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**Ticktin**

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(54) **LED ARRAY LIGHTING ASSEMBLY**

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§ 371 (c)(1),
(2), (4) Date: **Mar. 4, 2013**

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PCT Pub. Date: **Nov. 1, 2012**

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(51) **Int. Cl.**
***F21V 15/00*** (2006.01)
***F21V 8/00*** (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC .............. ***G02B 6/0005*** (2013.01); ***F21V 29/20*** (2013.01); ***F21V 5/04*** (2013.01); ***F21V 7/0008*** (2013.01); *F21V 19/001* (2013.01); ***F21V 23/007*** (2013.01); ***F21V 29/004*** (2013.01); *F21W 2131/406* (2013.01); *F21Y 2101/02* (2013.01); *F21Y 2105/001* (2013.01); *F21Y 2111/002* (2013.01); *F21Y 2113/005* (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC ...... F21V 29/004; F21V 29/2293; F21K 9/19
USPC .......................... 362/147, 373, 404, 148, 364
See application file for complete search history.

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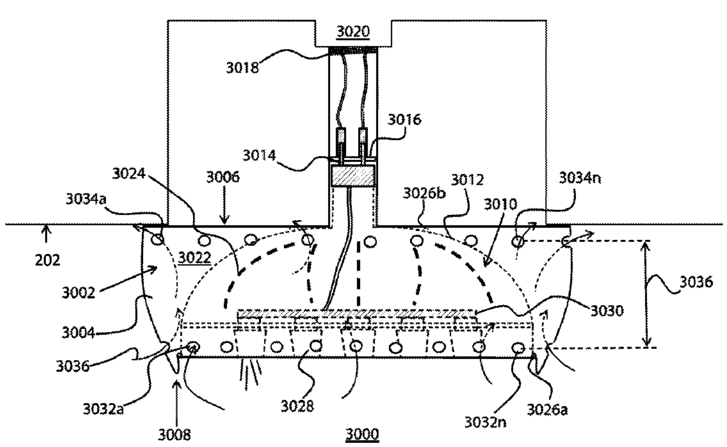
*Primary Examiner* — Sean Gramling
(74) *Attorney, Agent, or Firm* — The Concept Law Group, P.A.; Scott D. Smiley; Mark C. Johnson

(57) **ABSTRACT**

A lighting assembly including a plurality of LED light sources and a light-guide assembly with a plurality of light guides each having a proximal end terminating in a recess and a distal end, a mating cap coupled to the proximal end of the plurality of light guides and aligning each recess with a corresponding LED light source in the plurality of LED light sources, and a light-emitting lens with a receiving surface coupled to the distal end of each of the plurality of light guides and able to transfer light emitted from the distal end of each of the plurality of light guides into the light-emitting lens and a curved light-emitting surface opposite the receiving surface, the light-emitting surface able to emit light from within the light-emitting lens, the light within the light emitting lens being a blend of light emitted from two of the plurality of light guides.

**14 Claims, 15 Drawing Sheets**



(51) **Int. Cl.**

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|---|---|
| ***F21V 29/00*** | (2006.01) |
| ***F21V 5/04*** | (2006.01) |
| ***F21V 7/00*** | (2006.01) |
| ***F21V 23/00*** | (2006.01) |
| ***G02B 6/04*** | (2006.01) |
| *F21V 19/00* | (2006.01) |
| *F21W 131/406* | (2006.01) |
| *F21Y 101/02* | (2006.01) |
| *F21Y 105/00* | (2006.01) |
| *F21Y 111/00* | (2006.01) |
| *F21Y 113/00* | (2006.01) |
| *F21V 3/00* | (2006.01) |
| *F21K 99/00* | (2010.01) |

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

CPC ............... ***G02B 6/0008*** (2013.01); ***G02B 6/04*** (2013.01); *F21V 3/00* (2013.01); *F21K 9/135* (2013.01); ***F21V 29/763*** (2013.01); ***F21V 29/83*** (2013.01)

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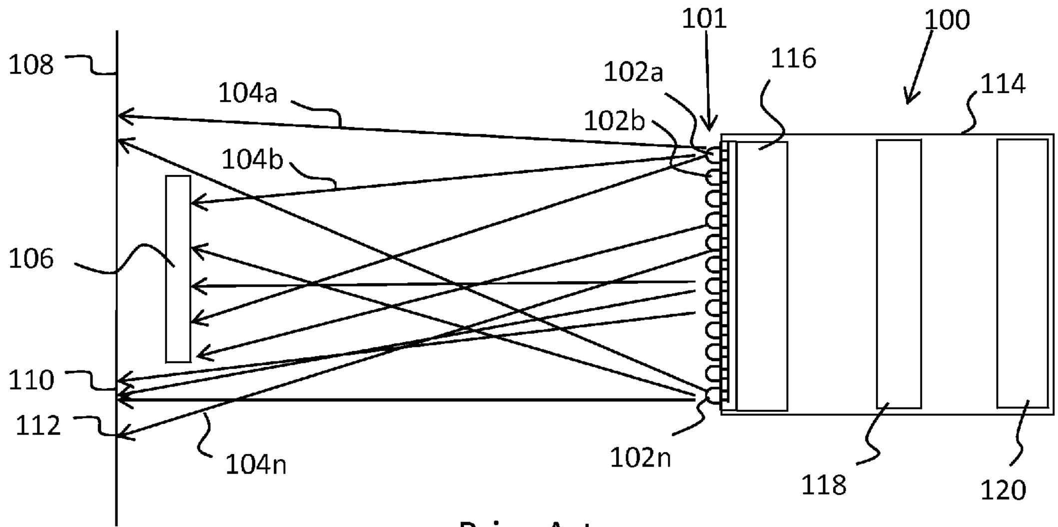
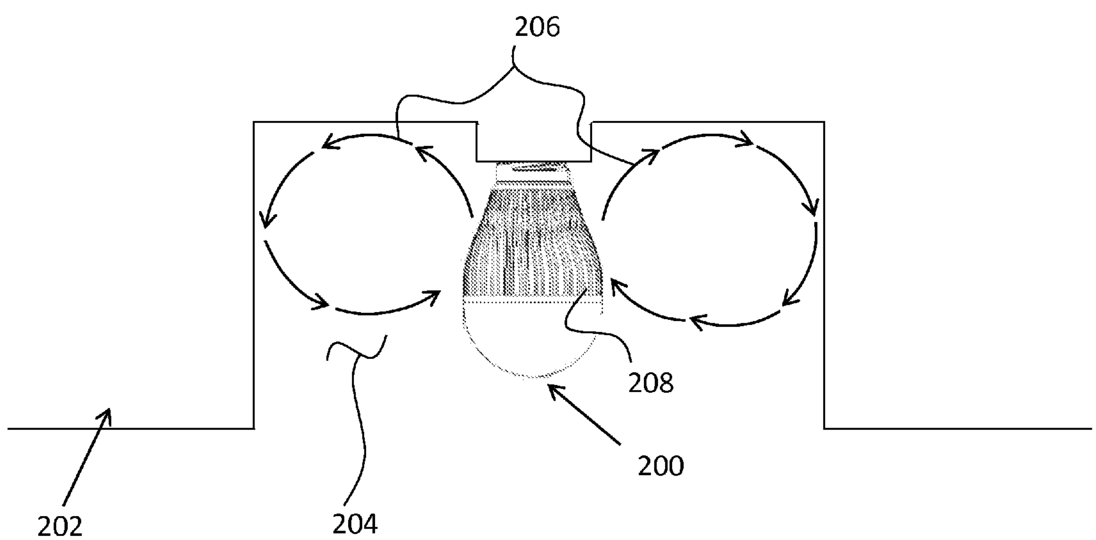
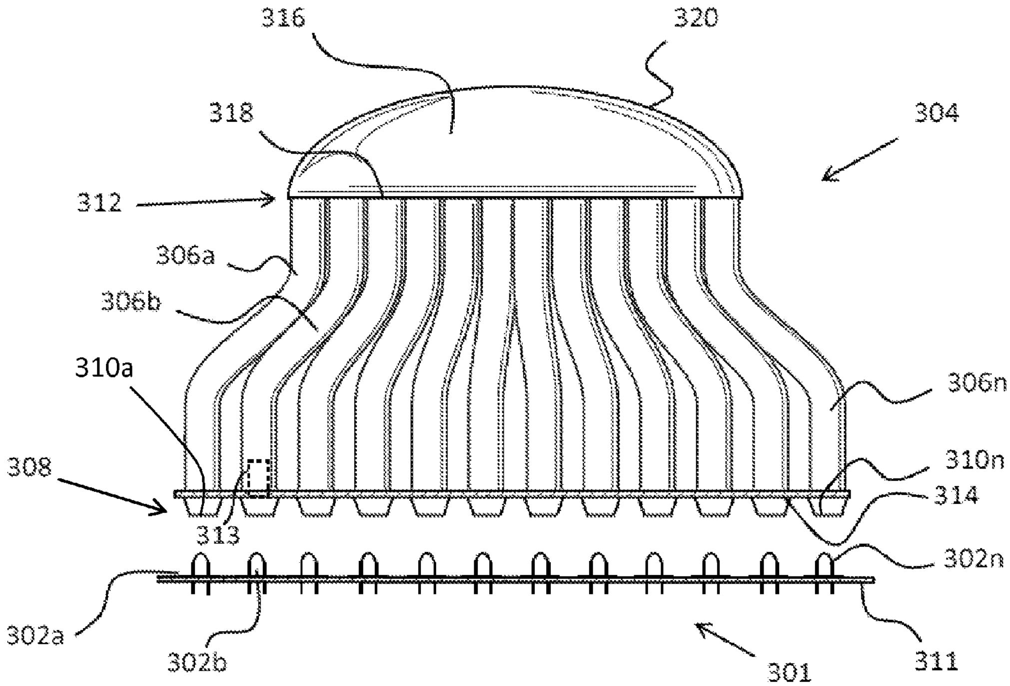


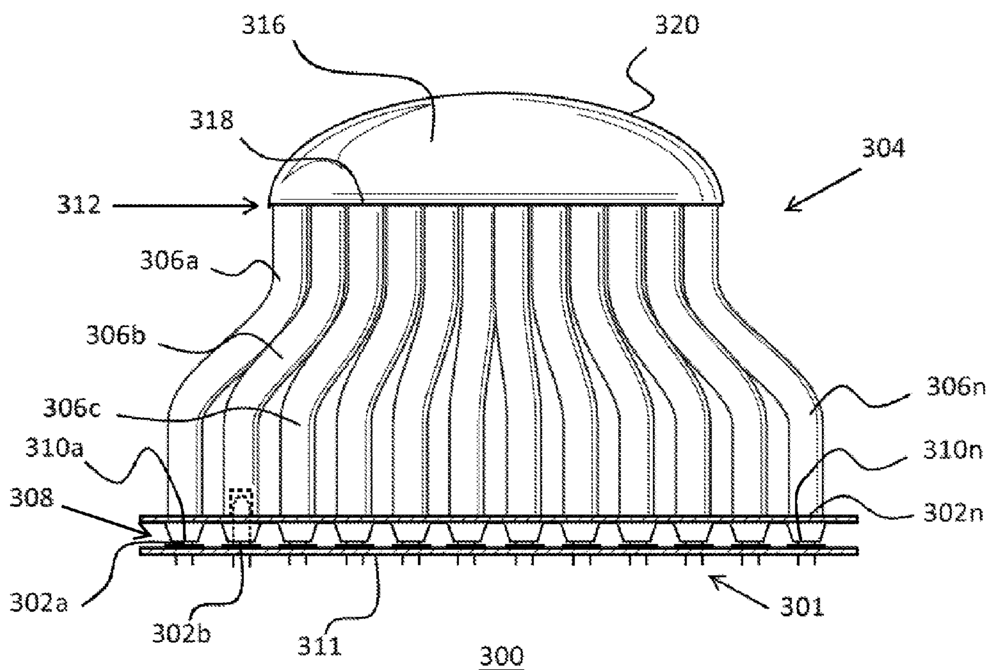

Prior Art
FIG. 1




Prior Art
FIG. 2




300
FIG. 3




300
FIG. 4

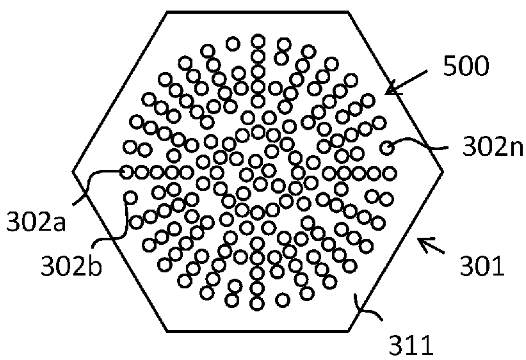



FIG. 5

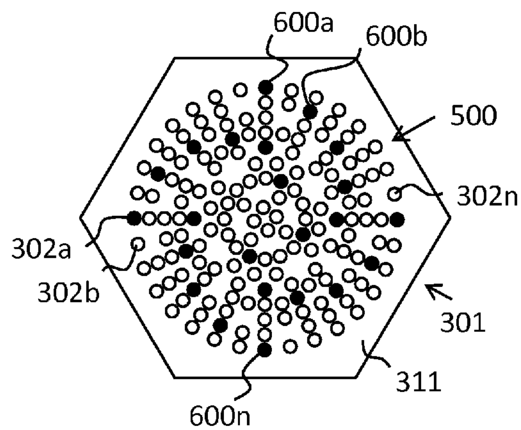



FIG. 6

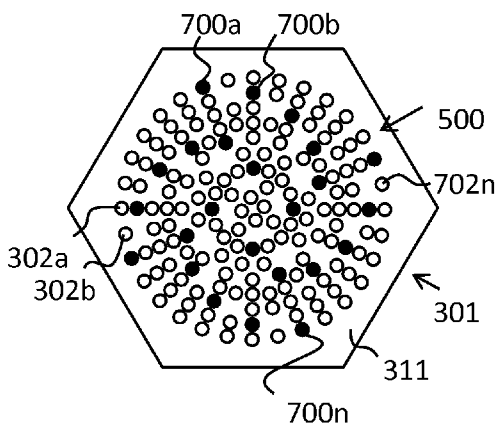



FIG. 7

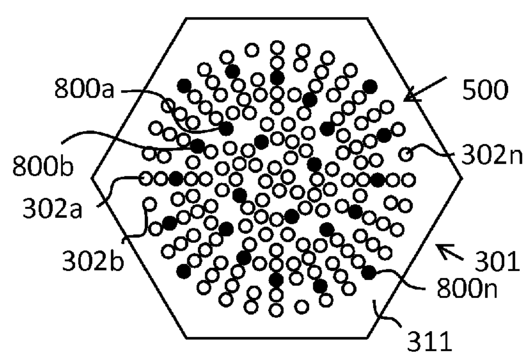



FIG. 8

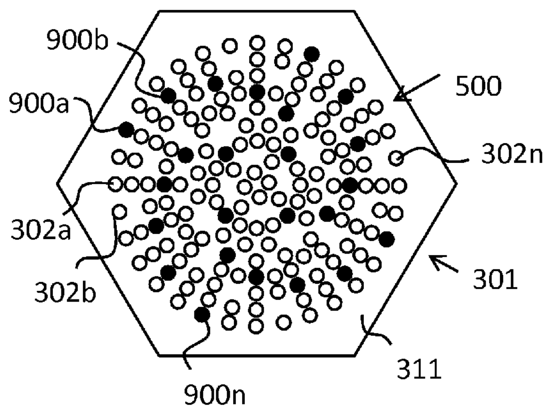



FIG. 9

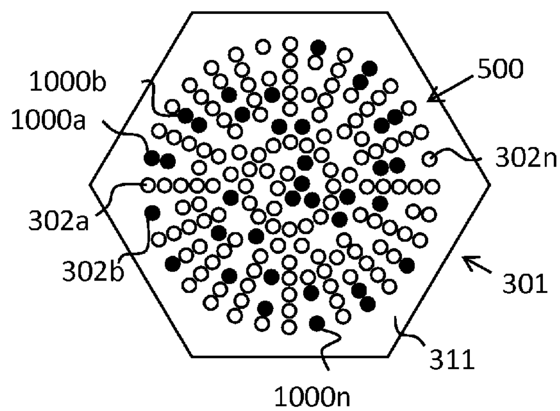



FIG. 10

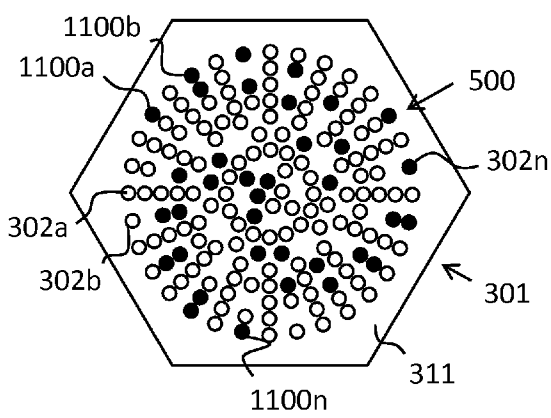



FIG. 11

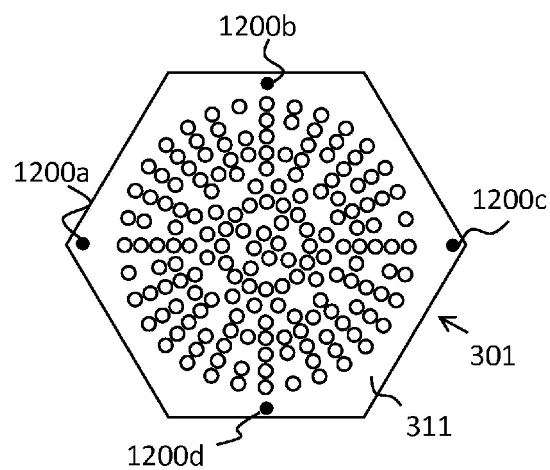



FIG. 12

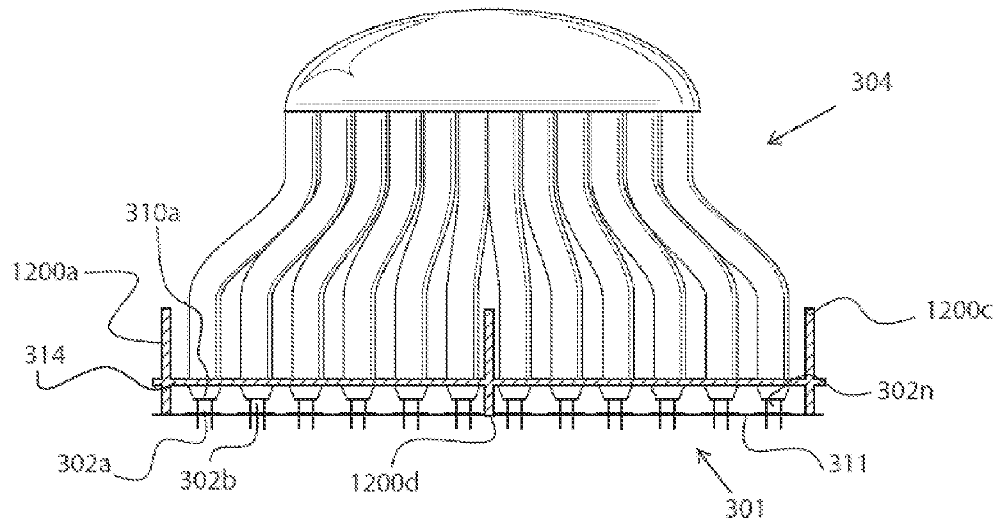
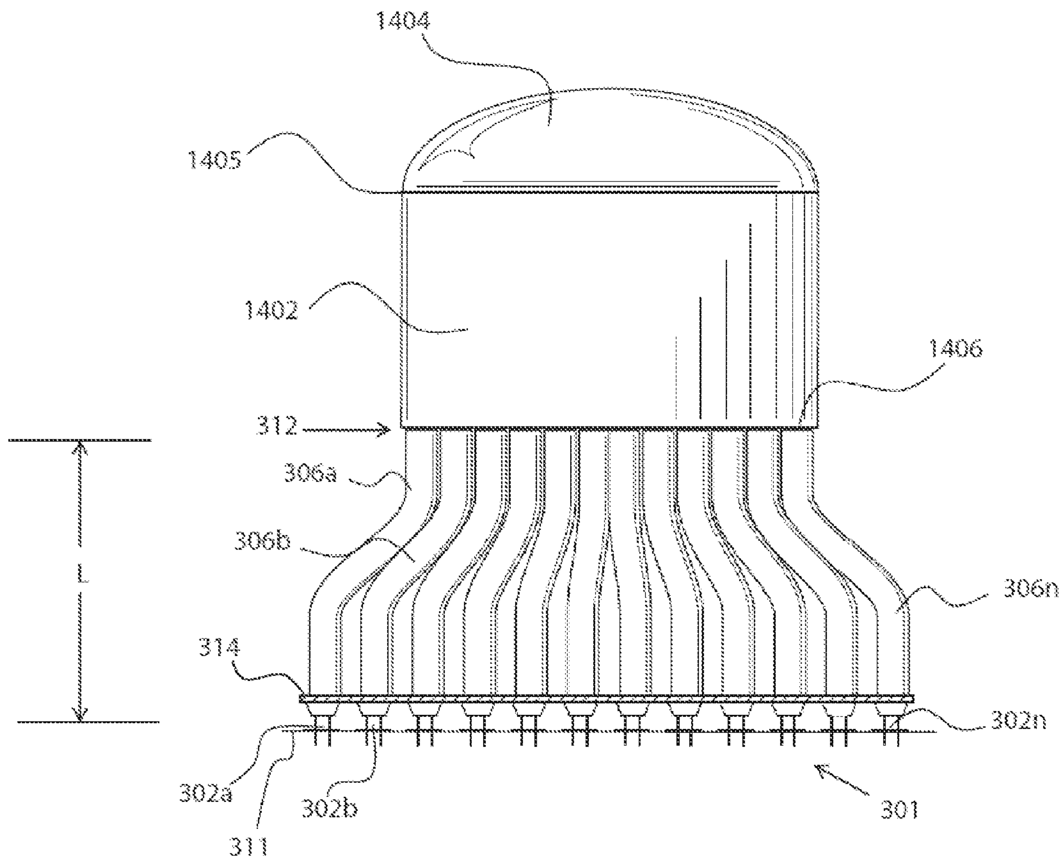
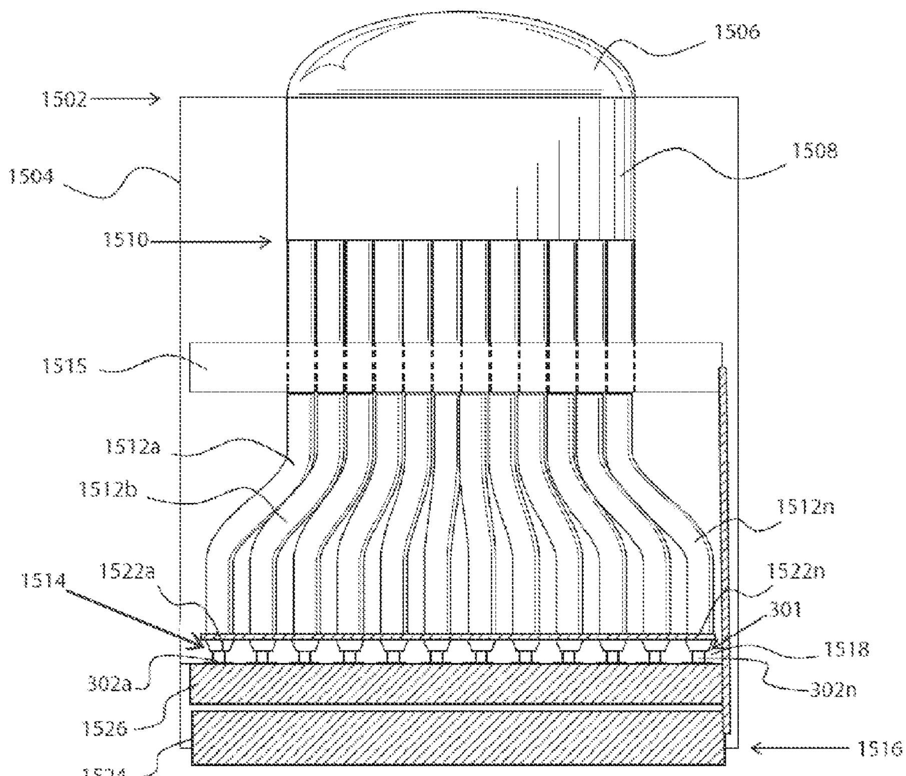


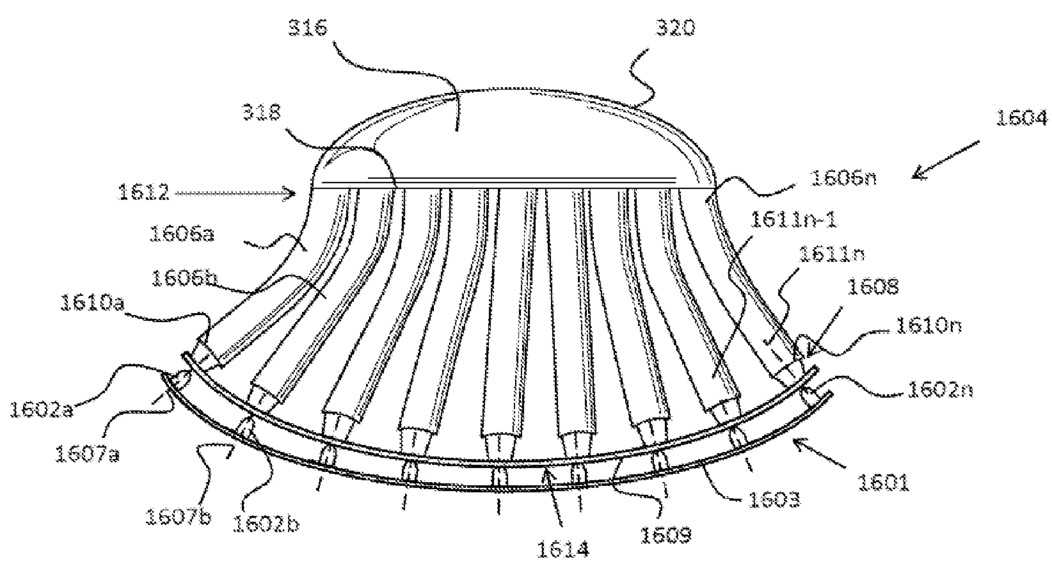

FIG. 13




1400
FIG. 14




1500
FIG. 15




1600
FIG. 16

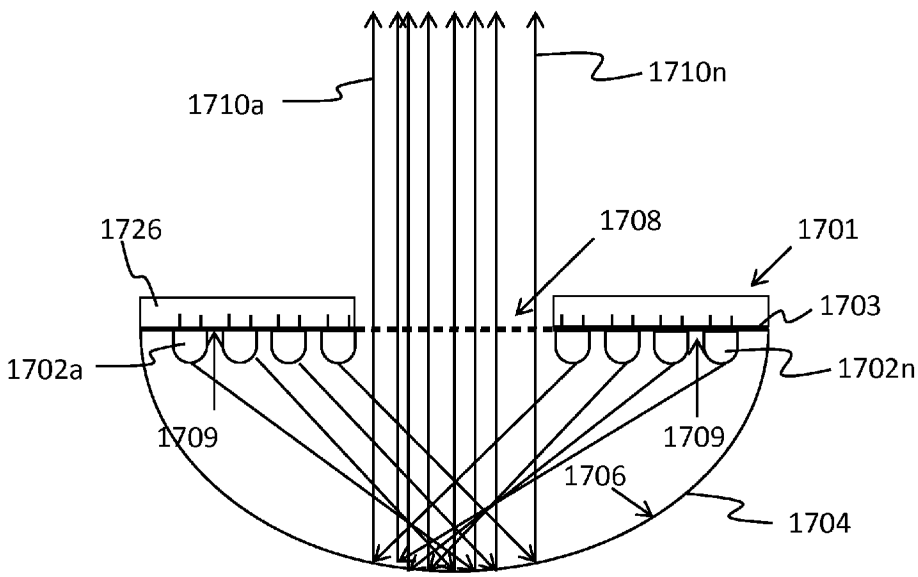



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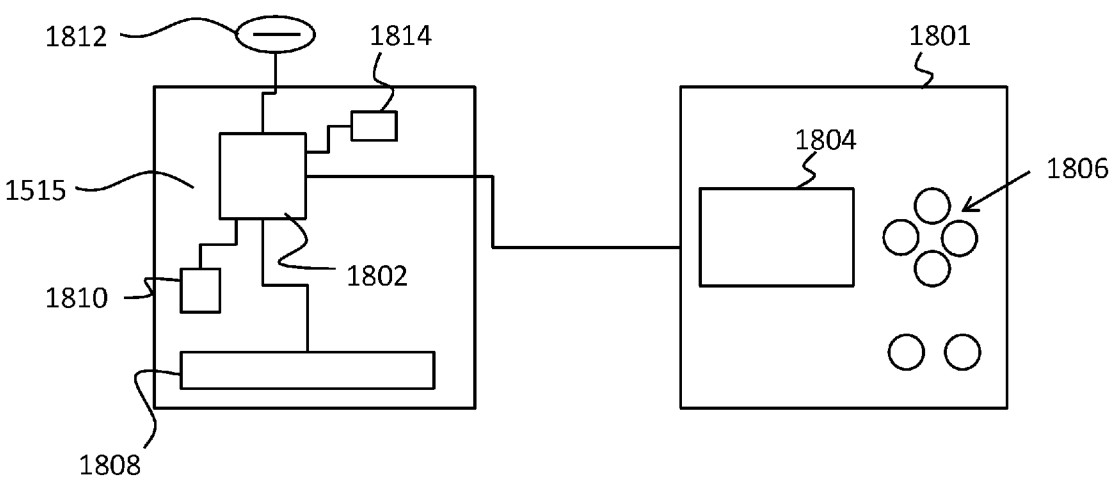
FIG. 17

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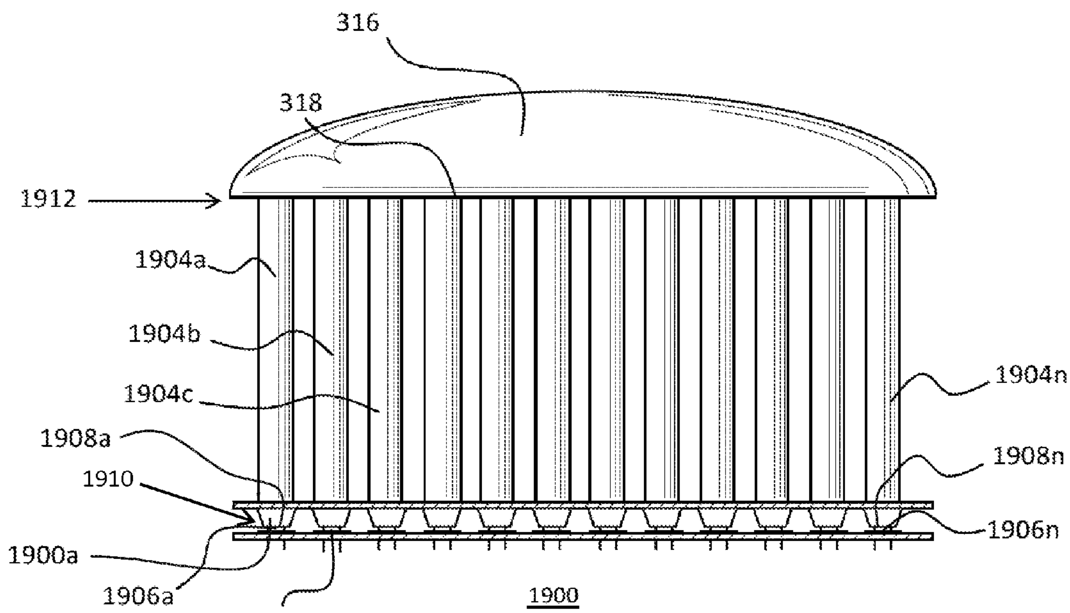
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318
1912
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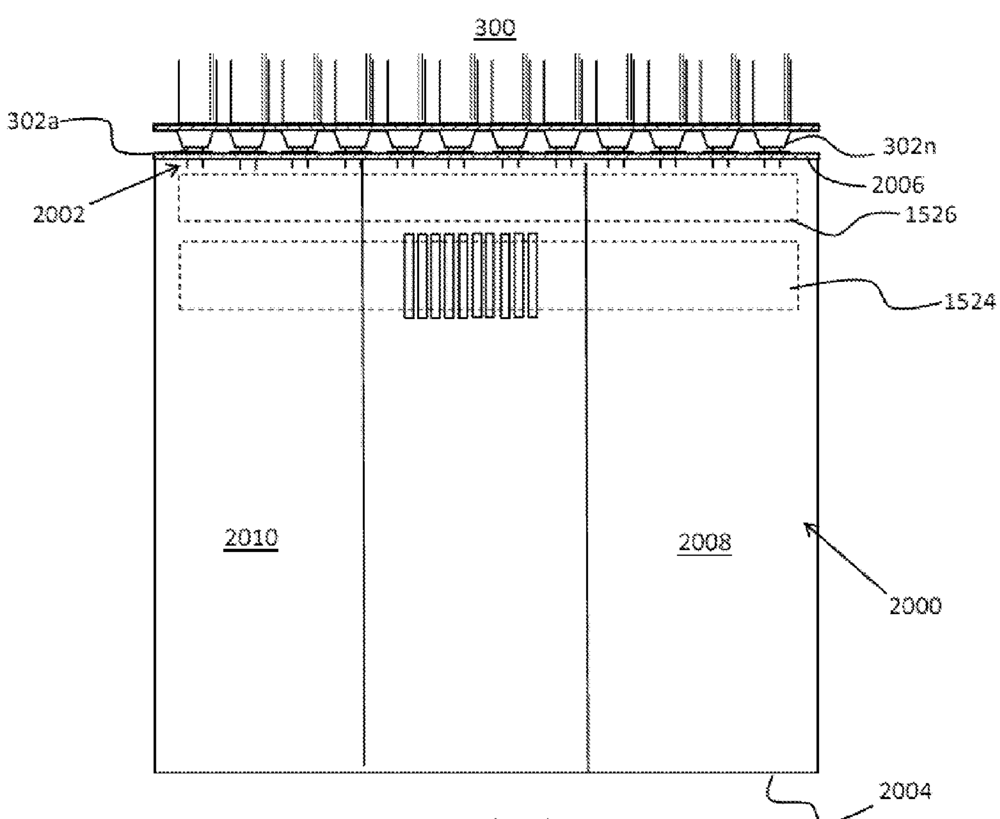
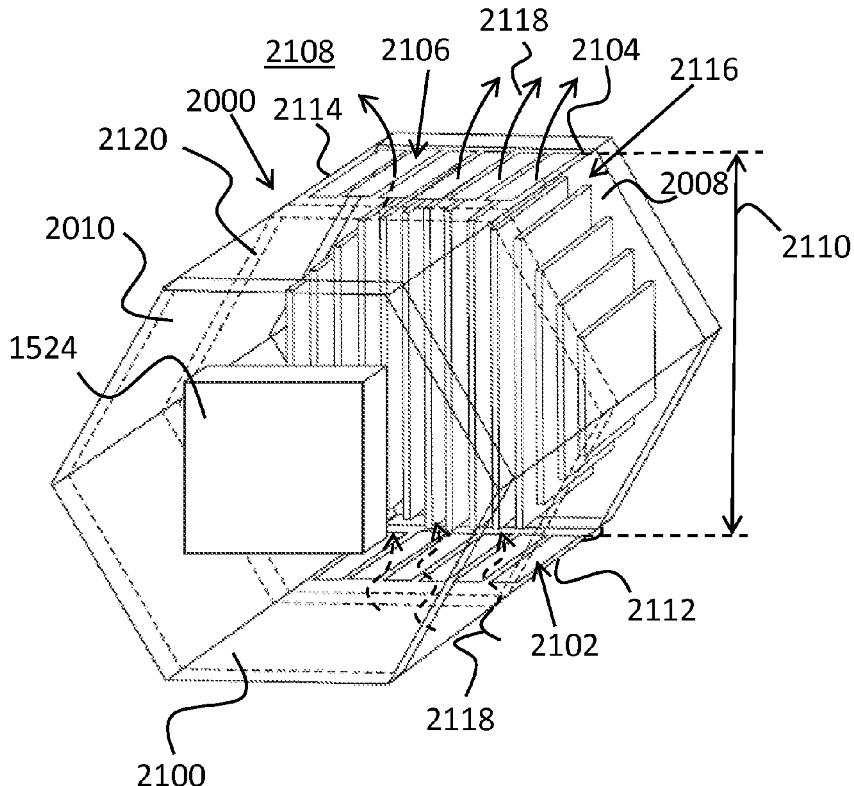
1904c
1904n
1908a
1908n
1910
1906n
1900a
1906a
1906b
1900
FIG. 19


300
302a
302n
2006
2002
1526
1524
2010
2008
2000
2004
FIG. 20


2108
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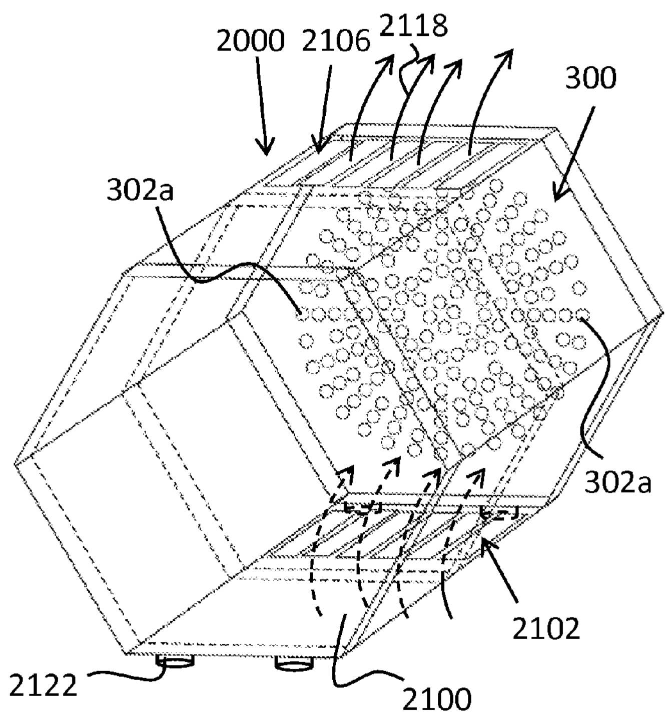
2118
2100

FIG. 21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2118
300
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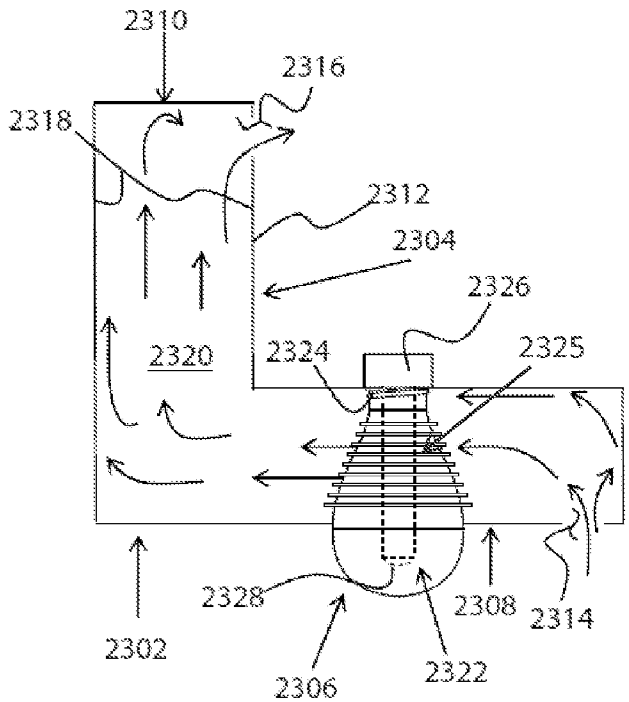
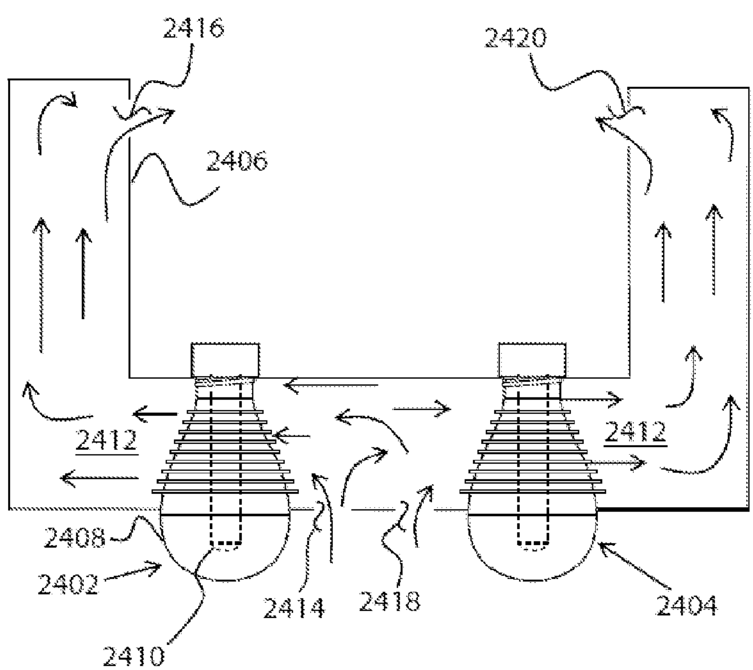
302a
2102
2122
2100

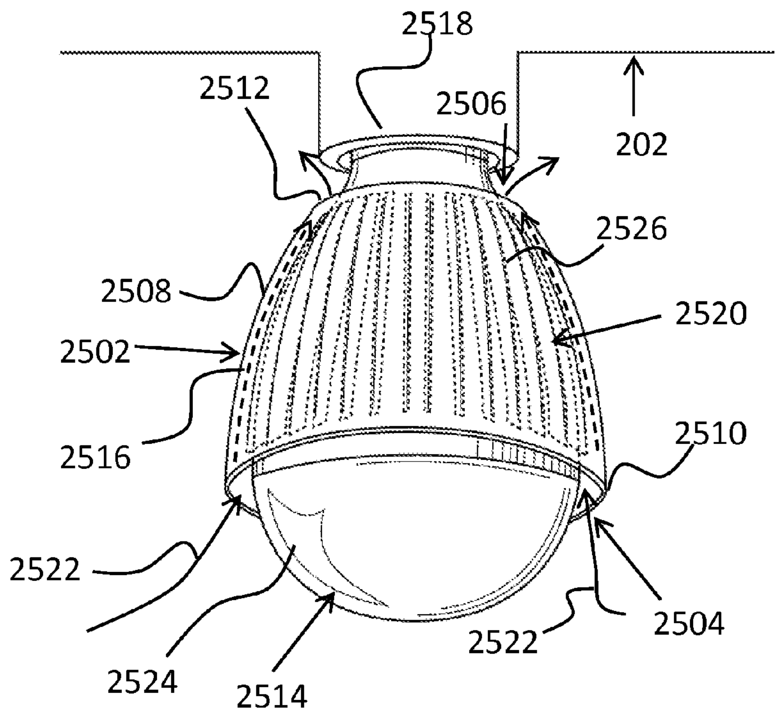
FIG. 22



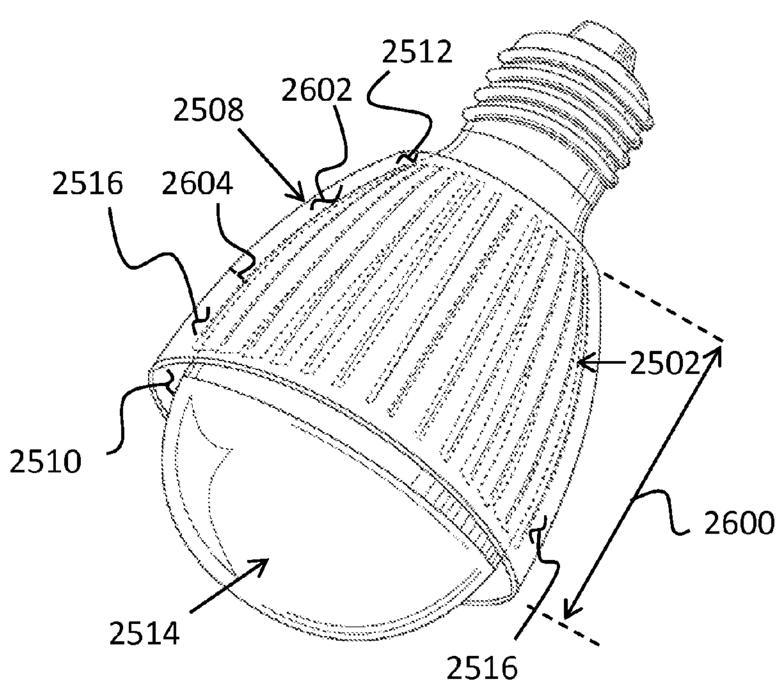

2300
FIG. 23



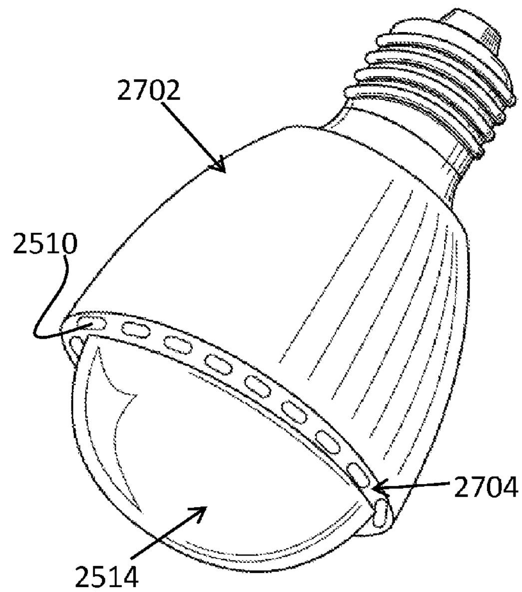

2400
FIG. 24




2500
FIG. 25




2500
FIG. 26




2700
FIG. 27

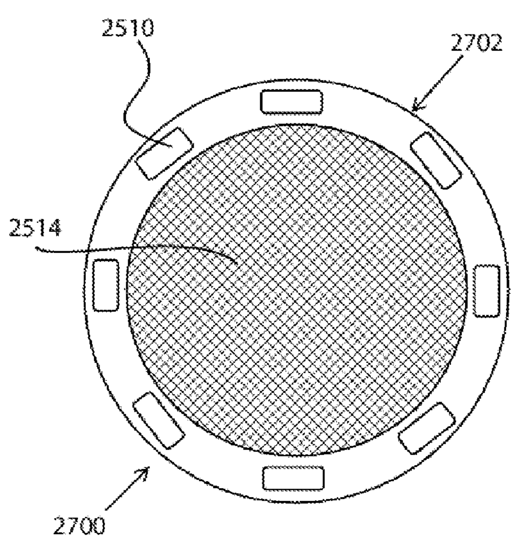



FIG. 28

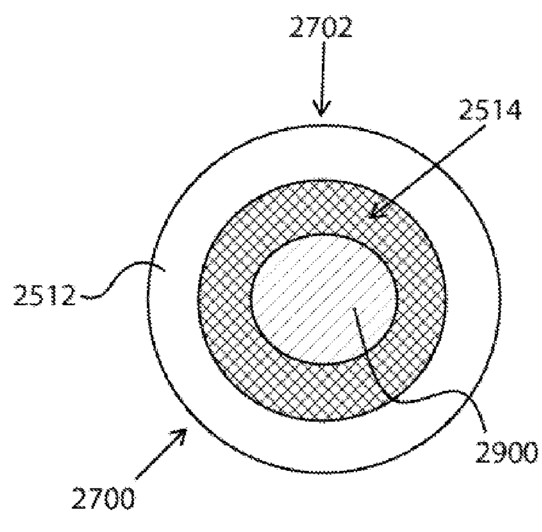
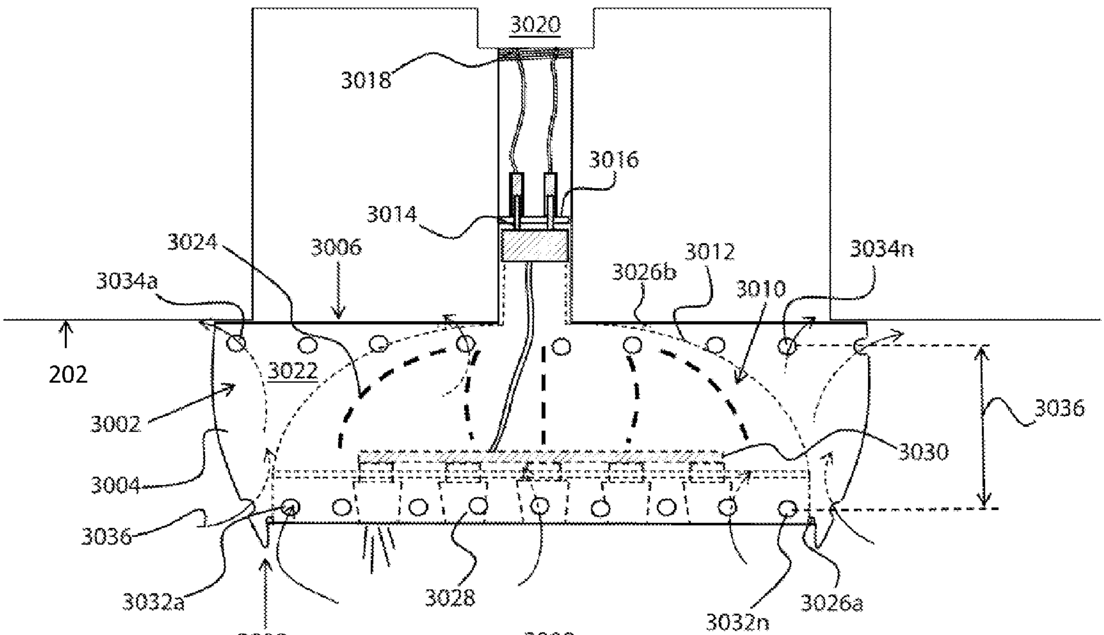
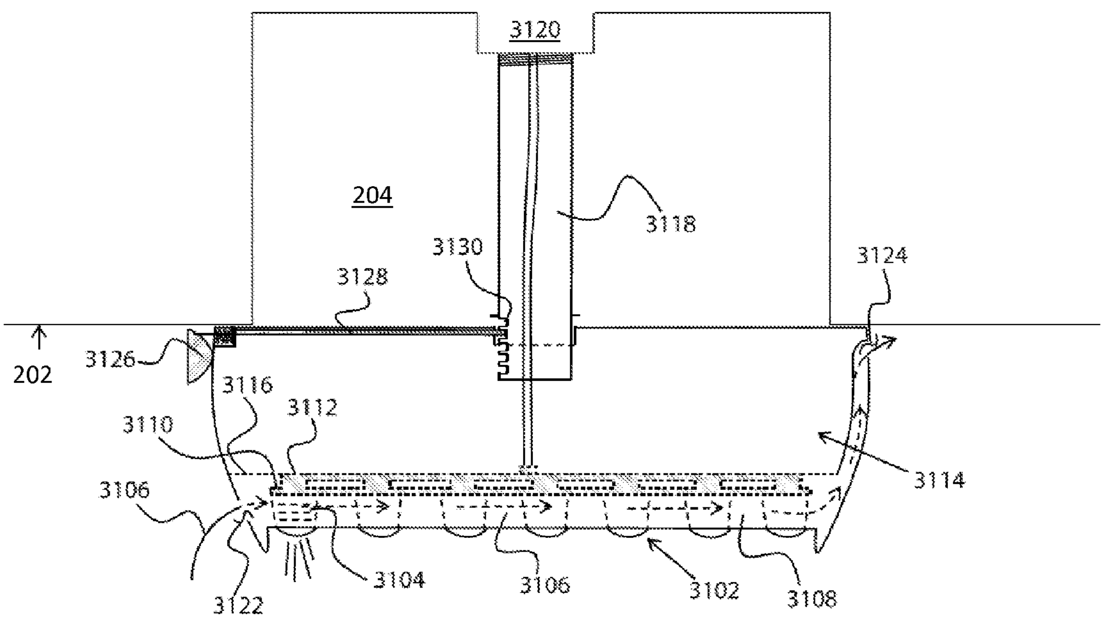


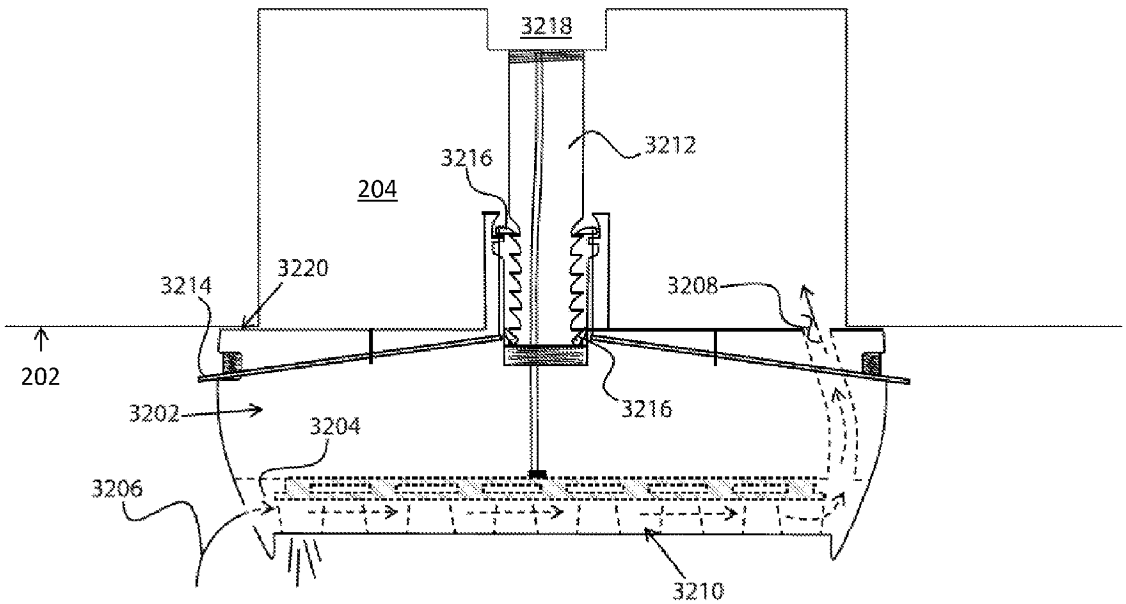

FIG. 29



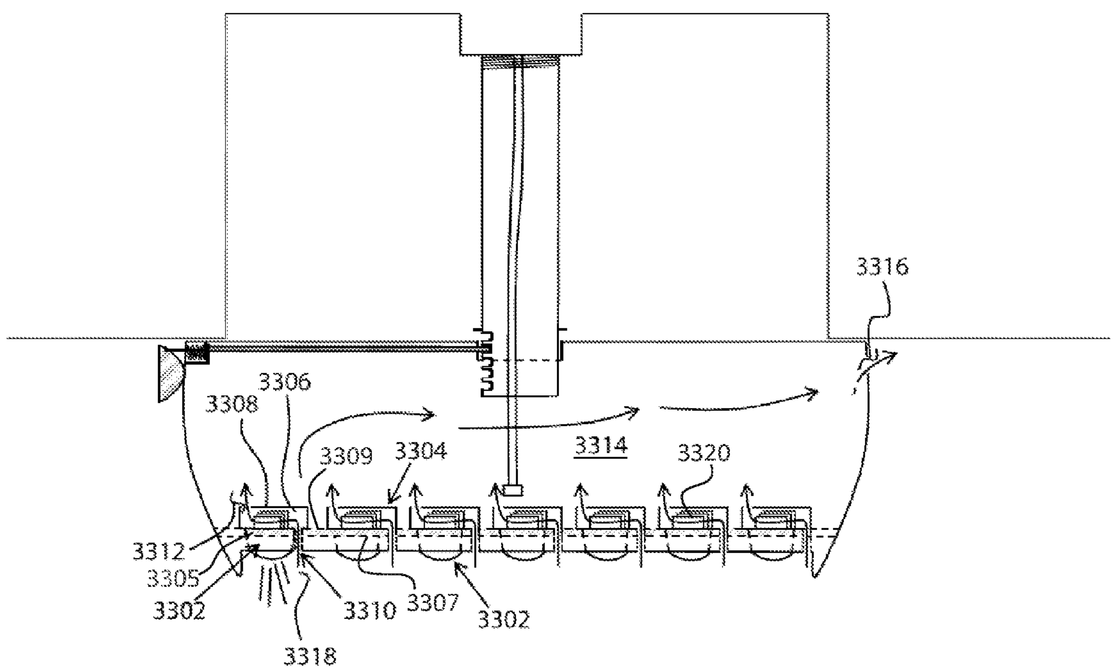

3000
FIG. 30



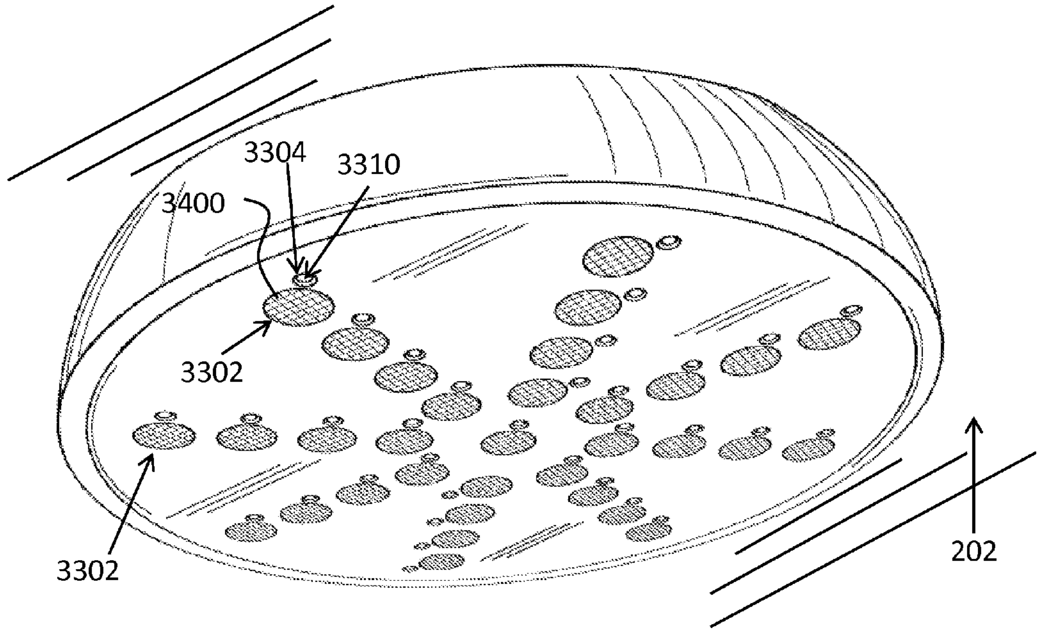

3100
FIG. 31




3200
FIG. 32




3300
FIG. 33




3300
FIG. 34

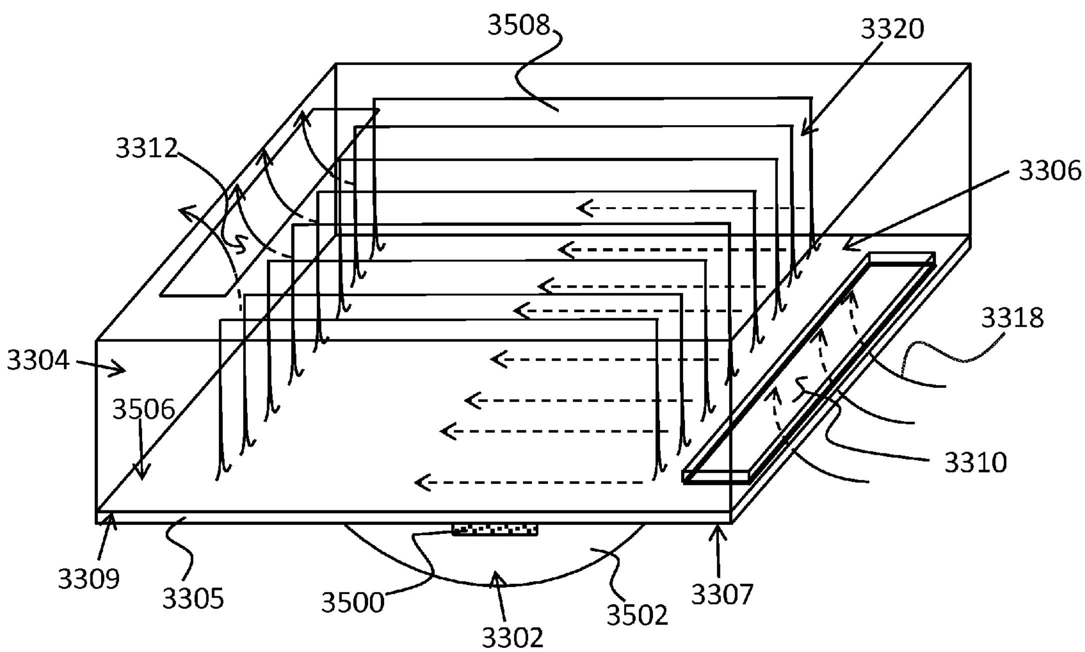



FIG. 35

## LED ARRAY LIGHTING ASSEMBLY

### FIELD OF THE INVENTION

The present invention relates generally to lighting assemblies utilizing LED arrays, and more particularly relates to an LED array lighting assembly that blends light from multiple elements forming the array. The present invention also specifically relates to an LED lighting assembly that is operable to utilize outside ambient air to facilitate the cooling process without the need for electric fans.

### BACKGROUND OF THE INVENTION

Lighting structures vary widely and accordingly with the applications in which they are utilized. In residential situations, for example, regular low-power lighting is sufficient to light the target area. In other situations, however, such as television studios, high-powered industrial lighting structures are needed. In these studio-type situations, high-powered lighting is utilized to project light onto the subject being filmed or photographed. By providing enhanced lighting, i.e., bright light, the camera is able to focus and clearly depict the subject matter.

Traditionally, brighter lighting means higher-power bulbs, higher energy consumption, and a corresponding increase in heat produced by the light. In fact, in many commercial studio lighting structures, a person cannot safely stand within 3 feet of the light without experiencing a physical discomfort or actual harm from the heat being radiated from the device. Fortunately, at least in film or photography studios, many of these lights are attached to the ceiling, placing them out of reach from most people. However, the increased heat being radiated into the atmosphere must be compensated for by cooling the building or room in which the lighting structure is being used. Therefore, these high-power bulbs are not only are dangerous and expensive to purchase, but end up greatly increasing operating costs in both energy consumption of the lights and in cooling costs for the area. Also, in applications where the lighting structures cannot be placed out of contact from people, such as on-location shoots, the intensely-hot lights provide a constant safety concern.

One application that particularly suffers from the shortcomings of the prior art is the surgical environment. In an operating room, the temperature should remain cool to prevent disease and bacteria from spreading. At the same time, bright lights are needed to light the surgery area. Prior-art bright lights produce heat and are often located in close proximity to the surgeon's head, causing him or her to sweat and/or be uncomfortable. The heat also raises the temperature in the operating room.

Recently, light emitting diode (LED) structures have begun appearing in myriad applications. This is partly because LED lights use dramatically less power than traditional bulbs and, as a result, also produce very little heat. In addition, the lifespan of an LED bulb greatly exceeds that most known prior-art light bulbs. For these reasons, it is becoming clear that LEDs will soon be a viable option for completely replacing most bulbs as lighting elements within the home and elsewhere.

Several entities have experimented with utilizing LEDs in studio lighting structures. Because LEDs do not produce the output of standard light bulbs, in particular, the high-powered studio lights, multiple LEDs, organized in arrays, are utilized to replace each bulb. One example of such a light **100** is shown in FIG. **1**, which includes an array **101** of individual LED light sources **102***a-n* (where a-n represents any number range from 1 to infinity) broadcasting light rays **104***a-n* in the direction of a subject **106** being lit. Unfortunately, the light rays **104***a-n* produced by each LED in the array **101** hit the subject **106** at a unique angle, which produces a multitude of shadows with varying intensities on the background **108**. More specifically, the light from some of the light sources **102***a-n* in the array **101** reach the background and are additive, thereby producing a first shadow intensity level **110**. This first intensity level **110** is also dependent on the proximity between the radiating light source **102** and the background **108**. On other portions of the background **108** a different number of the light sources **102***a-n* in the array **101** reach the background and produce a second shadow intensity level **112**, which is different from the first shadow intensity level **110**. FIG. **1** provides only a two-dimensional depiction of this multi-shadow effect. With a three-dimensional subject, the differences in shadow intensities are greatly enhanced. The adjacent multiple shadows are not only unattractive, but are sometimes rather eerie looking. For at least this reason, LED light arrays have not been well received in a studio lighting situation.

Although LEDs generate less heat than typical traditional light bulbs, they, nevertheless, do generate heat. Currently-known LED studio lighting structures require the presence of one or more fans that constantly run and pull air from the environment into the lighting structure and across a set of heat dissipating heat-sink fins. These fans require energy, add weight and cost to the lighting device, provide a point of potential electrical failure (which can serious damage the remaining components that will become too hot), and create noise.

LED lighting devices and systems have come into widespread use in homes and buildings. Known LED structures for regular ambient lighting currently dissipate heat by exposing one or more portions of the LED structure to atmospheric conditions. Some known LED lighting assemblies also expose portions, e.g., the power supply **120** and/or driver/controller circuit **118**, if applicable, to the atmosphere as those portions of LEDs also generate heat. In addition, a limited number of LED lighting assemblies have one or more heat sinks **116** attached thereto to facilitate the dissipation of heat through convection. However the form, and although having a generally longer life than traditional bulbs, these known LEDs, when ran for normal periods of time, experience a drastic reduction in bulb intensity.

This is specifically applicable when LED lighting assemblies are obstructed or placed in enclosed spaces where hot air is not easily exchanged with cooler air. One example of this is LED lighting structures placed within a recessed lighting "can." When an LED light is placed within small or enclosed areas, the space surrounding the LED bulbs is not cooled and much of the generated heat from the bulbs remains in that area. This effect is shown in FIG. **2**, which illustrates a prior-art LED lighting assembly **200** within a recessed portion **204** of a ceiling **202**. The hot air, represented with arrows **206**, is not effectively dissipated and continually subjects the assembly **200** to air at high temperatures. As the LED assembly **200** is continually subjected to high temperatures, the lifespan of the assembly **200** is reduced and the probability of heat-related malfunctions is increased. This also renders any heat sinks **208** coupled to those prior-art assemblies **200** to be ineffective and inefficient as they still suffer from the same problems as described above, i.e. the LED assembly **200** is still subjected to previously dissipated heat.

Furthermore, as LED lighting technology is still being developed or has increased manufacturing costs, when compared to those prior-art lighting assemblies, those costs are generally placed on the consumer. As such, LED lighting assemblies can range anywhere from three to ten times more per unit price than for traditional lighting assemblies, such as incandescent light bulbs. Many users dilute those additional initial up-front costs with the continued energy savings associated with LEDs. Therefore, most users desire to maintain the LED lighting assembly lifespan as long as possible to maximize cost efficiency.

Therefore, a need exists to overcome the problems with the prior art as discussed above.

## SUMMARY OF THE INVENTION

The invention provides an LED array lighting assembly that overcomes the hereinafore-mentioned disadvantages of the heretofore-known devices and methods of this general type and that provides an array of LED light sources that are coupled to a light-emitting lens through a plurality of light guides, where the light-emitting lens blends the light from each of the individual light guides and transmits a blended light product. Furthermore, the novel lighting assembly provides a light-generation source that is disposed in a central or rear section of the overall lighting assembly and guided to a light-emitting lens through one or more light guides. The light assembly further provides one embodiment where the heat generated from the LED light source is effectively and efficiently dissipated. The generated heat is removed by a constant stream of cool air that is driven through the device by a novel heat-dissipating air engine created by a novel structure as described herein.

With the foregoing and other objects in view, there is provided, in accordance with the invention, a lighting assembly that includes a plurality of LED light sources and a light-guide assembly featuring a plurality of light guides, each light guide having a proximal end terminating in a recess and a distal end opposite the proximal end. The light-guide assembly further includes mating cap coupled to the proximal end of the plurality of light guides and that aligns each recess with a corresponding LED light source in the plurality of LED light sources. A light-emitting lens has a receiving surface coupled to the distal end of each of the plurality of light guides and able to transfer light emitted from the distal end of each of the plurality of light guides into the light-emitting lens and a curved light-emitting surface opposite the receiving surface, the light-emitting surface able to emit light from within the light-emitting lens, the light within the light emitting lens being a blend of light emitted from least two of the plurality of light guides.

In accordance with a further feature of the present invention, the light-guide assembly further includes a physical arrangement of the distal ends of the plurality of light guides, where a spacing between each of the distal ends of the plurality of light guides is less than a spacing between each of the proximal ends of the plurality of light guides.

In accordance with another feature, an embodiment of the present invention includes a length separating the proximal end of the of light guides from the distal end of the of light guides and at least one curvature along the length.

In accordance with a further feature of the present invention, a light-source controller is electrically coupled to and operable to energize selective ones of the plurality of LED light sources.

In accordance with a yet one more feature of the present invention, the light-source controller is at least partially disposed between the proximal end of the plurality of light guides and the distal end of the plurality of light guides.

In accordance with an additional feature of the present invention, the plurality of light guides further includes a length separating the proximal end from the distal end and the midsection or length passes through at least a portion of the light-source controller.

In accordance with a yet one more feature of the present invention, the mating cap includes a curved mating surface placing a central axis of at least two of the recesses at angles that differ from each other and a curved mating surface places a central axis of at least two of the recesses at angles that differ from each other.

In accordance with another feature, an embodiment of the present invention also includes a light-guide assembly and a light-source assembly, the light-source assembly including a plurality of LED light sources disposed in a light-emitting arrangement. The light-guide assembly has a light-receiving portion forming a plurality of LED light-receiving recesses, each disposed to correspond to a one of the plurality of LED light sources in the light-emitting arrangement. A light-emitting portion is shaped to broadcast light rays in one or more directions away from the LED light sources. A light-channeling portion including a plurality of light-communication channels, each light-communication channel coupling a one of the plurality of LED light-receiving recesses to the light-emitting portion, wherein the light-emitting portion is further shaped to combine light emitted from at least two of the light-communication channels prior to broadcasting.

In accordance with yet another feature, an embodiment of the present invention includes an overall dimension of the light-emitting arrangement that exceeds an overall dimension of the light-channeling portions coupled at the light-emitting portion.

In accordance with a further feature of the present invention, the plurality of light-communication channels further includes at least one curvature between the LED light-receiving recesses and the light-emitting portion.

In accordance with one more feature of the present invention, a light-source controller is electrically coupled to and operable to energize selective ones of the plurality of LED light sources and the light-source controller is at least partially disposed between the LED light-receiving recesses and the light-emitting portion where the plurality of light-communication channels have a portion that passes through at least a portion of the light-source controller.

Although the invention is illustrated and described herein as embodied in an LED array lighting assembly, it is, nevertheless, not intended to be limited to the details shown because various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims. Additionally, well-known elements of exemplary embodiments of the invention will not be described in detail or will be omitted so as not to obscure the relevant details of the invention.

Other features that are considered as characteristic for the invention are set forth in the appended claims. As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which can be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one of ordinary skill in the art to variously employ the present invention in virtually any appropriately detailed structure. Further, the terms and phrases used herein are not intended to be limiting; but rather, to provide an understandable description of the invention. While the specification concludes with claims defining the features of the invention that are regarded as novel, it is believed that the invention will be better understood from a consideration of the following description in conjunction with the drawing figures, in which like reference numerals are carried forward. The figures of the drawings are not drawn to scale.

Before the present invention is disclosed and described, it is to be understood that the terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting. The terms "a" or "an," as used herein, are defined as one or more than one. The term "plurality," as used herein, is defined as two or more than two. The term "another," as used herein, is defined as at least a second or more. The terms "including" and/or "having," as used herein, are defined as comprising (i.e., open language). The term "coupled," as used herein, is defined as connected, although not necessarily directly, and not necessarily mechanically.

As used herein, the terms "about" or "approximately" apply to all numeric values, whether or not explicitly indicated. These terms generally refer to a range of numbers that one of skill in the art would consider equivalent to the recited values (i.e., having the same function or result). In many instances these terms may include numbers that are rounded to the nearest significant figure. In this document, the term "longitudinal" should be understood to mean in a direction corresponding to an elongated direction of the structure being referred to. The terms "program," "software application," and the like as used herein, are defined as a sequence of instructions designed for execution on a computer system. A "program," "computer program," or "software application" may include a subroutine, a function, a procedure, an object method, an object implementation, an executable application, an applet, a servlet, a source code, an object code, a shared library/dynamic load library and/or other sequence of instructions designed for execution on a computer system. The term "downstream," as used herein indicates a location along a path of flow that is further down the path of flow and occurs after a reference point in that path of flow.

## 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 explain various principles and advantages all in accordance with the present invention.

FIG. **1** is a downward-looking elevational view of a prior-art lighting fixture broadcasting light on a subject as well as the background behind the subject;

FIG. **2** is a front elevational view of a prior-art LED light assembly recessed within a wall ceiling;

FIG. **3** is a side elevational, partially cross-sectional, view of a lighting-assembly featuring a light-guide assembly aligned with an adjacent light-source assembly in accordance with the present invention;

FIG. **4** is a side elevational, partially cross-sectional, view, of the light-guide assembly of FIG. **3** mated with the light-source assembly of FIG. **3**;

FIG. **5** is a top plan view of the light-source assembly of FIG. **3** illustrating an exemplary arrangement of light sources in accordance with the present invention;

FIG. **6** is a top plan view of the light-source assembly of FIG. **3** illustrating an exemplary arrangement of red light sources in accordance with the present invention;

FIG. **7** is a top plan view of the light-source assembly of FIG. **3** illustrating an exemplary arrangement of green light sources in accordance with the present invention;

FIG. **8** is a top plan view of the light-source assembly of FIG. **3** illustrating an exemplary arrangement of blue light sources in accordance with the present invention;

FIG. **9** is a top plan view of the light-source assembly of FIG. **3** illustrating an exemplary arrangement of amber (yellow) light sources in accordance with the present invention;

FIG. **10** is a top plan view of the light-source assembly of FIG. **3** illustrating an exemplary arrangement of warm white light sources in accordance with the present invention;

FIG. **11** is a top plan view of the light-source assembly of FIG. **3** illustrating an exemplary arrangement of cool white light sources in accordance with the present invention;

FIG. **12** is a top plan view of a light-source assembly featuring alignment posts in accordance with the present invention;

FIG. **13** is a side elevational partial view of a lighting-assembly featuring a light-guide assembly aligned with a light-source assembly through use of the alignment posts of FIG. **12**;

FIG. **14** is a side elevational partial view of a lighting-assembly featuring a light-guide assembly that includes a lens body disposed between the lens and the light guides in accordance with an exemplary embodiment of the present invention;

FIG. **15** is a side elevational, cross-sectional, view of a lighting-assembly where a light-source assembly is located in a proximal portion of the lighting-assembly, a lens is located in a distal portion of the lighting-assembly, and a driver/controller circuit is disposed between the light-source assembly and the lens in accordance with an exemplary embodiment of the present invention;

FIG. **16** is a side elevational partial view of a lighting-assembly featuring a light-guide assembly aligned with an adjacent light-source assembly, where the support surface of the light-source assembly features a curvature and the mating cap of the light-guide assembly features a corresponding curvature in accordance with the present invention;

FIG. **17** is a side elevational, cross-sectional, partial view of a lighting-assembly featuring an inverted light-source assembly with a light-transmitting aperture positioned above a parabolic mirror in accordance with the present invention;

FIG. **18** is a schematic view of a driver/controller circuit communicatively coupled to a user interface of a lighting-assembly in accordance with the present invention;

FIG. **19** is a side elevational partial view of a lighting-assembly featuring a light-guide assembly with straight light guides aligned with an adjacent light-source assembly in accordance with the present invention;

FIG. **20** is a side elevational, cross-sectional, partial view of a light-source assembly of a proximal portion of the lighting-assembly is coupled to a heat sink surrounded by a LED light casing in accordance with an exemplary embodiment of the present invention;

FIG. **21** is a perspective, cross-sectional, view of a lighting-assembly contained within a LED light casing in accordance with an exemplary embodiment of the present invention;

FIG. **22** is a perspective, partially hidden, view of a hexagon-shaped light-assembly housing with air vents in a bottom surface and a top surface, the air vents collectively pulling and pushing, respectively, air through the light-assembly housing in accordance with an exemplary embodiment of the present invention;

FIG. **23** is a side elevational, cross-sectional, view of a self-cooled lighting assembly with a light-bulb assembly placed at least partially within an airflow channel defined by an airflow chamber in accordance with one exemplary embodiment of the present invention;

FIG. **24** is a side elevational, cross-sectional, view of a self-cooled lighting assembly with two light-bulb assemblies placed at least partially within an airflow channel defined by an airflow chamber in accordance with another embodiment of the present invention;

FIG. **25** is a side elevational, cross-sectional, view of a self-cooled lighting assembly coupled to a standard-sized light bulb outlet with a light-bulb assembly subjected to a stream of air entering a first opening and exiting a second opening in accordance with an embodiment of the present invention;

FIG. **26** is a downwardly-looking perspective, partially cross-sectional, view of the self-cooled lighting assembly of FIG. **25** in accordance with an embodiment of the present invention;

FIG. **27** is a downward-looking perspective view of the self-cooled lighting assembly of FIG. **25** with a portion of the airflow chamber covering portions of the first opening in accordance with another embodiment of the present invention;

FIG. **28** is a top plan view of the self-cooled lighting assembly of FIG. **27** in accordance with an embodiment of the present invention;

FIG. **29** is a bottom plan view of the self-cooled lighting assembly of FIG. **27** in accordance with an embodiment of the present invention;

FIG. **30** is a side elevational, cross-sectional, view of a self-cooled lighting assembly in operation that is coupled to a standard-sized light bulb outlet, with a light-bulb assembly that is removably-couplable to airflow chamber and a stream of air entering a plurality of first openings and exiting a plurality of second openings a height above the first openings in accordance with an exemplary embodiment of the present invention;

FIG. **31** is a side elevational, cross-sectional, view of a self-cooled lighting assembly in operation that is coupled to a standard-sized light bulb outlet, with the assembly being adjustable in accordance with an embodiment of the present invention;

FIG. **32** is a side elevational, cross-sectional, view of a self-cooled lighting assembly in operation that is coupled to a standard-sized light bulb outlet, with the assembly being adjustable in accordance with an embodiment of the present invention;

FIG. **33** is a side elevational, cross-sectional, view of a self-cooled lighting assembly in operation with individualized airflow chambers inducing a stream of airflow across multiple light bulb assemblies when the assembly is in operation in accordance with an exemplary embodiment of the present invention;

FIG. **34** is an upwardly-looking perspective partial view of the lighting assembly of FIG. **33** when coupled to the ceiling of a building in accordance with an embodiment of the present invention; and

FIG. **35** is a perspective, partially cross-sectional, view of the individualized airflow chamber coupled to a portion of the light bulb assembly shown in FIG. **33**.

## DETAILED DESCRIPTION

While the specification concludes with claims defining the features of the invention that are regarded as novel, it is believed that the invention will be better understood from a consideration of the following description in conjunction with the drawing figures, in which like reference numerals are carried forward. It is to be understood that the disclosed embodiments are merely exemplary of the invention, which can be embodied in various forms.

The present invention provides a novel and efficient lighting assembly for use in studios and other applications. Embodiments of the invention provide an array of LED light sources that are coupled to a light-emitting lens through a plurality of light guides, where the light-emitting lens blends the light from each of the individual light guides and transmits a blended light product. In addition, embodiments of the invention provide a light-generation source that is disposed in a central or rear section of the overall lighting assembly and guided to a light-emitting lens through one or more light guides. Furthermore, embodiments of the invention provide a parabolic reflector that receives and directs light generated by an array of LED light sources within a lighting assembly.

Referring now to FIG. **3**, one embodiment of a lighting assembly in accordance with the present invention is shown in an elevational partial view. FIG. **3** shows several advantageous features of the present invention, but, as will be described below, the invention can be provided in several shapes, sizes, combinations of features and components, and varying numbers and functions of the components. The first example of a lighting assembly **300**, as shown in FIG. **3**, includes a light-source assembly **301** which includes a plurality of LED light sources **302***a-n*. As used herein, the nomenclature "a-n" is intended to represent a numerical range starting from any number "a" and spanning to any number "n" that is greater than the number "a." LED lights are well known in the art. The specific details of LED construction are deemed not necessary for the instant discussion and will, therefore, not be described herein.

The lighting assembly **300** further includes a light-guide assembly **304** that features a plurality of light-communication channels formed from light guides **306***a-n*. Light guides are known in the art and are also referred to as "optical waveguides," "light pipes," "optical fibers," or other similar terms. The present invention is not restricted to any particular technology or physicality and contemplates utilization of any connecting element that is capable of communicating light waves from one end of the transmitting element to the other. For example, the light guides **306***a-n*, in accordance with one embodiment of the present invention, are optical fibers with a cylindrical dielectric waveguide (nonconducting waveguide) that transmits light along its axis, by the process of total internal reflection. The light guides **306***a-n* may include a core surrounded by a cladding layer, both of which are made of dielectric materials. To confine the optical signal in the core, the refractive index of the core is selected to be much greater than that of the cladding. The boundary between the core and cladding may either be abrupt, in step-index fiber, or gradual, in graded-index fiber and serves to contain the light waves within the core. As shown in FIG. **3**, the light guides **306***a-n* fully extend to mate with a portion of the light sources **302***a-n*.

Each light guide **306***a-n* will be described with reference to its light-receiving proximal end **308** and its light-emitting distal end **312** opposite the proximal end **308**, both of which are illustrated in FIG. **3**. The proximal end **308** of each light guide **306***a-n* terminates in an LED light-receiving recess **310***a-n*. More specifically, in one embodiment, each light guide **306***a-n* may have cores of transparent material within each recess **310***a-n*. FIG. **3** also illustrates a cross-section of light guide **306***b* with an aperture **313** formed in a bottom area shaped to receive the end portion of the light source **302***b*. The light guide may have transparent cores that may be formed in the proximal end **308** of the light guides **306***a-n*. In other embodiments, as shown in FIG. **19**, the cores **1900***a-n* are removably-couplable to the recesses **310***a-n* with male-female inserts. With the cores **1900***a-n* being removably-couplable, the cores **1900***a-n* may have various-sized apertures **313** to be sized to receive various-sized light sources **302***a-n*. In further embodiments, the light guide **306***a-n* may not have cores such that the recesses **310***a-n* would directly couple with the end of the light sources **302***a-n* and the light guides **306***a-n* may terminate in flat surfaces that physically couple to junctions that couple the recesses **310***a-n* to the light guides **306***a-n*.

In accordance with one embodiment of the present invention, the lighting assembly **300** includes a mating cap **314** that is coupled to the proximal end **308** of the plurality of light guides **306***a-n*. The mating cap **314** secures each of the recesses **310***a-n* in a fixed configuration. Advantageously, the fixed configuration of the recesses **310***a-n* is selected so that one or more recesses **310***a-n* match and align with a corresponding LED light source **302***a-n* in the plurality of LED light sources **302***a-n*. In other words, the mating cap **314** is configured to mate with the array of LED light sources **302***a-n*. This mating is illustrated in FIG. **4**, where an upper light-emitting portion of each of the LED light sources **302***a-n* has been placed within a corresponding one of the recesses **310***a-n*, more specifically the apertures **313** formed by the light guides **306***a-n*.

Referring still to FIG. **3**, it can be seen that the light assembly **300** further includes a light-emitting lens **316**. The light-emitting lens **316** is coupled to the distal end **312** of each of the light guides **306***a-n*. The light-emitting lens **316** includes a receiving surface **318** and a light-emitting surface **320**. The coupling between the light-emitting lens **316** and the distal end **312** of the light guides **306***a-n* occurs at the receiving surface **318** of the light-emitting lens **316**. The light-emitting lens **316** is formed from a material that facilitates reception of light at the receiving surface **318** and transfers that light to the light-emitting surface **320** with minimal attenuation of the light waves. Similarly, the light guides **306***a-n* and any cores are formed from a material that facilitates transfer of light from one of the plurality of LED light sources **302***a-n* to the light-emitting lens **316** with minimal attenuation of the light waves.

Advantageously, the light received from each one of the plurality of light guides **306***a-n* is combined within the body of the light-emitting lens **316** with the light received from another one of the plurality of light guides **306***a-n*. The combined light waves are then emitted from the light-emitting surface **320** as a combined light wave instead of a plurality of individual light sources as is generally emitted from the prior-art array of LED light sources **302***a-n* that operate without the assistance of the inventive lighting assembly **300**. Because of this blending of the light waves, the present invention advantageously and for the first time makes it possible to replace the high-power, high-heat producing, and high energy consumption prior-art light sources with an array of low-power low-heat producing and low energy consuming LED light sources that do not produce the unwanted multi-shadow effect behind the subject being lit.

As the side elevation views of FIGS. **3** and **4** show, there is a difference between the physical spacing of the LED light sources **302***a-n* and the distance between each of the distal ends **312** of the light guides **306***a-n*. In other words, an overall dimension of the light-source assembly **301** exceeds an overall dimension of the light-channeling portions **304** coupled at the light-emitting surface **320**. Even more specifically, the present invention provides a physical arrangement of the distal ends **312** of the plurality of light guides **306***a-n*, wherein a spacing between each of the distal ends **312** of the plurality of light guides **306***a-n* at their connection point to the lens **316** is less than a spacing between each of the proximal ends **308** of the plurality of light guides **306***a-n*. This difference in spacing can advantageously provide a more focused and intense light at the lens **316** while also providing sufficient spacing between the LED light sources **302***a-n* to properly dissipate heat generated by each source. Also, as will be explained below, this difference in spacing can provide several further advantages in the overall design of a lighting assembly.

It should be noted that the above-described difference in spacing is not necessary and, as is shown in FIG. **19**, each of the light guides **306***a-n* can be a straight light path, i.e., perpendicular to a support medium **311** on which the LED light sources **302***a-n* are supported, with a direct physical correspondence on the receiving surface **318** of the lens **316** to the physical spacing of the adjacent light sources **302***a-n* on the light-source assembly **301**.

FIG. **5** provides a top plan view of the light-source assembly **301**, specifically illustrating the top side of each of the LED light sources **302***a-n* in an exemplary light-emitting spacing arrangement. The invention, however, is not limited to any particular arrangement of the light sources **302***a-n*. However, because of the below-described distribution of colored LED lights, the arrangement shown is novel in its ability to produce a broad spectrum of light colors and effects. Advantageously, the LED array pattern **500** is arranged to provide balanced color for the entire output area. The arrangement and specific placement of LED light sources **302**, both colored and white, provide a robust lighting device that is capable of simulating myriad conditions and effects.

The LED light sources **302***a-n* are grouped into strings based on their colors. In the particular embodiment shown, each LED color is spread from the center of the pattern **500** in a spiraling arrangement toward the outer edge of the LED board **311**. This arrangement provides a spread that is even, with the outer LEDs overlapping the inner LEDs to produce a consistent color pattern across the face of the light-source assembly **301**.

For the color LEDs light sources **600**, **700**, **800**, **900**, shown in FIGS. **6-9**, there are, in accordance with an embodiment of the present invention, four strings of six LED light sources spread from the center of the pattern **500**. This arrangement forms a spiral pattern with FIG. **6** showing the position of red LED light sources **600***a-n*, FIG. **7** showing the position of green LED light sources **700***a-n*, FIG. **8** showing the position of blue LED light sources **800***a-n*, and FIG. **9** showing the position of Amber (yellow) LED light sources **900***a-n*. In each figure, that color is represented by a darkened circle. The invention however, is not limited to these particular colors or placement of colors.

For the White LEDs there are two groups **1000**, **1100**, shown in FIGS. **10** and **11**, of three strings that are spread from the center of the pattern **500**. The first group **1000***a-n* is shown in FIG. **10** and is a warm white group of LEDs that are in the approximately 3000 Kelvin range. The second group **1100***a-n* is shown in FIG. **11** and is a cool white group that is in the approximately 6500 Kelvin range. By adjusting the intensity of the two groups **1000**, **1100**, the light-source assembly **301** is able to provide the desired White Temperature that the user desires. Specific examples of which are provided below.

Referring now to FIG. **12**, a top plan view of the light-source assembly **301** is shown. The embodiment of FIG. **12** includes a set of alignment posts **1200***a-d*. The alignment posts **1200***a-d* are attached to the surface of the LED board **311** and extend perpendicularly away (upwards from the drawing page) from the LED support board **311**. The alignment posts **1200***a-d* advantageously ensure that the light-guide assembly **304** is aligned so that each LED light source **302***a-n* properly mates with each recess **310***a-n* within the mating cap **314** when the light-guide assembly **304** is attached to the light-source assembly **301**. This alignment is illustrated in FIG. **13**, where the alignment posts **1200***a-d* are shown extending from the LED support board **311** and passing through apertures within the mating cap **314**. The alignment posts **1200***a-d* allow each of the recesses **310***a-n* within the mating cap **314** to drop down and rest directly above each upper surface of each LED light source **302***a-n*. Although four alignment posts **1200***a-d* are shown in FIG. **12**, the invention is not limited to any specific number of posts. Furthermore, the posts **1200***a-d* may not be equidistant, or may be equidistant.

In addition to providing alignment between the light-source assembly **301** and the light-guide assembly **304**, the alignment posts **1200***a-d* can have bullet-nosed upper portions for easy insertions and provide an automatic stopping point, which prevents the recesses **310***a-n* from making physical contact with the LED light sources **302***a-n*. The presence of a space between the recesses **310***a-n* and the LED light sources **302***a-n* and provide improved cooling for the LED light sources **302***a-n* and possibly improved optical performance. Alternatively, if physical contact between the recesses **310***a-n* and the LED light sources **302***a-n* is desired, a stopping point along the alignment posts **1200***a-d* can prevent excessive contact, i.e., more than just a touching, which could cause damage to either component.

Furthermore, the alignment posts **1200***a-d* can be provided with threads or other structure that can be used to physically removably couple the light-guide assembly **304** to the light-source assembly **301**. More specifically, once the alignment posts **1200***a-d* are inserted within the apertures formed within the edges of the mating cap **314**, and the mating cap **314** is slid down into position where the LED light sources **302***a-n* mate with the recesses **310***a-n*, nuts, clamps, or other devices are coupled to the alignment posts **1200***a-d* and prevent the mating cap **314** from being removed from the alignment posts **1200***a-d*.

Referring now to FIG. **14**, a further embodiment of a light-guide assembly **1400** is illustrated. The light-guide assembly **1600** shares many similarities with the light-guide assembly **304** shown in FIG. **3**, but includes an intermediate body portion **1402** disposed between its lens **1404** and the light-source assembly **301**. The intermediate body portion **1402** features lens-mating surface **1405** and a light-guide mating surface **1406**, which mates with the distal ends **312** of the light guides **306***a-n*. It should be noted that the intermediate body portion **1402** and the lens **1404** can be a single integral component and an actual junction or surface **1405** is not necessary between the two elements. The intermediate body portion **1402** is selected of a material that is capable of receiving light rays from the distal ends **312** of the light guides **306***a-n* and communicating the light to the lens **1404**. Preferably, the communication of light through the intermediate body portion **1402** results in minimal attenuation of the light rays.

Advantageously, the intermediate body portion **1402** provides enhanced directivity of the multiple sources of light, i.e., multiple outputs from the light guides **306***a-n*. More specifically, as light is emitted from each of the LED light sources **302***a-n*, the light rays exit each of the LED light sources **302***a-n* at multiple angles. With reference to the surface of the LED board **311**, light is emitted from each of the LED light sources **302***a-n* at angles from perpendicular to parallel with the surface of the LED board **311**. Most, if not all, of the light emitted from the LED light sources **302***a-n* is contained within each of the corresponding light guides **306***a-n* and, due to the internally-reflective properties of the light guides **306***a-n*, is guided into the intermediate body portion **1402**. As the light exits each respective light guide **306***a-n*, some components of the light rays will have angular values greater than one, i.e., will not be parallel with a longitudinal axis of the light guide **306***a-n* at its point of connection to the surface **1406** of the intermediate body portion **1402**. The intermediate body portion **1402** provides additional internally-reflective structure that guides and aligns the individual light rays in a direction toward the lens **1404**. Stated differently, the intermediate body portion **1402** becomes somewhat of a master light guide that receives and channels light from the plurality of light guides **306***a-n* to the lens **1404**.

In addition, because the multiple light rays are being guided by and reflected within the intermediate body portion **1402**, the light rays exiting each of the individual light guides **306***a-n* are further blended as they pass through the intermediate body portion **1402** allowing the lens **1404** to output a smooth blend of the multiple light sources **302***a-n*.

In each of the embodiments so far shown in the figures, there is a distance L between the mating cap **314** and the connection point of the distal ends **312** of the light guides **306***a-n*. In addition, in each of the embodiments so far shown in the figures, there is less space between each of the adjacent distal ends **312** of the light guides **306***a-n* than between each of the LED light sources **302***a-n*. This difference in spacing causes at least some of the light guides **306***a-n* to have a curvature along their length. As is known in the field of optics, as the amount of curvature in the transmission path increases, so too does the attenuation of the light rays trying to pass through the length of the light guide **306**. Conversely, the straighter the light path through the light guide, the less the attenuation, diffraction, and degradation of directivity experienced by the light rays. Therefore, it is advantageous to reduce the amount of curvature along the length of each light guide **306***a-n*. This can be accomplished by increasing the value of the length L between the mating cap **314** and the connection point of the distal ends **312** of the light guides **306***a-n*.

Referring briefly once again to FIG. **1**, the prior-art lighting assembly **100** is shown in an elevational cutaway view, and illustrates three components located within the interior of the housing **114** of the lighting assembly **100**. Attached to a backside of the light-source assembly **100** is a heat sink assembly **116**. A "heat sink" is a term of art for a component or assembly that transfers heat generated within a solid material to a fluid medium, such as air or a liquid. A heat sink is physically designed to increase the surface area in contact with the cooling fluid surrounding it, such as the air, allowing the heat transfer through convection. Heat sink assemblies are known in the art and the heat sink assembly **116** can include a variety of components that facilitate the removal of heat from the light-source assembly **100**. Exemplary components include cooling fans, cooling fluids, cooling fins, and others. The function of the heat sink assembly **116** is to remove or reduce heat generated by the light-source assembly **100** during operation. As is known in the art, LED light sources **102***a-n* produce drastically less heat than conventional light bulbs, such as incandescent light bulbs. However, heat is generated and is preferably reduced or removed from within the interior of the lighting assembly **100**.

In addition, the prior-art lighting assembly **100** includes a driver/controller circuit **118** that is at least partially disposed within the housing **114**. The driver/controller circuit **118** controls which ones of the plurality of LED light sources **102***a-n* are activated at any given time and can also control intensities of particular ones of the plurality of LED light sources **102***a-n* and colors thereof. Finally, near the rear or, in many cases, fully or partially on the exterior of the rear of the prior-art lighting assembly **100**, is a power supply **120**. The power supply **120** provides the appropriate voltages to the light-source assembly **100** as controlled by the driving circuit **120**.

The components of prior-art lighting assemblies, such as the one illustrated in FIG. **1**, are restricted to the layout shown. That is, the light-source assembly **100** must be at one extreme end of the housing **114** so that no other components block its light output. Because the heat sink assembly **116** must be coupled to or in close proximity to the light-source assembly **100**, the heat sink assembly **116** as always found within the housing **114**. The power supply **120** and driving circuit **118** are not necessarily restricted to their order with reference to the light-source assembly **100** but, because the power supply **120** generates heat, it is virtually always located on a side of the housing **114** opposite the light-source assembly **100**.

Advantageously, the present invention is not restricted to the component architecture shown in FIG. **1** and found in the prior-art devices. Thus, the present invention enjoys several benefits that result from exchanging the order of components shown in FIG. **1**. More specifically, with reference now to FIG. **15**, one exemplary embodiment of the present invention is shown in an elevational side partially cross-sectional view. This view shows that the light-source assembly **301** is no longer at the distal end **1502** of the light-assembly housing **1504**, but, instead, resides near the proximal end **1516** of the light-assembly housing **1504**. At the distal end **1502** is a lens **1506**. The lens **1506** is coupled to a lens body **1508**, however, the lens body **1508** is not necessary and the lens **1506** may be coupled directly to the distal end **1510** of the light guides **1512***a-n*.

At a location along a length of the light-guides **1512***a-n*, i.e., between the distal ends **1510** and the proximal ends **1514**, is a driver/controller circuit **1515**. As will be explained in greater detail below, the driver/controller circuit **1515** includes the processing ability to individually address (energize—at various levels) certain ones, if not all, of the light sources **302***a-n* within the light-source assembly **301**.

As with the light-guide assembly **304** shown in FIG. **3**, the proximal end **1514** of each light guide **1512***a-n* terminates in a recess **1522***a-n*. More specifically, each light guide **1512***a-n* may have one or more cores **1900***a-n* (shown in FIG. **19**) of transparent material at least partially within each recess **1522***a-n*, in accordance with an embodiment of the present invention. As described above, the core **1900***a-n* has a concave upper area formed in the core of the proximal end **1514** of the light guides **1512***a-n*. In other embodiments, the light guides **1512***a-n* can terminate in flat surfaces that physically coupled to junctions that couple the recesses **1522***a-n* to the light guides **1512***a-n* or may terminate in other surfaces shaped to couple to one or more light sources **302***a-n*.

Continuing toward the proximal end **1516** of the lighting assembly **1600**, a mating cap **1518** is found on a side of the driver/controller circuit **1515** opposite from the lens **1506**. The mating cap **1518** is coupled to the proximal end **1514** of the plurality of light guides **1512***a-n*. The mating cap **1518** secures each of the recesses **1522***a-n* in a fixed configuration. Advantageously, the fixed configuration of the recesses **1522***a-n* is selected so that one or more recesses **1522***a-n* match and align with a corresponding LED light source **302***a-n* in the plurality of LED light source array **301**. In other words, the mating cap **1518** is configured to mate with the array of LED light sources **301**.

In one embodiment, the driver/controller circuit **1515** is formed on a circuit board with an aperture formed within its center so that the light guides **1512***a-n* can pass through this aperture to reach the lens body **1508** or lens **1506** (in embodiments where the lens body **1508** is not present). Alternatively, the light guides **1512***a-n* can pass next to the driver/controller circuit **1515**. Regardless of the exact physical relationship between the light guides **1512***a-n* and the driver/controller circuit **1515**, never before has the driver/controller circuit **1515** been able to be provided on the light broadcasting side of the LED light sources **302***a-n*, i.e., between the LED light sources **302***a-n* and the lens **1506**. The repositioning of the LED light sources **302***a-n* to the proximal end **1516** of the lighting assembly **1600** advantageously straightens the light guides **1512***a-n*, thereby eliminating or reducing any curvature along the light path through the light guides **1512***a-n*. The reduction in curvature of the light guides **1512***a-n* eliminates or reduces attenuation and reflection losses of the light waves being communicated.

In addition, the majority of the heat producing components, i.e., the power supply **1524** and the heat sink **1526**, are on the proximal or rear portion of the lighting assembly **1600**. Advantageously, the main focus of any heat reduction measures can now be directed to the rear section of the lighting assembly **1600**, where they can efficiently remove heat from that portion of the lighting assembly **1600**. Furthermore, the driver/controller circuit **1515**, which may feature several components that are sensitive to heat, is removed or distanced from the area where the greatest amount of heat is produced. That is, with prior-art devices, the driver/controller circuit **1515** was always positioned between the heat-producing light source assembly **301** and the heat-producing power source **1524**. Through embodiments of the present invention, the driver/controller circuit **1515** can now, for the first time, be positioned toward the distal (front) portion **1502** of the lighting assembly **1600** where less heat is present.

Referring now to FIG. **16**, another exemplary embodiment of the present invention is shown in a side elevational view. FIG. **16** shows several advantageous features of the present invention, but the invention can be provided in various shapes, sizes, combinations of features and components, and varying numbers and functions of the components. The lighting assembly **1600**, as shown in FIG. **16**, includes a light-source assembly **1601** which includes a plurality of LED light sources **1602***a-n* supported on a curved support surface **1603**, e.g., a circuit board. The curved support surface **1603** places a central axis **1607***a-n* of at least two of the light sources **1602***a-n* at angles that differ from each other.

They lighting assembly **1600** further includes a light-guide assembly **1604** that features a plurality of light guides **1606***a-n*, each having a proximal end **1608** and its distal end **1612** opposite the proximal end **1608**. The proximal end **1608** of each light guide **1606***a-n* terminates in a recess **1610***a-n*. More specifically, each light guide **1606***a-n* has an aperture at least partially within each recess **1610***a-n*, in accordance with an embodiment of the present invention. In other embodiments, the light guides **1606***a-n* can terminate in flat surfaces that physically coupled to junctions that couple the recesses **1610***a-n* to the light guides **1606***a-n*.

In accordance with one embodiment of the present invention, the lighting assembly **1600** includes a mating cap **1614** that is coupled to the proximal end **1608** of the plurality of light guides **1606***a-n*. The mating cap **1614** secures each of the recesses **1610***a-n* in a fixed configuration and is also shaped in a curvature that is complimentary to the curvature of the curved support surface **1603**. More specifically, the curved mating surface **1609** of the mating cap **1614** places a central axis **1611***a-n* of at least two of the recesses **1610***a-n* at angles that differ from each other. Advantageously, the curvature of the mating cap **1614** places each of the recesses **1610***a-n* in a position to match and align with a corresponding LED light source **1602***a-n* in the plurality of LED light sources. In an alternative embodiment, the recesses **1610***a-n* are integral with the mating cap **1614**. That is, the recesses **1610***a-n* and the mating cap **1614** are formed as a single component.

FIG. **16** also shows that the light assembly **1600** further includes a light-emitting lens **316** that is coupled to the distal end **1612** of each of the light guides **1606***a-n*. The light-emitting lens **316** includes a receiving surface **318** and a light-emitting surface **320**. The coupling between the light-emitting lens **316** and the distal end **1612** of the light guides **1606***a-n* occurs at the receiving surface **118** of the light-emitting lens **316**. The light-emitting lens **316** is formed from a material that facilitates reception of light at the receiving surface **318** and transfer of that light to the light-emitting surface **320** with minimal attenuation of the light waves. Similarly, the light guides **1606***a-n* and any cores **1900***a-n* are formed from a material that facilitates transfer of light from one of the plurality of LED light sources **1602***a-n* to the light-emitting lens **316** with minimal degradation of the light waves.

Advantageously, the curvature of the curved support surface **1603** places each of the LED light source **1602***a-n* at an angle that faces the receiving surface **318** of the lens **316**. This variation in angle from the embodiment shown in FIGS. **3** and **4** reduces the needed bend of the light guides **1606***a-n*, which therefore reduces the transmission loss of the light waves being communicated within and through the light guides **1606***a-n*.

Advantageously, once inside the lens **316**, the light received from each one of the plurality of light guides **1606***a-n* is combined with the light received from another one of the plurality of light guides **1606***a-n*. The combined light waves are then emitted from the light-emitting surface **320** as a combined light wave. Because of this blending of the light waves, the present invention advantageously and for the first time makes it possible to replace the high-power, high-heat producing, and high energy consumption prior-art light sources with an array of low-power low-heat producing and low energy consuming LED light sources that do not produce the unwanted multi-shadow effect behind the subject being lit.

As the side elevation views of FIG. **16** show, there is a difference between the physical spacing of the LED light sources **1602***a-n* and the distance between the distal ends **1612** of the light guides **1606***a-n*. That is, the present invention provides a physical arrangement of the distal ends **1612** of the plurality of light guides **1606***a-n*, wherein a spacing between each of the distal ends **1612** of the plurality of light guides **1606***a-n* at their connection point to the lens **316** is less than a spacing between each of the proximal ends **1608** of the plurality of light guides **1606***a-n*. This difference in spacing can advantageously provide a more focused and intense light at the lens **316**.

In one embodiment, the light guide assembly **1604** shown in FIG. **16** is not present. Because of the curvature of the supporting surface **1603**, light from the light sources **1602***a-n* is focused directly on the receiving surface **318** of the lens **316**. The light directed to the receiving surface **318** is received through the receiving surface **318** and efficiently emitted from the emitting surface **320**.

Referring now to FIG. **17**, a further embodiment of the present invention is illustrated in a side elevational cross-sectional view. The exemplary light assembly **1700** of FIG. **17** includes a light-source assembly **1701**, which includes a plurality of LED light sources **1702***a-n* coupled to a support surface **1703**. The support surface **1703** can be, for example a circuit board selectively delivering power to the LED light sources **1702***a-n*. In this embodiment, unlike those shown and described above, the plurality of LED light sources **1702***a-n* are coupled to a side of the support surface **1703** that is opposite to the light-transmission direction, illustrated by light rays **1710***a-n*. Coupled to an upper side of the support surface **1703** is a heat sink **1726**. The heat sink **1726** functions to remove heat from the light-source assembly **1701**.

Disposed below the support surface **1703**, i.e., on the same side of the support surface **1703** as the LED light sources **1702***a-n*, is a parabolic reflector **1704**. The parabolic reflector **1704** is provided with a reflective interior surface **1706** that reflects light produced by the LED light sources **1702***a-n* when they are energized. Parabolic reflectors are well known in the art; therefore, the details of which will not be described here. In addition, the support surface **1703** can be provided with a reflective surface **1709** that further reflects light back to the parabolic reflector **1704**.

As can also be seen in FIG. **17**, the support surface **1703** has an aperture **1708** that allows light rays **1710***a-n* reflected by the parabolic reflector **1704** to pass through the support surface **1703**. Of course, the light rays **1710***a-n* shown in FIG. **17** illustrate only a small sample of the light rays that would actually be generated by the LED light sources **1702***a-n* and reflected within and by the parabolic reflectors **1704**. Advantageously, the individual light rays generated by each of the individual LED light sources **1702***a-n*, would be combined and focused by the effect of the parabolic reflectors **1704**, thereby producing a composite light ray that is not predisposed to producing a multi-shadow behind the subject being eliminated by the inventive light assembly **1700**. Although not shown in FIG. **17**, the light rays **1710***a-n* can be directed to a lens that further directs the light rays **1710***a-n* to the intended subject.

FIG. **18** illustrates an exemplary embodiment of the driver/controller circuit **1515**. In the embodiment shown, the driver/controller circuit **1515** includes a processor **1802**, a memory **1810**, a clock **1814**, a communication port **1812**, and a controller **1808**. The processor **1802** is operable to read a set of instructions from a memory **1810** and deliver control signals to the controller **1808**. The instructions can be in the form of a program or software application with predefined lighting settings. The controller **1808** receives the control signals from the processor **1802** and, in certain embodiments, is able to individually address each of the plurality of LED light sources. In other embodiments, the array of LED light sources acts as a single bulb and the controller **1808** causes the entire array of LED light sources to energize as desired.

A user interface **1801** is communicatively coupled to the driver/controller circuit **1515**. The user interface **1801** includes a display **1804** and a plurality of user inputs **1806**. In accordance with the present invention, the inventive light assembly **300** is fully programmable through the user interface **1801** or through one or more communication ports **1812**, e.g., USB, coupled to the processor **1802** and/or memory **1810**. In other embodiments, the light assembly **300** is operable wirelessly, using a WiFi network, for example, or other systems utilizing radio waves. The assembly **300** may also be operable through use of data applications of mobile devices.

Through use of the user interface **1801**, and in particular, the user inputs **1806** and the display **1804**, the user can configure the lighting assembly **300** to produce one of many available lighting effects, such as emergency vehicle emergency lights, fire, water, lightning, shadows cast by televisions, and many more. Settings that contribute toward creating a specific effect include a temperature adjustment, a color correction adjustment, a color adjustment, a white adjustment, a frequency adjustment, a duty cycle adjustment, and more.

A temperature adjustment, which adjusts the white temperature level from, for example, about 3200 to about 6800 Kelvin in approximately 10 degree increments and be determined by a user through the user interface **1801** or port **1812**. Exemplary preset values are MAX=5600, MIN=3200. A configurable master adjustment adjusts the LED level for all LEDs from about 0-100%. Exemplary preset values of the master adjustment are MAX=100, MIN=0. A color correction adjustment applies either a green or magenta offset to the white light to adjust the color to the desired whiteness value from about −8 to 8, although other values are acceptable. Exemplary preset values of the color correction adjustment are MAX=8, MIN=−8. A color adjustment adjusts the LED level for all color LEDs (Red, Green, Blue, and Amber) from about 0-100%. Exemplary preset values of the color adjustment are MAX=100, MIN=0. A white adjustment adjusts the LED level for the white LEDs from about 0-100%. Exemplary preset values of the white adjustment are about MAX=100, MIN=0. An effect selector selects the effect for the lighting assembly to produce. Several, but not all, exemplary effects are described below. The frequency selector can be used to adjust the cycle time of the selected effect from about 0.01-5.0 seconds, although other values are acceptable. An exemplary available frequency selection range varies from about a maximum of 100 and a minimum of 0. The duty cycle selector can be used to adjust the Duty cycle for the selected effect from about 1-100%. Exemplary preset values of the duty cycle selector are about MAX=100, MIN=1.

The table below provides several exemplary special-effects settings, a description of each, and exemplary setting values.

| Effect | Description | Initial settings |
|---|---|---|
| None | All LEDs off | White = 0<br>Red = 0<br>Green = 0<br>Blue = 0<br>Amber = 0<br>Temperature = 5600<br>Frequency = 0.5<br>Duty = 20 |
| Strobe | Flash selected LEDs at the selected duty cycle and frequency. | White = 100<br>Red = 0<br>Green = 0<br>Blue = 0<br>Amber = 0<br>Temperature = 5600<br>Frequency = 0.5<br>Duty = 20 |
| Chase 1 | Cycles through the red, green, blue, and amber LEDs at the selected frequency with a fade on and off for each LED. | White = 0<br>Red = 100<br>Green = 100<br>Blue = 100<br>Amber = 100<br>Temperature = 5600<br>Frequency = 0.25<br>Duty = 100 |

-continued

| Effect | Description | Initial settings |
|---|---|---|
| Chase 2 | Cycles through the red, green, blue, and amber LEDs at the selected frequency with a hard on and off for each LED. | White = 0<br>Red = 100<br>Green = 100<br>Blue = 100<br>Amber = 100<br>Temperature = 5600<br>Frequency = 0.25<br>Duty = 100 |
| Police Old | Fades the blue LEDs to full on for the first half of the cycle, then sets the blue LEDs to off and sets the red LEDs to full on and fades the red LEDs to off for the second half of the cycle. Cycle time is determined by the Frequency value. | White = 0<br>Red = 100<br>Green = 0<br>Blue = 100<br>Amber = 0<br>Temperature = 5600<br>Frequency = 0.6<br>Duty = 80 |
| Police New | Flashes the blue LEDs four times, then the red LEDs four times for each cycle. Cycle time is determined by the frequency value. | White = 0<br>Red = 100<br>Green = 0<br>Blue = 100<br>Amber = 0<br>Temperature = 5600<br>Frequency = 0.6<br>Duty = 80 |
| Fire Truck Old | Fades the red LEDs to full on for the first half of the cycle, then sets the red LEDs to off and sets the amber LEDs to full on and fades the amber LEDs to off for the second half of the cycle. Cycle time is determined by the Frequency value. | White = 0<br>Red = 100<br>Green = 0<br>Blue = 0<br>Amber = 100<br>Temperature = 5600<br>Frequency = 0.6<br>Duty = 80 |
| Fire Truck New | Flashes the red LEDs four times, then the amber LEDs four times for each cycle. Cycle time is determined by the frequency value. | White = 0<br>Red = 100<br>Green = 0<br>Blue = 0<br>Amber = 100<br>Temperature = 5600<br>Frequency = 0.6<br>Duty = 80 |
| Ambulance Old | Fades the red LEDs to full on for the first half of the cycle, then sets the red LEDs to off and sets the white LEDs to full on and fades the white LEDs to off for the second half of the cycle. Cycle time is determined by the frequency value. | White = 50<br>Red = 100<br>Green = 0<br>Blue = 0<br>Amber = 0<br>Temperature = 3600<br>Frequency = 0.6<br>Duty = 80 |
| Ambulance New | Flashes the red LEDs four times, then the white LEDs four times for each cycle. Cycle time is determined by the frequency value. | White = 50<br>Red = 100<br>Green = 0<br>Blue = 0<br>Amber = 0<br>Temperature = 3600<br>Frequency = 0.6<br>Duty = 80 |
| Fire/Candle | Random settings of the red and amber LEDs to produce a flickering effect simulating a fire or candle. Flickering frequency is determined by the Frequency value. | White = 0<br>Red = 100<br>Green = 0<br>Blue = 0<br>Amber = 100<br>Temperature = 3600<br>Frequency = 0.15<br>Duty = 100 |
| Water | Blue with pulsing white. | White = 50<br>Red = 0<br>Green = 0<br>Blue = 100<br>Amber = 0 |

-continued

| Effect | Description | Initial settings |
|---|---|---|
| | | Temperature = 3600<br>Frequency = 4.0<br>Duty = 100 |
| TV | Alternating shades of White to emulate a TV changing scenes. | White = 50<br>Red = 0<br>Green = 0<br>Blue = 100<br>Amber = 100<br>Temperature = 3600<br>Frequency = 1.25<br>Duty = 100 |
| Lightning | Random flashes of high intensity White light. | White = 100<br>Red = 0<br>Green = 0<br>Blue = 100<br>Amber = 0<br>Temperature = 5600<br>Frequency = 1.5<br>Duty = 100 |

Color Correction can be applied by calculating the green or magenta level needed to adjust the White color. This allows the user to shift the white light to either green or magenta for their application. It has been determined that a negative value on the color correction, for example, −1 to −8, will apply a magenta level. This is done by applying the blue and red LEDs with increasing brightness to change the white light output. The value applied is proportional to the white light intensity, so if the white light is at a low setting the color correction may not have any effect. The following table shows exemplary percentages for the red and blue LEDs with the white LEDs set to 100%:

| Color Correction Value | Blue Percentage | Red Percentage |
|---|---|---|
| −1 | 4 | 4 |
| −2 | 8 | 8 |
| −3 | 12 | 12 |
| −4 | 16 | 16 |
| −5 | 20 | 20 |
| −6 | 24 | 24 |
| −7 | 28 | 28 |
| −8 | 32 | 32 |

A positive value on the color correction, 1 to 8, will apply a green level. This is done by applying green LEDs with increasing brightness to change the white light output. The value applied is proportional to the white light intensity, so if the white light is at a low setting the color correction may not have any effect. The following table shows the percentage for the green LEDs with the white LEDs set to 100%:

| Color Correction Value | Green Percentage |
|---|---|
| 1 | 4 |
| 2 | 8 |
| 3 | 12 |
| 4 | 16 |
| 5 | 20 |
| 6 | 24 |
| 7 | 28 |
| 8 | 32 |

Although far superior to traditional light-bulbs, LEDs also generate heat when turned on for extending periods of time or when there are multiple LEDs turned on at one time. Generally, in order to achieve the optimum lifespan, LEDs should be exposed to an environment with relatively cool air. Prior-art lighting devices utilize one or more electric fans to force air into the body of the light, across the heat-generating components, and out a series of vents provided usually on all sides of the light body. Unfortunately, the electric fans utilize a considerable amount of electrical energy and it has been found that fluid dynamics controlling the flow of air into and out of the body results in a considerable amount of turbulence that pushes back and resists the input of fresh air into the body. This resistance is a further waste of energy and the cooling effect is not efficient on the components inside the light body. Embodiments of the present invention provide vents on only an upper side and a lower side of the light body and eliminate the need for an electric fan or any other type of active air introduction device. Embodiments of the present invention advantageously utilize the principles of physics to accomplish an improved cooling effect on the components within the light body.

FIG. **19** illustrates a side elevational partial view of a lighting-assembly **1902** featuring straight light-guides **1904***a-n* aligned and mated with an adjacent light-source assembly **1906***a-n* in accordance with the present invention. As previously discussed, FIG. **19** also illustrates the light guides having cores **1900***a-n* within the recessed portions **1908***a-n* at the end **1910** of the light-guides **1904***a-n*. The cores **1900***a-n* may also have an aperture sized to receive the end of the light-source assembly **1906***a-n*. Similar to FIG. **3**, at the distal end **1912** of the light-guides **1904***a-n* is the receiving surface **318** of the light-emitting lens **316**.

FIG. **20** illustrates a further exemplary embodiment of the present invention. As previously discussed, one embodiment of the present invention includes a heat sink **1526** coupled to the LED light sources **302***a-n* as shown in FIG. **15**. This advantageously allows those heat-producing components to be placed in the back of the assembly **1500** where they can be effectively cooled. As the heat sink **1526**, power supply **1524**, and, potentially, the driver/controller circuit **1515** all generate heat, the embodiment shown in FIGS. **20** and **21** illustrate an effective and efficient way of dissipating the heat that is generated. In one embodiment, the LED light casing **2000** houses at least one portion **2002** of the light sources **302***a-n*, particularly a portion that generates heat. The housing assembly **2000** has a first end **2004** and a second end **2006** that is substantially enclosed. The term "substantially encloses" or "substantially enclosed" as used herein, unless otherwise stated, means completely, or with small opening(s) less than one-half inch of the opening's smallest diameter, surrounding a referenced object, plane, surface or material.

To further prevent air from escaping, the LED light casing **2000** also has a right upper face **2008** and a left upper face **2010**, which are also substantially enclosed. The left and right lower sides of the casing **2000** are partially hidden in FIG. **20** and may also be substantially enclosed as well. Now, referring to FIG. **21**, a perspective cross-sectional downward-looking view of the assembly **2000** of FIG. **20** is shown in accordance with an embodiment of the present invention. The LED light casing **2000** has a substantially enclosed lower portion **2100** defining a lower aperture **2102** for air to pass through. The LED light casing **2000** also has a substantially enclosed upper portion **2104**, opposite the lower portion **2100**, defining an upper aperture **2106**. The lower and upper apertures **2102**, **2106** create openings sufficient to allow air to enter and exit, respectively, and form part of a heat-dissipating air-flow engine. In contrast to electric fans, which are noisy, waste energy, add cost, add failure rates, and create turbulent air flow within an enclosed light assembly, thereby causing inefficient cooling, the present invention advantageously removes generated heat from components without the need or use of fans or blowers. As with most electric components, removing the heat prolongs the life of the components inside of the LED light casing **2000**, especially those sensitive to heat, such as LED bulbs, circuits, and/or control boards.

To achieve the effective cooling, the LED light casing **2000** is substantially enclosed on all sides and ends, except for two portions, e.g., the lower and upper apertures **2102**, **2106**, opposite each other, where it is desired for air to flow at a certain velocity. As the LED light casing **2000** is substantially enclosed, except for the apertures **2002**, **2006**, a pressure difference is created between the heated air inside of the LED light casing **2000** and the outside cooler ambient air **2108**. The heat within the LED light casing **2000** is removed by a constant stream of cool air that is driven through the device by a novel heat-dissipating air engine created by the lower and upper apertures **2102**, **2106**. This movement of air is referred to herein as the "chimney effect" and is illustrated in connection with the lighting assembly **300** shown in FIG. **3**. Never before has a commercial studio light, such as that depicted in FIG. **21**, been sufficiently cooled without the use of a fan or any other active cooling device.

Still referring to FIG. **21**, when heat is generated by the LED light sources **302***a-n* or other heat generating components inside the LED light casing **2000**, the temperature of the air enclosed within the casing **2000** is greater than the ambient air **2108** temperature outside the casing **2000**. The increase in air temperature has an inversely-proportional correlation to the density of the corresponding air. As such, not only does the hotter, less dense, air rise through the upper aperture **2106**, but a pressure difference is created between the higher pressure outside ambient air **2108** and the lower pressure enclosed air. The increase in temperature, in combination with a height **2110** separating the upper aperture(s) **2106** and lower aperture(s) **2102**, generates a flux of cooler air generally known as the aforementioned, "chimney effect." The overall rate of flow is a function of the temperature inside of the casing **2000**, the enclosed area inside the casing **2000**, the size of the apertures **2102**, **2106**, and the height **2110** separating those apertures.

In one embodiment, there will be one or more apertures on the lowest extent **2112** of the lower portion **2100** or the highest extent **2114** of the upper portion **2104**. In other embodiments, the apertures may be located on an upper portion **2116** of the sides **2008**, **2010**. In one embodiment, to maximize heat transfer from heat sink and/or the LED light sources **302***a-n*, the apertures **2102**, **2106** are substantially collinear, or having two points lying along a straight line, or within one inch displaced from one another. In other embodiments, the apertures **2102**, **2106** may be offset and located in different locations on the casing **2000**. There may also be more than one set of apertures which further facilitate in the creation of other airflows that cool other components of the lighting assembly **300**.

Although never before thought possible, as FIG. **21** illustrates, the air flow created by the novel heat-dissipating airflow engine, represented with arrows **2118**, efficiently removes heat dissipated from the heat sink **1526** and other components within the casing **2000**. In one embodiment, the casing **2000** may include a portion of the light sources **302***a-n*. In other embodiments, the casing **2000** may include other components desired to be cooled, such as the power supply **1524** or one or more circuit boards. Moreover, an embodiment of the present invention may also include a heat sink coupled to any of the above mentioned components to further reduce the heat generated. The casing **2000** also may include one or more partitions **2120** that are coupled to the side walls of the casing **2000**. The partition **2120** may serve the role of restraining the components of the assembly **300** and provides a boundary that directs the flow of air **2118** outwardly through the top vent **2106**. The partition **2120** also facilitates the creation of the temperature difference between the inside of the casing and the outside environment that is a driving force behind the air exchange rate.

In one embodiment, shown in FIG. **22**, the light-assembly casing/housing **2200** is shaped in the form of a hexagon. In other embodiments, the light-assembly housing **2200** may be formed in various shapes and sizes, and may have various components connected thereto. The side walls of the light-assembly housing **2000** are also shown as being substantially enclosed, while the top and the bottom walls have apertures **2202** that, through the chimney effect described above, pull cooler air, represented with arrows **2204**, from the bottom of the housing **2200**, through the interior, across the components therein, and out through the top. FIG. **22** also illustrates the assembly **300** with the heat sink **1526** removed, revealing the end of the plurality of light sources **302***a-n* which generates the majority of heat. The casing **2000**, which includes the light assembly **300**, may have legs **2122** that assist the casing **2000** in standing upright. The legs **2122** also position casing **2000** where the upper aperture **2106** is at a higher altitude above the lower aperture **2102** in order to facilitate the removal of heat from the light assembly **300**.

Further embodiments of the present invention also provide a novel and efficient self-cooled lighting assembly that removes the heat generated from one or more light bulb assemblies by exposing those heating generating portions of the light bulb assemblies to airflow produced by a novel heat-dissipating air engine. Embodiments of the invention also provide that the self-cooled light assembly may be built into a pre-existing structure that creates ventilation from a novel heat-dissipating engine when at least one light emitting source is inserted therein, and in operation. In further embodiments of the present invention, the light assembly has a light bulb assembly with an airflow chamber coupled thereto and is portable to be removably-couplable a standard-sized light bulb port and creating a chimney effect when the light bulb assembly is in operation.

Referring now to FIG. **23**, one embodiment of the present invention is shown in an elevational cross-sectional front view. FIG. **23** shows several advantageous features of the present invention, but, as will be described below, the invention can be provided in several shapes, sizes, combinations of features and components, and varying numbers and functions of the components. As shown in FIG. **23**, the first example of a self-cooled lighting assembly **2300** is shown being applied to a pre-existing structure, such as a wall or ceiling **2302** of a building. Although the present invention may be applied to virtually any light emitting source encapsulated in a bulb-like structure, for the ease of the reader, the lighting assembly **2300** will be discussed with reference to one or more LED light sources. In other embodiments, the pre-existing structure is a lamp, a vehicle, or other similar structure with a power source sufficient to supply power to the light assembly **2300**. The assembly **2300**, in its basic form includes an airflow chamber **2304** and a light bulb assembly **2306**, also referred to herein as a LED assembly, which is coupled to the airflow chamber **2304**.

The airflow chamber **2304** has a first end **2308** and a second end **2310** opposite to the first end **2308**. In one embodiment, the airflow chamber **2304** may be formed in the general circular shape. In other embodiments, however, the chamber **2304** may be formed in various other shapes sufficient to enclose and transport the air within. Separating the first and second ends **2308**, **2310** is a side wall **2312**. In one embodiment, the side wall **2312** extends horizontally and vertically and may include portions of the ceiling **2302**, as shown in FIG. **23**. In other embodiments, the side wall **2312** may extend vertically, at an angle, or may extend in a variety of directions. The side wall **2312** is shown defining a first opening **2314** and a second opening **2316** that is in fluid communication with an outside environment, e.g., air. The outside environment varies depending on the location of the assembly **2300**, but may include the inside room of a house, the attic, a ceiling space, or the outside atmospheric air. When the assembly **2300** is in operation and confined within a small enclosed space, as shown in FIG. **2**, the first opening **2314** should be placed directly toward the larger area of cool air and away from any obstructions that would inhibit the intake of air.

Furthermore, when the assembly **2300** is in operation, as shown in FIG. **23**, the second opening **2316**, also referred to as the distal opening, releases the air upwardly through the walls or spaces of the home where it is subsequently expelled into the environment outside of the home. The first opening **2314**, also referred to as the proximal opening, intakes air from the room of the home where the assembly **2300** is located. Although FIG. **23** illustrates the side wall **2312** completely defining the first and second openings **2314**, **2316**, in other embodiments, the side wall **2312** at least partially defines the first and second openings **2314**, **2316**. To achieve the desired flow across one or more portions of the LED assembly **2306**, the second opening **2316** is downstream to the first opening **2314**.

As previously mentioned, the flow of air generated by the novel heat-dissipating engine of the present invention is a function of height between at least two openings, the average area of the openings, the average volume of an airflow channel **2320** defined by the airflow chamber **2304**, and the temperature difference between the average temperature of the airflow channel **2320** and the temperature outside of the chamber **2304**. More specifically, the side wall **2312** includes an inner surface **2318** which defines the airflow channel **2320**. As shown, the inner surface **2318** completely defines the airflow channel **2320**. In other embodiments, the inner surface **2318** at least partially defines the airflow channel **2320** as one or more portions of the LED assembly **2306** may also define the airflow channel **2320**, as shown in FIG. **25**. Contrary to all known modes of simply placing an LED lighting assembly in an environment and letting heat randomly dissipate, now, for the first time, and in accordance with one embodiment of the present invention, the LED assembly **2306** is continually cooled by an organized steady stream of air. This stream of cool air is provided without the use of external devices, which generally produce heat and require electricity themselves, thereby creating an efficient and effective cooling process.

The LED assembly **2306**, more specifically, at least one light emitting source **2322**, also referred to herein as at least one LED light source **2322**, is also shown at least partially placed within the airflow channel **2320** such that it can be said to be thermally coupled to the channel **2320**. As the LED light source **2322** generates heat and is also one of the components that is a focal point of novelty in another embodiment, the at least one LED light source **2322** may be placed entirely within the airflow channel **2320**. In other embodiments, the light source **2322** may have one or more heat sinks **2325** attached thereto to facilitate heat transfer, as described above. As the light source **2322** may have one or more heat conducting materials coupled thereto, such as the heat sink **2325**, the light source **2322** would still be considered at least partially within the airflow channel **2320** or, at a minimum, thermally coupled to the airflow channel **2320**. Stated another way, as long as heat generated from the at least one light source **2322** is transferred to the airflow channel **2320**, the light source **2322** is said to be thermally coupled to the channel **2320** in accordance with the present invention.

Still referring to FIG. **23**, the LED light source **2322** is shown with an electrical contact portion **2324** that is disposed for attachment to an electrical source **2326**. In embodiments where one or more LEDs are used, a diode **2328**, or other light emitting source, is in electrical communication with the electrical contact portion **2324**. In one embodiment, the electrical contact portion **2324** is a metallic base that is adapted to couple to standard electrical lighting outlet. The electrical source **2326** also includes the aforementioned outlet. In other embodiments, the contact portion **2324** may be in the form of any male portion of a male/female attachment, or other similar attachment, sufficient to transfer electricity from the electrical source **2326** to the diode **2328**, or other light emitting source. Further, the electrical source **2326** may include any female portion of a male/female attachment, or other similar attachment, sufficient to transfer electricity to the diode **2328**. In one embodiment, the electrical source **2326** may generate alternating current (AC) sufficient to power the LED assembly **2306**. In other embodiments, the electrical source **2326** may generate direct current (DC) to the LED assembly **2306** sufficient to power the assembly **2306**.

When the light source **2322** is supplied electricity, energy, in the form of heat and light, is released. This heat, in combination with the heat from any other components, such as a power source and/or a circuit board/controller, is transferred to the adjacent air within the channel **2320**. As the air within the channel **2320** is heated, it becomes less dense than the outside environmental air and therefore rises as the result of the buoyancy force. As the hot air is displaced, the cooler, denser, air enters and passes by the heating elements of the LED assembly **2306**. At the same time, the air within the channel **2320** and the atmospheric pressure are unequal, such that the high-pressure air within the channel **2320** seeks the low-pressure outside environment. As a result of this pressure difference, a flow is induced, which in turn provides and maintains the LED assembly **2306** at a lower temperature than those LED assemblies presently available in the prior-art, without the use of other devices, such as fans. The term “fan,” as used herein, is intended to generically describe any device with a moving element that forces a movement of air across some distance.

In one embodiment, the airflow chamber **2304**, which may include the side wall **2312** or the first or second ends **2308**, **2310**, surround and enclose the heat generating portions of the LED assembly **2306** so there are substantially no air leaks in the airflow channel **2320**. This may be accomplished by gaskets or another malleable medium that may be inserted between the LED assembly **2306** and chamber **2304**. In other embodiments, one or more portions of the chamber **2304** adjacent to the LED assembly may be open to allow air to flow in, but is sufficient to still generate and maintain a flux of airflow.

FIG. **24** illustrates another embodiment of the LED light assembly **2400**, with two LED assemblies **2402**, **2404** coupled to the airflow chamber **2406**. FIG. **24** shows the diverse and novel applications of the present invention. Similar to FIG. **23**, and taking assembly **2402** as an example, the assembly **2402** has a light case **2408** which includes a portion of the diode **2410**, or other light emitting source that may be utilized. The case **2408** prevents degradation of the light generated from the diode **2410** should the diode **2410** be completely or partially placed within the airflow channel **2412**. In one embodiment, the light case **2408** is placed partially or completely within the airflow channel **2412**. In such instances, the case **2408**, when the LED assembly **2402** is in operation, may receive transient airflow over the surface of the case **2408** or, as shown in FIG. **25**, may define one or more portions of the airflow channel **2412**. In further embodiments, the case **2408** is coupled to an outside surface of the chamber **2406** and not placed within the channel **2412**.

In addition to the first and second openings **2414**, **2416** supplying and expelling the air that drives the cooling process, the present invention anticipates that more than one opening at each end may be used. For example, in the configuration shown in FIG. **24**, the two lower openings **2414**, **2418** intake the outside air, while two upper openings **2416**, **2420** allow the air to exit. As such, each LED assembly **2402**, **2404** is cooled primarily by an induced flow created by all of the openings **2414**, **2416**, **2418**, **2420**. In other embodiments, the configuration of the airflow channel **2406** is similar to FIG. **23**, and more than one LED assembly **2402** is placed within the airflow channel **2406**. Stated another way, there may be multiple LED assemblies being cooled from at least two openings **2314**, **2316** defined by the airflow chamber **2304**.

Now referring to FIG. **25**, another embodiment of the present invention is shown from an elevational, partially cross-sectional, side view. The airflow chamber **2502** of the LED cooling assembly **2500** has first and second ends **2504**, **2506** with the side wall **2508** separating those ends **2504**, **2506**. When compared to the side wall **2312** shown in FIG. **23**, the side wall **2508** of FIG. **25** only partially defines the first and second openings **2510**, **2512**. The LED assembly **2514** also partially defines the first and second openings **2510**, **2512** along with partially defining the airflow channel **2516**. In contrast to FIG. **23**, where the assembly **2300** is formed within a ceiling **2302** or other structure, the assembly **2500** of FIG. **25** is portable and may be coupled to a standard-sized light bulb outlet **2518**.

In one embodiment, the side wall **2508** is substantially enclosed. With the side wall **2508** substantially enclosed, the assembly **2500** continually produces a constant flow of air across the LED assembly **2514**. In other embodiments, the side wall **2508** may not be substantially enclosed, but any openings, including the first and second openings **2510**, **2512**, and height **2600** (shown in FIG. **26**) of the side wall **2508** are sized to generate a flow when the LED assembly **2514** is in operation. In one embodiment, the side wall **2508** may have a height **2600** (shown in FIG. **26**) of approximately 4-6 inches, with an average inner area **2602** (shown in FIG. **26**) of approximately 9 $in^2$. The average area **2602** is the difference of an area defined by the side wall **2508** and an area defined by the LED assembly **2514**, including any attachments that protrude into the airflow channel **2516**, if applicable. In other embodiments, the average area **2602**, height **2600**, and any potential apertures in the side wall **2508** will vary, and may be more or less than the dimensions listed above.

The LED assembly **2514** may also have one or more heat sinks **2520** attached thereto to effectively dissipate the heat from the light source and any components that are sensitive to heat exposure. The heat sinks **2520** can be seen wrapping around the external surface of the LED assembly **2514**. In one embodiment, the heat sink **2520** has a plurality of heat dissipating members **2526**, each of those members **2526** with a portion oriented in a general direction of the airflow channel **2516** in which they are placed. When the heat dissipating members **2526** are in the general direction of the airflow channel **2516** they can effectively remove heat from one or more components from which they are attached. For example, as the airflow channel **2516** extends longitudinally upward toward the ceiling **202**, as should the heat dissipating members **2526**. This allows the members **2526** to expose the most surface area to the airflow generated by the assembly **2500**, while at the same time not inhibiting the induced airflow. In other embodiments, the LED assembly **2514** may not have a heat sink **2520** and/or any heat dissipating members **2516**, and the flow of air within the airflow channel **2516** passes one or more portions of the LED light source and any other components of the LED assembly **2514** directly. Furthermore, in other embodiments, when the LED assembly **2514** is installed on a vertical surface, as opposed to a horizontal ceiling as shown in FIG. **25**, the heat dissipating members **2526** are oriented vertically, and the openings **2510**, **2512** are placed in locations that create a height difference sufficient to induce airflow. That height varies depending on the aforementioned areas, but may be similar to those dimensions listed above. In other embodiments, the dimensions may vary.

The light bulb assembly **2514** may be a standard-sized LED assembly, which includes any of those embodiments described herein, including those utilizing light guides, or may be incandescent bulbs, fluorescent bulbs, or other light-emitting bulb that generates heat. Now, a light assembly can advantageously remove those components of the assembly **2500** that generate heat from an environment occupied by the heat produced from those components. Further, any heat generated from those components is effectively and efficiently removed by creating a flow of cooler air from an outside environment, and without the use of external devices, such as fans or blowers. This flow of air, represented by the arrows **2522**, is passed by the external surface of the LED assembly **2514**, thereby removing the heat generated. In one embodiment, the airflow chamber **2502** is formed as part of one or more portions of the LED assembly **2514**, such as the LED light case **2524**. In other embodiments, the chamber **2502** is independent to the LED assembly **2514** and is coupled using fastening screws or bolts, adhesives, or other fastening means.

In one embodiment, the airflow chamber **2502** may be made with a durable polymer, such as polystyrene or polyethylene. In other embodiments, the airflow chamber **2502**, including those embodiments shown in FIGS. **23** and **24**, is made from wood, various metallic-based materials, composites, or other polymers. Further, when applied to the embodiments shown in FIGS. **25** through **27**, the polymer may be flexible to allow it to contour to one or more portions of the outer surface of the LED assembly **2514**.

Referring to FIG. **26**, an additional view of the assembly of FIG. **25** is shown from a downward-looking, partially cross-sectional, perspective view. To create an airflow, as discussed herein, the second opening **2512** is a positive value height **2600** above the first opening **2510**. As such, the second opening **2512** will not be any height **2600** value, relative to the first opening **2510**, less than zero. Said another way, the second opening **2512** could be said not to be adjacent to, or below, the first opening **2510**. It is the placement of the opening **2512** above the opening **2510** that facilitates the creation of the heat-dissipating engine. If the assembly **2500** is rotated into another configuration, such as plugged into a light bulb outlet on floor lamp, the first and second openings **2510**, **2512** would be opposite to one-another, i.e. the first opening **2510** would now be the second opening **2512**.

FIG. **26** further illustrates how side wall **2508** continually surrounds the outer surface of those heat-generating components of the LED assembly **2514** to minimize air leaks and provide efficient cooling. In other embodiments, the side wall **2508** may still surround the LED assembly **2516**, but the airflow channel **2516** may have certain portions obstructed or filled in by material **2604** of the chamber **2502** or the LED assembly **2514**. The chamber **2502** may also form a plurality of individual airflow channels **2516** that subject the LED assembly **2514** to a stream of airflow. In other embodiments of the assembly **2700**, as shown in FIG. **27**, the airflow chamber **2702** may have portions **2704** that extend over the first opening **2510**, thereby creating smaller apertures. The second opening **2512** may also be partially covered. Although the assembly **2700** may be downwardly-tapered as shown in FIG. **27**, in other embodiments, the assembly **2700** may not have any curvature, may be upwardly-tapered, or any combination of the above.

FIGS. **28** and **29** illustrate top and bottom plan views of the assembly **2700** of FIG. **27**, respectively. The first and second openings **2510**, **2512** are shown defined by both the airflow chamber **2702** and the LED assembly **2514**. The second opening **2512** may be smaller, or larger than the first opening **2510** depending on the curvature of the chamber **2702** and/or LED assembly **2514**. The openings **2510**, **2512** may also vary depending on the whether any of the openings **2510**, **2512** are partially covered. e.g., the first opening **2510** as shown in FIG. **28**. The bottom electrical contact portion **2900** of the LED assembly **2514** can also be seen.

Now, turning to FIGS. **30** through **33**, alternative embodiments of the present invention are shown from elevational, cross-sectional, side views. FIG. **30** similarly illustrates the LED lighting assembly **3000** with the side wall **3004** separating the first and second ends **3006**, **3008** of the airflow chamber **3002**. The assembly **3000** is shown being adaptable to be placed outside those ceilings **202** formed for traditional recessed lighting systems.

As such, a user may modify those traditional recessed lighting systems with a novel lighting assembly **3000** that may be mounted to be flush with the ceiling **202** and provides efficient and effective cooling to the LED assembly **3010**. The LED assembly **3010** is shown outlined with hash-lines **3012** and being placed at least partially within the airflow chamber **3002**.

The LED assembly **3010** has a portion **3014** attached to an electrical source **3016**. As illustrated, the LED assembly **3010** is removably-couplable to the chamber **3002**, which has an electrical lead running to another contact portion **3018** that is screwed into a standard light-bulb outlet **3020**. In one embodiment, the chamber **3002** is a single piece of material that is screwed into the light-bulb outlet **3020** until a portion of the first end **3006** couples to the ceiling **202**. In other embodiments, the chamber **3002** may translate up and down the shaft that connects to the outlet **3020**. The chamber may also be attached on a swivel that allows it to be flush with a ceiling **202** that is at an angle. As the LED assembly **3010** may be removed from the chamber **3002**, a user may advantageously change the LED assembly **3010**, should it need to be replaced without removing the entire LED lighting assembly **3000**. When LED assembly **3010** is attached to the chamber **3002**, both the airflow chamber **3002** and the LED assembly create the airflow channel **3022**.

The LED assembly **3010** also is shown having one or more heat sinks **3024** attached thereto. To reduce airflow leaks and facilitate the flow of air within the airflow channel **3022**, the assembly **3000** has one or more gaskets **3026***a*, **3026***b* coupled thereto. In one embodiment, the gaskets **3026***a*, **3026***b*, made from a rubber based sealing-type material, surround and engage with the LED assembly **3010** when inserted therein, thereby creating a relatively air-tight seal. In other embodiments, the LED assembly **3010** may have another sealing-type material, the LED assembly **3010** may have the sealing material attached thereto, or the assembly **3000** may not have any sealing-type material.

The LED assembly **3010** has one or more light sources **3028** located therein that broadcast light when in operation. The light sources may have a power supply **3030** or may also have a circuit board/controller (not shown). When in operation, the heat generated from those components, and potentially any other components located therein, is transferred to the airflow channel **3022**. The assembly **3000** also has multiple proximal openings **3032***a-n* and distal openings **3034***a-n*. The heat generated from the components of the assembly LED assembly **3010** rises, and exits through the distal openings **3034***a-n*. The internal area of the airflow channel **3022**, the average height **3036** between the distal and proximal openings **3032***a-n*, **3034***a-n*, and the temperature difference between the airflow channel **3022** and outside ambient environment creates an airflow (represented with arrows **3038**) within the channel **3022**. As previously discussed, this creates a heat dissipating engine that displaces the hot air with cooler air. This airflow transports the heat away from those internal components, thereby generating and maintaining a relatively cool environment, not achieved with those prior-art lighting assemblies.

FIG. **31** illustrates another embodiment of the LED lighting assembly **3100**. The assembly **3100** has an LED assembly **3102** with multiple light sources **3104** within that have a portion subjected to airflow (represented with arrows **3106**) within the airflow channel **3108**. In one embodiment, the airflow chamber **3114** may form one single channel **3108** that subjects all of the light sources **3104** to the airflow. In other embodiments, the airflow chamber **3114** may section into multiple chambers **3114** that define a plurality of individual airflow channels **3108** that subject the airflow to one or more LED light sources **3104**. FIG. **31** also shows the LED assembly **3102** with a power supply **3112** and a circuit board **3110** coupled thereto and subjected to the airflow. In other embodiments, the power supply **3112** and/or circuit board **3110** may be located physically outside the airflow channel **3108**, but may have one or more heat sinks coupled thereto, such that they could be said to be thermally coupled to the airflow channel **3108**. The one or more light sources **3102** may be coupled to a portion **3116** of the airflow chamber **3114**. The chamber **3114** has a first opening **3122** at the lower side of the chamber **3114** and the second opening **3124** is located at the upper side of the chamber **3114**. In other embodiments, there may be more than one opening or the openings may be in different locations on the chamber **3114**. Further, the second opening **3124** is shown expelling the air on the side of the chamber, but in other embodiments, the second opening **3124** may expel the hot air into the recessed portion **204** of the ceiling **202** where it is then transported upwardly through the building.

In contrast to FIG. **30**, where the airflow chamber **3002** was a single piece of material and separate and independent from the LED assembly **3010**, the airflow chamber **3114** in FIG. **31** is integrated with the LED assembly **3102**. In one example of the present invention, the chamber **3114** is adjustable along a shaft **3118** either before, or after, the assembly **3100** is screwed into the light-bulb outlet **3120**. The chamber **3114** is translated upward or downward at will by a user. This can be accomplished, for example, by ball detents, friction, by pressing and depressing a button **3126** the releases a shaft **3128** into a plurality of slots **3130**, or any other mechanical mode for allowing two objects to selectively translate relative to one another. This feature allows the user to selectively adjust the chamber **3114** to an appropriate height sufficient for it to be flush against the ceiling **202**.

Referring now to FIG. **32**, another example of the present invention is shown. The chamber **3202** defines an airflow channel **3204** that facilitates and directs the transfer of airflow (represented by arrows **3206**) to the second opening **3208**. The second opening **3208** expels the hot air generated from the components of the LED assembly **3210** into the recessed **204** portion of the ceiling **202** where it is transferred into the ceiling through the electrical outlet **3218** or one or more portions **3220** of the upper surface of the assembly **3200**. Similar to FIG. **31**, the assembly **3200** is adjustable vertically along the shaft **3212**. In one embodiment, when the assembly **3200** is to be adjusted, the user presses the lever **3214**. The assembly **3200** is coupled to the shaft **3212** with rotatable hooks **3216** that prevents chamber **3202** from traveling pass the end of the shaft **3212**. The shaft **3212** may also have a void located therein for electrical wiring. In other embodiments, the assembly **3200** may be adjustable using notches, threading, or other similar means to allow the assembly **3200** to be adjusted as discussed.

Referring now to FIGS. **33-35**, one embodiment of the present invention is shown. Specifically, the assembly **3300** has multiple light bulb assemblies **3302**, or light sources **3302**, that each have a separate chamber **3304**, or heat-dissipating engine **3304**, that defines an airflow channel **3306**. The assembly **3300** has a substrate **3305** that supports the light source **3302** and has a front and back surface **3307**, **3309**. The front and back surfaces **3307**, **3309** define the first opening **3310**, also called an aperture **3310**. The light source **3302** is supported by the substrate **3305** and is adjacent to the aperture **3310**. The side wall **3308** of the chamber **3304** may also define the first opening **3310**. As shown, the light source **3302** is operable to emit light from the front surface **3307**. The heat-dissipating engine **3304** is coupled to the back surface **3309** of the substrate **3305**. In one embodiment, the substrate is also a circuit board. In other embodiments, the substrate **3305** is a structure attached to the light source **3302** or another portion of the assembly **3300**.

The airflow channel **3306** extends from the aperture **3310**, across a portion of the light-source, and out of the second opening **3312**, also called an exhaust port **3312**, which transmits the hot air to an outside environment. In contrast to prior figures, which have shown a single chamber **3304** or heat-dissipating engine **3304**, FIG. **33** illustrates how multiple airflow channels **3306** are defined from each heat-dissipating engine **3304**. The airflow from each channel **3306** are then accumulated into a separate chamber **3314** that dissipates the hot air through a distal opening **3316** in the assembly **3300**. The flow of air generated from the assembly, when in operation, is shown by the arrows **3318**. In one embodiment, the portion of the light-source **3302**, which the air flows across, is one or more heat sinks **3320**.

FIG. **34** is an upwardly-looking perspective view of the assembly **3300** when coupled to the ceiling. The light transmitting portion of the light-source **3302**, or more specifically a casing **3400** which covers the light-source **3302**, is shown protruding from the end face of the assembly **3300**. Also shown is the first opening **3310** which is placed in fluid communication with an outside environment. In one embodiment, the assembly **3300** may have the light-sources **3302** organized and configured in a star-like shape. In other embodiments, the light-sources **3302** may be configured in a circular fashion, or other orientation, as desired.

FIG. **35** illustrates a close up view of heat-dissipating engine **3304** coupled to the substrate **3305**, which is coupled to the light-source **3302**. In one embodiment, the light-emitting element **3500**, e.g., a LED diode, is located on the front surface **3307** of the substrate **3305**, which may be a circuit board. The element **3500** is encapsulated in a casing **3502** to protect the integrity of, and effectively prorogate, the light generated from the element **3500**. The back surface **3309** of the substrate **3305** is coupled to the engine **3304** and has an opening that mates with an opening in a bottom surface **3506** of the engine **3304** to at least partially define the aperture **3310**. In other embodiments, a power supply or other components may be at least partially within the airflow channel **3306**. Further, a mounting bracket may also be utilized to stabilize the light-source **3302** that may include a portion removed to form either the aperture or the exhaust port **3310**, **3312**.

Coupled to the bottom surface **3506** and extending upwardly therefrom is the heat sink **3320** with one or more members **3508** that are aligned in the general direction of airflow **3318**. In other embodiments, the light-source **3302** may not have a heat sink **3320** or the heat sink **3320** may take the form of a plate or other surface. In further embodiment, the heat engine **3304** may not have a bottom surface **3506** and may couple to the back surface **3309** of the substrate **3305**. When in operation, a stream of air **3318** enters the first opening **3310** and passes through the members **3508**, which are thermally coupled to the element **3500**, thereby removing the heat generated from the element **3500**. The heat from the element **3500** is then transported through the exhaust port **3312** into the separate collection chamber **3314** where it is expelled into the outside environment.

A novel and efficient lighting assembly has been disclosed that provides an array of LED light sources that are coupled to a light-emitting lens through a plurality of light guides, where the light-emitting lens blends the light from each of the individual light guides and transmits a blended light product. Furthermore, the novel lighting assembly provides a light-generation source that is disposed in a central or rear section of the overall lighting assembly and guided to a light-emitting lens through one or more light guides.

What is claimed is:

**1**. A self-cooled lighting assembly comprising:

a ceiling with a standard-sized light bulb recess therein, the light bulb recess having a standard light-bulb outlet therein and a maximum opening dimension limiting the dimension of objects insertable within the light bulb recess; and

a light fixture including:

a light-source power receiving portion dimensioned to fit within the light bulb recess and couplable to the standard light-bulb outlet;

a sidewall having a dimension exceeding the maximum opening dimension of the light bulb recess;

a light-source-supporting substrate within the sidewall and having a front surface and a back surface and defining an aperture between the front surface and the back surface;

a light-source supported by the substrate, adjacent the aperture, and operable to emit light from the front surface of the substrate; and

a heat-dissipating engine coupled to the back surface of the substrate and in fluid communication with the aperture, the heat-dissipating engine defining an airflow channel from the aperture, across a portion of the light-source, and out of an exhaust port in the sidewall higher in altitude than the aperture, the heat-dissipating engine driving a substantially continuous flow of air from the aperture, across a portion of the light-source, and out of the exhaust port without the use of a fan.

**2**. The self-cooled lighting assembly according to claim **1**, wherein the light source further comprises:

a light-emitting front face visible from the front surface of the substrate; and

a light-source driving circuit coupled to the back surface of the substrate and extending at least partially within the air-flow channel.

**3**. The self-cooled lighting assembly according to claim **2**, wherein:

the light-source driving circuit includes a heat sink extending at least partially within the air-flow channel.

**4**. The self-cooled lighting assembly according to claim **1**, wherein:

the light-source is a plurality of light-sources; and

the aperture is a plurality of apertures, wherein each of the plurality of apertures is adjacent one of the plurality of light-sources.

**5**. The self-cooled lighting assembly according to claim **1**, wherein:

the exhaust port is a plurality of exhaust ports.

**6**. The self-cooled lighting assembly according to claim **1**, further comprising:

a shaft electrically coupling the light-source power receiving portion to the standard light-bulb outlet for supplying power to the light-source, the light-source being translatable on the shaft relative to the electrical receptacle.

**7**. The self-cooled lighting assembly according to claim **6**, further comprising:

a lever mechanically coupled to the shaft and operable to selectively allow the light-source to translate on the shaft relative to the electrical receptacle.

**8**. The self-cooled lighting assembly according to claim **1**, wherein:

the exhaust port in the sidewall is located outside of the light bulb recess and directs air away from the light bulb recess.

**9**. The self-cooled lighting assembly according to claim **1**, wherein:

the standard-sized light bulb recess is a can in a ceiling, the can sized and shaped to receive substantially all of a standard-sized light bulb.

**10**. A flush mounted self-cooled ceiling lighting assembly comprising:

a light assembly dimensioned and shaped not to completely fit within a standard-sized light bulb recess in a ceiling, the standard-sized light bulb recess being of a size and shape to receive substantially all of a standard-sized light bulb therein, the light assembly having a light-emitting face and an electrical contact portion;

an airflow chamber shaped to be in contact with a ceiling and having a side wall:

with an upper end dimension that exceeds the largest dimension of the standard sized light bulb recess in the ceiling;

with a lower end that defines an aperture for passing light emitted from the light source;

defining at least one proximal opening; and

defining at least one distal opening in fluid communication with the proximal opening, wherein heat created by the light assembly drives a substantially continuous flow of air from the proximal opening, across a portion of the light assembly, and out of the distal opening without the use of a fan.

**11**. The flush mounted self-cooled ceiling lighting assembly according to claim **10**, wherein the airflow chamber further comprises:

a light-bulb electrical receptacle shaped to receive the electrical contact portion of the light assembly; and

a contact portion electrically couplable with a standard light-bulb outlet.

**12**. The flush mounted self-cooled ceiling lighting assembly according to claim **11**, further comprising:

a shaft separating the light-bulb electrical receptacle from the contact portion.

**13**. The flush mounted self-cooled lighting assembly according to claim **12**, further comprising:

a lever mechanically coupled to the shaft and operable to selectively allow the airflow chamber to translate on the shaft relative to the light-bulb electrical receptacle.

**14**. The flush mounted self-cooled lighting assembly according to claim **10**, wherein:

the at least one distal opening is aligned to emit the substantially continuous flow of air from the proximal opening away from the recess in the ceiling.

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