical conductors 107 are used for electrically connecting to a heat sink wedge assembly as described herein. Although shown using wire conductors, those skilled in the art will recognize that respective portions of the driver 205 may be configured so as to be in direct electrical contact with an electrically conductive heat sink. Although not shown herein, this would enable the driver 205 to supply a voltage and current without the use of electrical conductors 107.

FIG. 2B illustrates a heat sink assembly 209 that preferably comprise of a first wedge 211 and second wedge 213 that form the respective halves or complementary pieces of the assembly 209. Although referred herein as “wedge” other analogous terms such as portion, section or segment could also be used. The first wedge 211 and the second wedge 213 are formed of an electrically and thermally conductive material, such as a metal or conductive polymer, for allowing the heat sink to act as an electrical conductor. When assembled, the first wedge 211 and second wedge 213 work as electrical conductors for providing power directly from the driver 205 to one or more LED die and/or light sources as described herein. An electrically isolative material 215a, 215b is positioned between the first wedge 211 and second wedge 213 for providing isolation to prevent electrical contact therebetween as each is used for conducting different voltage polarity (+/-). The electrically isolative material 215a, 215b will preferably also be thermally conductive so as to allow heat to be transferred between the first wedge 211 and second wedge 213 when in its assembled state. Although separate pieces of electrically isolative material 215a, 215b are shown in FIG. 2B, it will be also evident to those skilled in the art that a single material substrate of material may be used directly between the first wedge 211 and second wedge 213 for providing electrical isolation. Moreover, although illustrated as wedges forming a trun-

cated conical bulb-like shape, other shapes such as discs, cubes cones are also within the spirit and scope of the invention.

FIG. 2C illustrates a magnified view of main and sub-board assembly. Both the main circuit board 217 and one or more sub-boards 219 are printed circuit boards that are manufactured from thermal conductive materials such as aluminum or fiber reinforced epoxy laminate (FR-4). These materials operate to remove or “sink” heat away from LEDs and other components mounted thereon. The main board 217 may include a plurality of plated pads 219 or the like for allowing one or more sub-boards 221 to be mounted thereon. Although FIG. 2C illustrates only one sub-board 221, it should be evident to those skilled in the art that the main board 217 will preferably be configured to allow a plurality of sub-boards 217 to be mounted thereon. In many lighting applications, it is not uncommon to see up to 40 sub-boards 221 mounted on the main board 217.

Each sub-board 221 includes one or more semiconductor devices for providing illumination such as LEDs 223 or the like. As is well known in the art, when the LED 223 is forward biased (switched on), electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the color of the light (corresponding to the energy of the photon) is determined by the energy gap of the semiconductor. In this type of application, the preferred color of the LED is white. Each sub-board can include a plurality of solder pads 225 or ball pads that form a ball grid array (BGA) type connection for making an electrical connection to the plated pads 219 on the main board 217. A plurality of thermal pads may also be used below the sub-board 221 to promote thermal conductivity. In an alternative embodiment, the LED die can be soldered directly to the heat sink without the use of a main circuit board or sub-board 221.

When assembled, heat generated by the LED 223 will sink away from the LED through the sub-board 221 to the main board 217. The main board 217 is both electrically and thermally connected with a top portion 227 of the first wedge 211 and second wedge 213. The main board 217 is electrically connected in a manner so the respective polarity of each wedge 211, 213 is attached with the main board 217. When in its assembled state, power supplied by the driver board 205 is supplied through the first wedge 211 (+) and second wedge 213 (-) to electrical conductors on the bottom of the main board 217. Those skilled in the art will appreciate that both the first wedge 211 and second wedge 213 have multiple functionality by acting as both an electrical conductor as well as a thermal conductor. The first wedge 211 and second wedge 213 eliminate the need for a wired connection but also remove heat away from the LEDs 223 mounted on the one or more of the sub-board(s) 221.

Thus, FIG. 2 illustrates the LED lighting assembly in its assembled condition showing the driver board 205 electrically connected with the first wedge 211 and second wedge 213. The main board 217 is shown in an alternative embodiment with one or more wire conductors 229 electrically connecting the main board 217 to the first wedge 211 and second wedge 213 respectively. The first wedge 211 and second wedge 213 can be joined to form a housing shell of the lighting assembly or alternatively an outer cover may also be used over the first wedge 211 and second wedge 213 for protecting the heat sink wedge assembly 209 from damage. Various embodiments of the invention present advantages over the prior art since manufacturing and assembly can be

greatly simplified through the use of a multifunctional heat sink operating both as an electrical conductor and thermal conductor.

In the foregoing specification, specific embodiments of the present invention have been described. However, one of ordinary skill in the art appreciates that various modifications and changes can be made without departing from the scope of the present invention as set forth in the claims below. Accordingly, the specification and figures are to be regarded in an illustrative rather than a restrictive sense, and all such modifications are intended to be included within the scope of present invention. The benefits, advantages, solutions to problems, and any element(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential features or elements of any or all the claims. The invention is defined solely by the appended claims including any amendments made during the pendency of this application and all equivalents of those claims as issued.

I claim:

1. A lighting assembly comprising:
at least two electrically isolated, thermally coupled segments, wherein each of the at least two electrically isolated, thermally coupled segments are electrical conductors and thermal conductors; and
a light emitting diode (LED) source electrically and thermally coupled to the at least two electrically isolated, thermally coupled segments, wherein the LED source receives power from all of the at least two electrically isolated, thermally coupled segments;
wherein the LED source includes:
a thermally conductive main circuit board electrically and thermally coupled to the at least two electrically isolated, thermally coupled segments, and
a plurality of sub-boards mounted to corresponding pads provided on the main circuit board, and wherein at least one LED is mounted to each sub-board.
2. The lighting assembly of claim 1, wherein the at least two electrically isolated, thermally coupled segments further remove heat from the LED source.
3. The lighting assembly of claim 1, wherein each sub-board includes a plurality of solder pads for making electrical connection to the pads of the main circuit board.
4. The lighting assembly of claim 3, further comprising: at least one thermal pad provided below each sub-board to promote thermal conductivity.
5. The lighting assembly of claim 1, further comprising: an electrically isolative material disposed between the at least two electrically isolated, thermally coupled segments.
6. The lighting assembly of claim 5, wherein said electrically isolative material is thermally conductive.
7. The lighting assembly of claim 1, wherein the at least two electrically isolated, thermally coupled segments each have at least one shape selected from the group of wedge, disc or block.
8. The lighting assembly of claim 1, further comprising: a potted base having a threaded lamp connector.
9. The lighting assembly of claim 8, further comprising: a power supply driver, wherein the threaded lamp connector provides AC power to the power supply driver, which converts the AC power to DC output power.
10. The lighting assembly of claim 9, wherein the power supply driver supplies the DC output power to the LED source through the at least two electrically isolated, thermally coupled segments.

11. The lighting assembly of claim 1, wherein the LED source comprises a bare semiconductor die mounted directly to the at least two electrically isolated, thermally coupled segments.

12. The lighting assembly of claim 1, wherein the lighting assembly has a form factor of a parabolic aluminized reflector (PAR) 38 bulb.

13. A lighting assembly comprising:

at least two electrically isolated, thermally coupled segments that are formed of a material that is an electrical conductor and thermal conductor; and

a light emitting diode (LED) source electrically and thermally coupled to all of the at least two electrically isolated, thermally coupled segments, the at least two electrically isolated, thermally coupled segments cooperatively powering the LED source,

wherein the LED source includes:

a thermally conductive main circuit board electrically and thermally coupled to the at least two electrically isolated, thermally coupled segments; and

a plurality of sub-boards mounted to corresponding pads provided on the main circuit board, and wherein at least one LED is mounted to each sub-board.

14. The lighting assembly of claim 13, wherein the at least two electrically isolated, thermally coupled segments remove heat from the LED source.

15. The lighting assembly of claim 13, further comprising:

an electrically isolative material disposed between the at least two electrically isolated, thermally coupled segments.

16. The lighting assembly of claim 15, wherein said electrically isolative material is thermally conductive.

17. The lighting assembly of claim 13, further comprising:

a potted base having a threaded lamp connector; and
a power supply driver, wherein the threaded lamp connector provides AC power to the power supply driver, which converts the AC power to DC output power and wherein the power supply driver supplies the DC output power to the LED source through the at least two electrically isolated, thermally coupled segments.

18. The lighting assembly of claim 13, wherein the LED source comprises a bare semiconductor die mounted directly to the at least two electrically isolated, thermally coupled segments.

19. A lighting assembly comprising:

at least two electrically isolated, thermally coupled segments which are electrical and thermal conductors and at least provide differential power; and

a light emitting diode (LED) source electrically and thermally coupled to the at least two electrically isolated, thermally coupled segments,

wherein the LED source further comprises:

a thermally conductive main circuit board electrically and thermally coupled to the at least two electrically isolated, thermally coupled segments; and

a plurality of sub-boards mounted to corresponding pads provided on the main circuit board, and wherein at least one LED is mounted to each sub-board.

20. The lighting assembly of claim 19, wherein the at least two electrically isolated, thermally coupled segments remove heat from the LED source.

21. The lighting assembly of claim 19, further comprising:

an electrically isolative material disposed between the at least two electrically isolated, thermally coupled segments.

22. The lighting assembly of claim 21, wherein said electrically isolative material is thermally conductive. 5

23. The lighting assembly of claim 19, further comprising a potted base having a threaded lamp connector; and a power supply driver, wherein the threaded lamp connector provides AC power to the power supply driver, which converts the AC power to DC output power and 10 wherein the power supply driver supplies the DC output power to the LED source through the at least two electrically isolated, thermally coupled segments.

24. The lighting assembly of claim 19, wherein the LED source comprises a bare semiconductor die mounted directly 15 to the at least two electrically isolated, thermally coupled segments.

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