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(54) **SCREW-IN LED BULB COMPRISING A BASE HAVING OUTWARDLY PROJECTING NODES**

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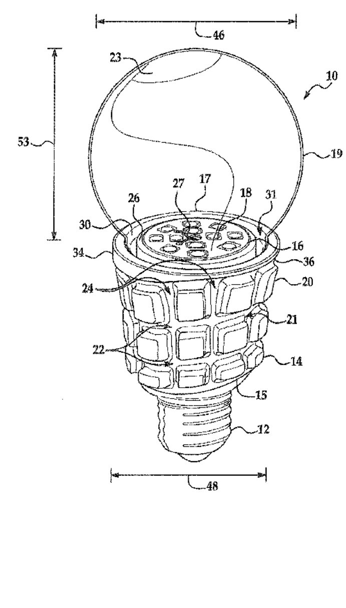
(57) **ABSTRACT**

An LED-based light can include a highly thermally conductive base having multiple radially outward projecting nodes. The nodes can be spaced apart in an axial and circumferential directions of the base. An electrical connector and at least one LED can be attached to the base, and a light transmitting bulb can be attached to the base and can cover the at least one LED. The geometry of the base can promote heat dissipation, which can allow the at least one LED to use enough power to produce an amount of luminosity that allows the LED-based light to replicate, for example, an incandescent light without overheating.

27 Claims, 4 Drawing Sheets



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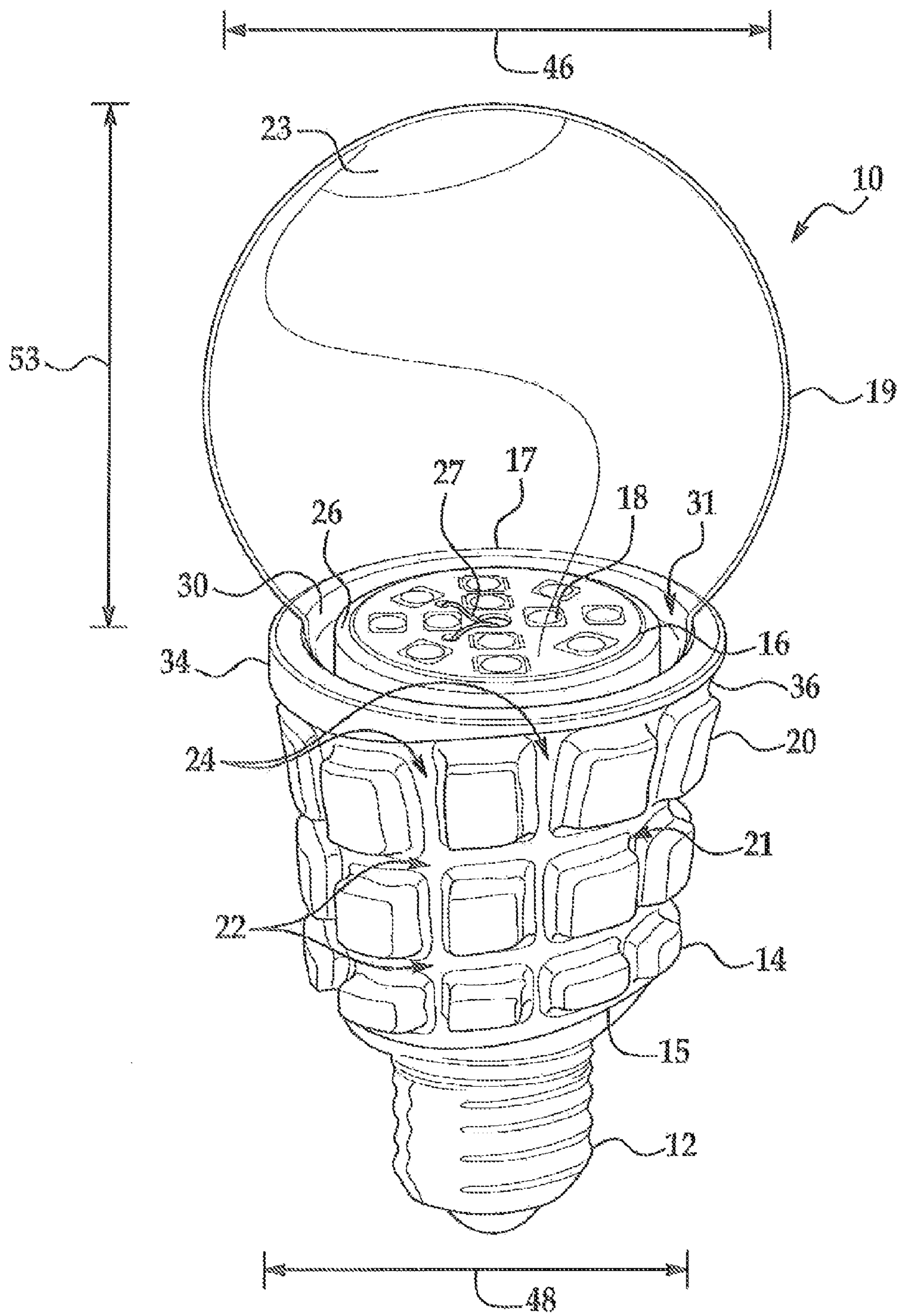


FIG. 1

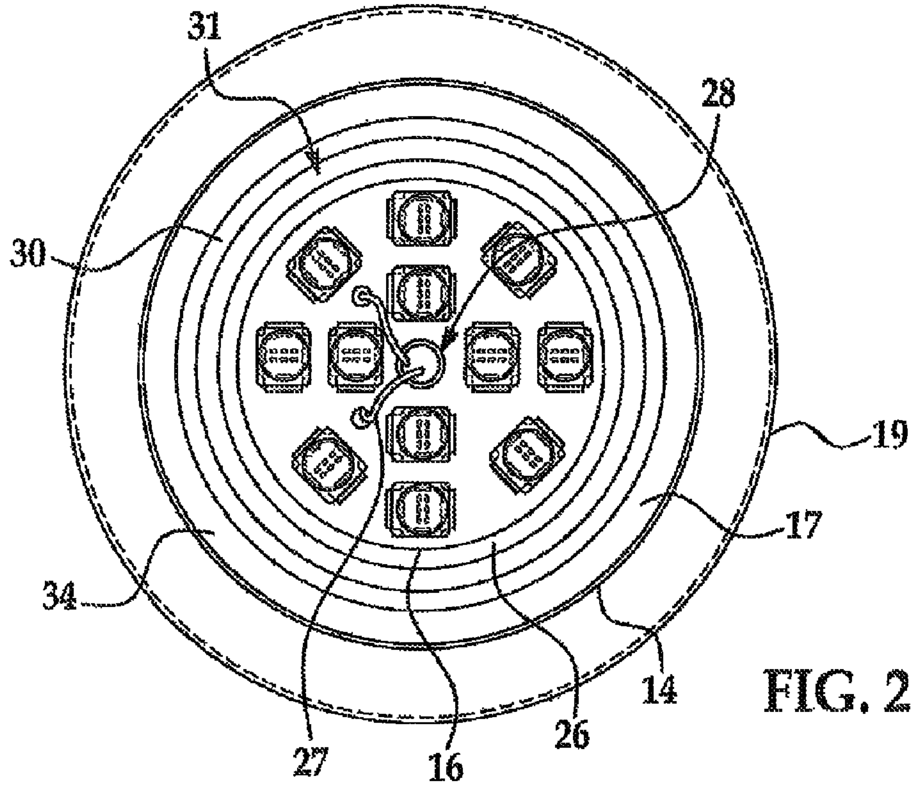


FIG. 2

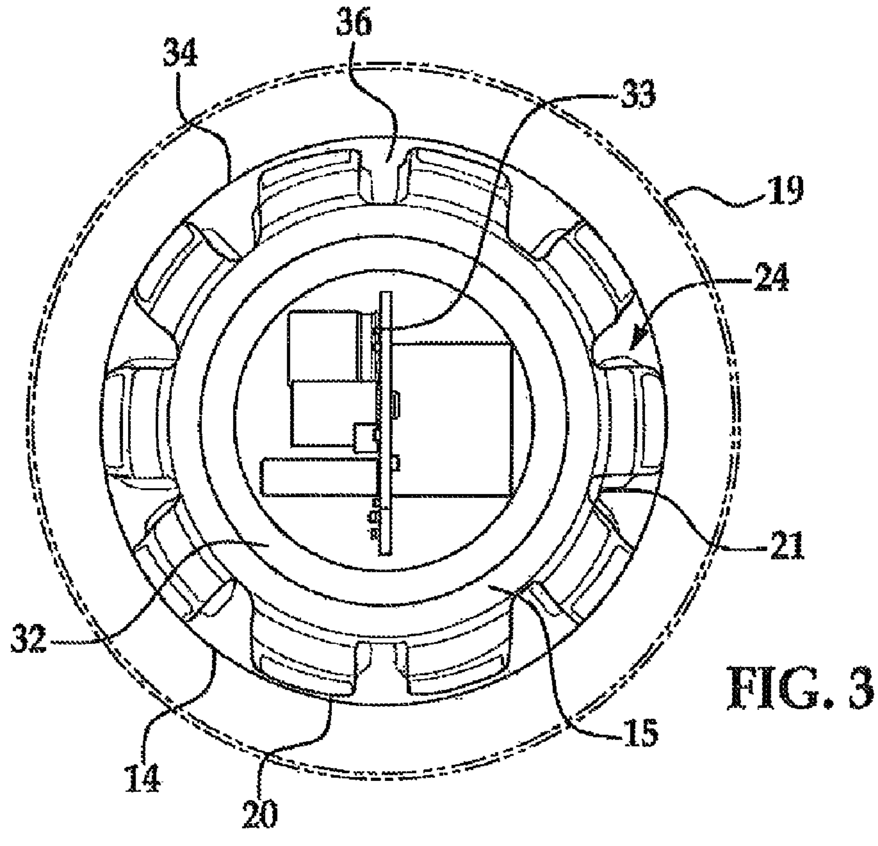
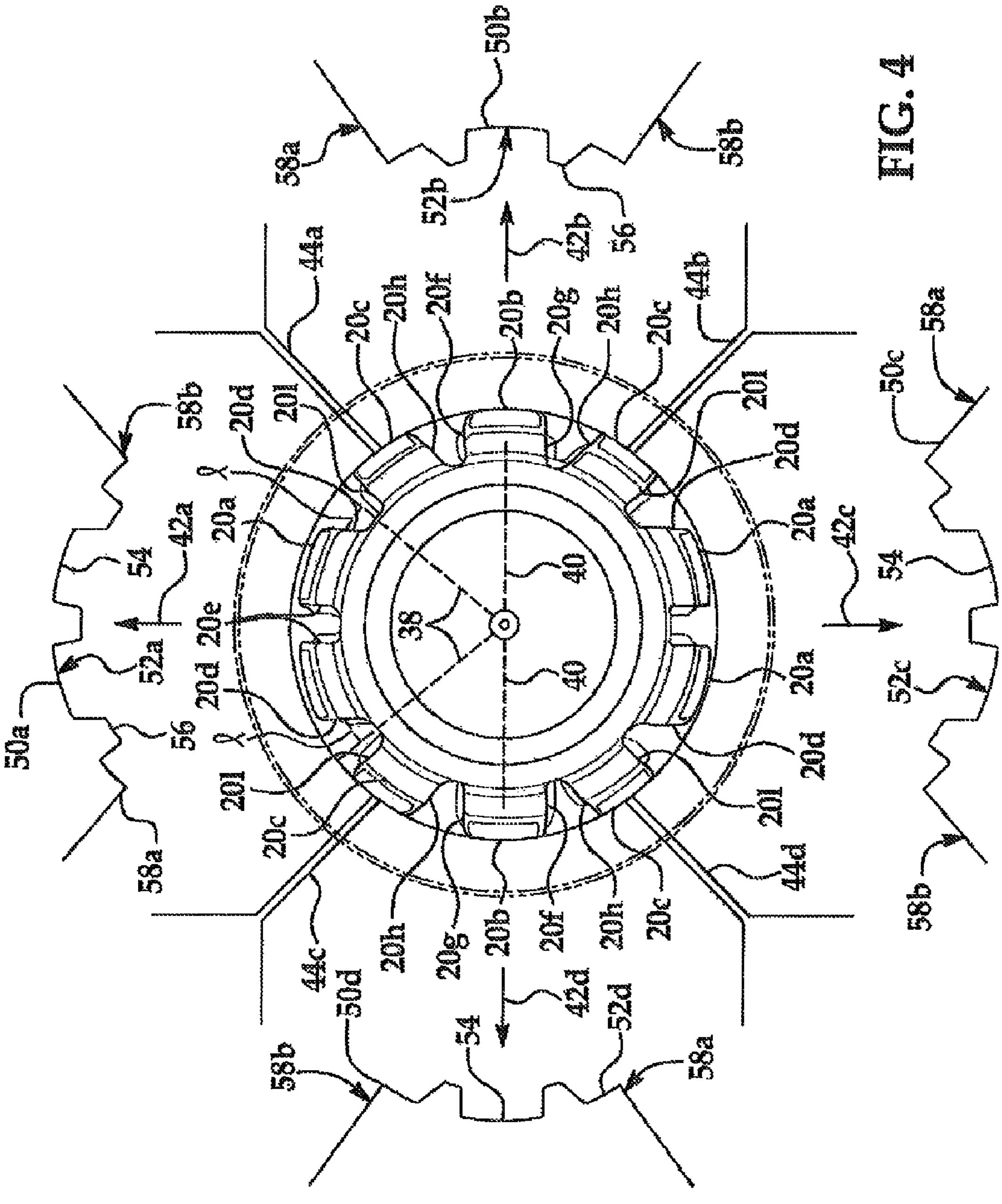


FIG. 3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50c
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52c
52d
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56
58a
58b
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42b
42c
42d
44a
44b
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20a
20b
20c
20d
20e
20f
20g
20h
20l
38
40

FIG. 4

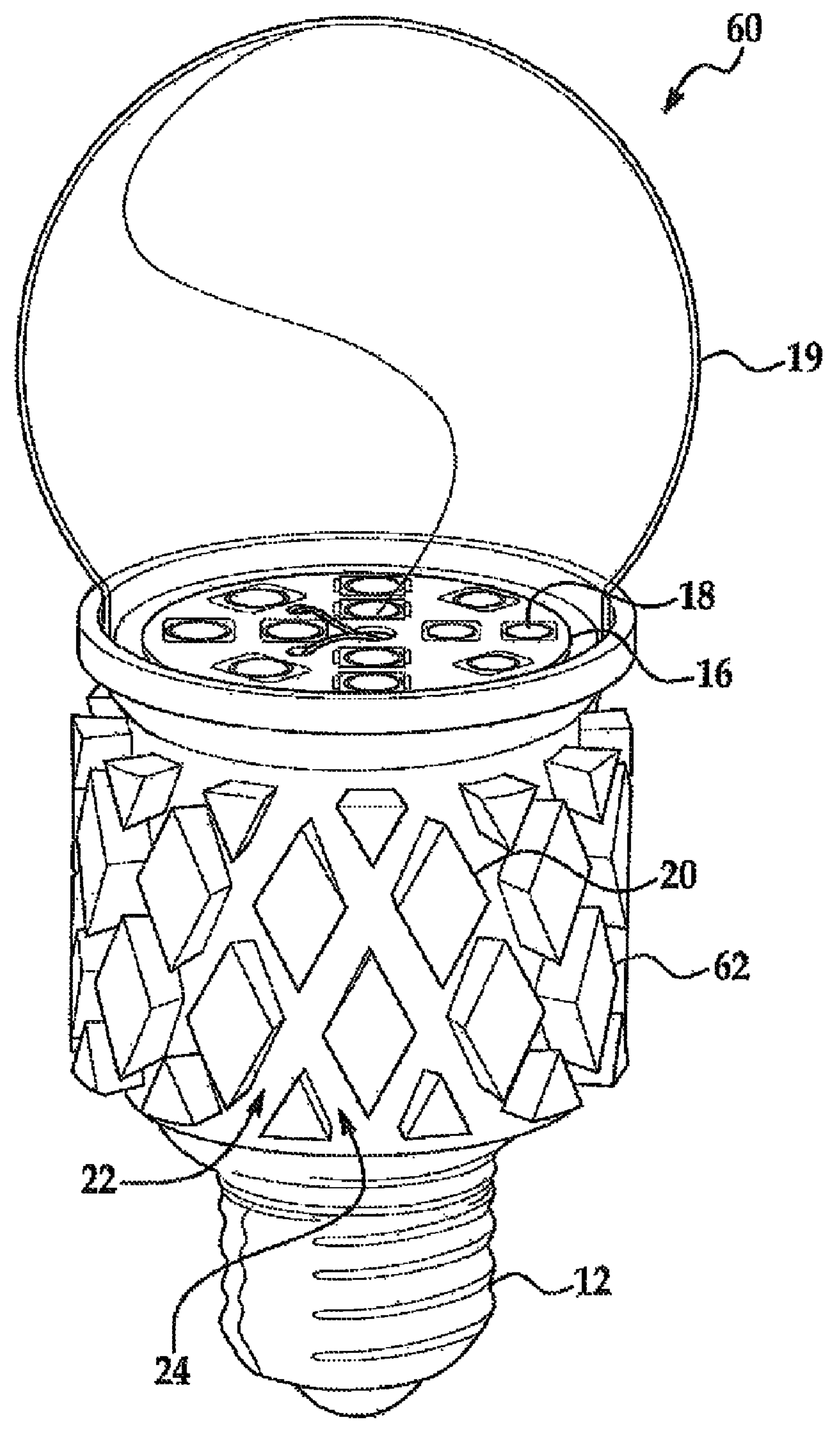

FIG. 5

SCREW-IN LED BULB COMPRISING A BASE HAVING OUTWARDLY PROJECTING NODES

STATEMENT OF RELATED CASES

This application claims priority to Provisional Application No. 61/183,307 filed Jun. 2, 2009, which is hereby incorporated by reference in its entirety.

BACKGROUND

Incandescent light bulbs are commonly used in many environments, such as households, commercial buildings, and advertisements, and in many types of fixtures, such as desk lamps and overhead fixtures. Incandescent bulbs can have a threaded electrical connector for use in Edison-type fixtures, though incandescent bulbs can include other types of electrical connectors such as a bayonet or pin electrical connector. Incandescent light bulbs generally consume large amounts of energy and have short life-spans. Indeed, many countries have begun phasing out or plan to phase out the use of incandescent light bulbs entirely.

Compact fluorescent light bulbs (CFLs) are gaining popularity as replacements for incandescent light bulbs. CFLs are typically much more energy efficient than incandescent light bulbs, and CFLs typically have much longer life-spans than incandescent light bulbs. However, CFLs contain mercury, a toxic chemical, which makes disposal of CFLs difficult. Additionally, CFLs require a momentary start-up period before producing light, and many consumers do not find CFLs to produce light of similar quality to incandescent bulbs. Further, CFLs are often larger than incandescent lights of similar luminosity, and some consumers find CFLs unsightly when not lit.

Known LED-based light bulbs have been developed as an alternative to both incandescent light bulbs and CFLs. Known LED light bulbs typically each include a base that functions as a heat sink and also include an electrical connector at one end, a group of LEDs attached to the base, and a bulb. The bulb often has a semi-circular shape with its widest portion attached to the base such that the bulb protects the LEDs.

SUMMARY

Known LED-based light bulbs suffer from multiple drawbacks. A base of a typical known LED-based light bulb is unable to dissipate a large amount of heat, which in turn limits the amount of power that can be supplied to LEDs in the known LED-based light bulb without a high risk of the LEDs overheating. As a result of the power supplied to the LEDs being limited, the typical known LED-based light bulb has a limited luminosity and as a result is not as bright as an incandescent light bulb that the LED-based light bulb is intended to replace.

In an effort to increase the luminosity of known LED-based light bulbs, some known LED-based light bulbs include over-sized bases having large surface areas. The large surface areas of the over-sized bases are intended to allow the bases to dissipate sufficient amounts of heat such that the LEDs of each known LED-based light can be provided with enough power to produce as much luminosity as the respective incandescent bulbs that these known LED-based light bulbs are intended to replace. However, the total size of one of the LED-based lights is often limited, such as due to a fixture size constraint. For example, a desk lamp may only be able to accept a bulb having a three to four inch diameter, in which case the over-sized base of an LED-based light should not

exceed three to four inches in diameter. Thus, the size of the over-sized base for the known LED-based light bulb is constrained, and heat dissipation remains problematic.

Further, the use of over-sized bases in some known LED-based light bulbs detracts from the distributions of light emanating from the bulbs. That is, for a typical known LED-based light bulb having one of the over-sized bases, the over-sized base has a diameter as large as or larger than a maximum diameter of the bulb of the known LED-based light bulb. As a result of its small bulb diameter to base diameter ratio, the base blocks light that has been reflected by the bulb and that would otherwise travel in a direction toward an electrical connector at an end of the base. The typical known LED-based light bulb thus does not direct much light in a direction toward the electrical connector. For example, when the typical known LED-based light bulb having an over-sized base is installed in a lamp or other fixture in which the bulb is oriented with its base below its bulb, very little light is directed downward. Thus, the use of over-sized bases can also prevent known LED-based lights from closely replicating the distribution of incandescent bulbs.

As an alternative to using over-sized bases, other attempts have been made to increase the ability of known LED-based light bulbs to dissipate heat. For example, bases of some known LED-based light bulbs include motorized fans for increasing the amounts of airflow experienced by the bases. However, known LED-based light bulbs including fans often produce audible noises and are expensive to produce. As another example of an alternative to using an over-sized base, bases of some known LED-based lights have been provided with axially (e.g., if the LED-based light is intended to replace a conventional incandescent bulb, then the axial direction is from an end of the Edison-type connector opposite the bulb along the major length of the bulb to an opposing end of the light) extending ribs in an attempt to increase the surface areas of the bases without too greatly increasing the diameters of the bases. However, such ribs often have the effect of acting as a barrier to air flow and, as a result, tend to stall air flow relative to the base. As a result, bases with axially extending ribs typically do not provide a sufficient amount of heat dissipation.

Examples of a screw-in LED bulb described herein have many advantages over known LED-based light bulbs. For example, an example of a screw-in LED bulb as described herein can include a base with a plurality of nodes, and channels between the nodes can extend about the base in multiple directions, such as axially and circumferentially. The nodes can increase the surface area of the base, thereby improving the conductive heat dissipation abilities of the base, and the geometry of the base can enhance airflow relative to the base, thereby improving the convective heat dissipation abilities of the base. The base can thus dissipate a sufficient amount of energy for the screw-in LED bulb to produce as much light as a known incandescent bulb.

The exact geometry of the base can be determined using, as an example, fluid dynamics software. The material of the base, the amount of heat produced by LEDs in the screw-in LED bulb, and the temperature at which the LEDs safely operate can be among the considerations used to determine the geometry of the base. Additionally, the base can be shaped to improve airflow, thus improving convective heat transfer, and both the speed and direction of airflow can be considered. Airflow at the time the bulb is initially turned on, airflow between the time at which the screw-in LED bulb is initially turned on and the time at which the screw-in LED bulb reaches steady state operation, and airflow at the time at which steady state operation of the screw-in LED bulb has been reached can all be considered to determine the geometry of the base.

Additionally, the nodes can be shaped to allow for easy manufacturing of the base using die casting. A die can be made in sections or pieces, and the die pieces can be arranged to contact one another to form a mold cavity having the shape of the base. Liquid material, e.g., molten aluminum, can be poured into the mold cavity, and the liquid material can be allowed to cool to form the base. The die pieces can be pulled away from the formed base in different directions, such as in four directions angled approximately ninety degrees from one another. Thus, the nodes can be shaped to not interfere with removal of the die pieces.

The geometry of the base relative to a geometry of a bulb of the screw-in LED bulb can be set such that the light distribution from the screw-in LED bulb closely replicates the distribution of light from an incandescent bulb. A maximum width of the bulb measured perpendicularly to an axial direction of the base can be about 120% or more of a maximum diameter of the base, and a height of the bulb measured along the axial direction of the base can be about equal to the maximum width of the bulb or greater than the maximum width of the bulb. These ratios can allow the bulb to distribute light in a direction toward an electrical connector at an end of the base opposite the bulb and for light to disperse prior to contacting the bulb to reduce the appearance of a bright spot. Also, a portion of the bulb that is in the path of a high amount of light can be coated or otherwise modified to reduce its transmissiveness, thereby directing light toward portions of the bulb that would otherwise receive only a low amount of light.

BRIEF DESCRIPTION OF THE DRAWINGS

The description herein makes reference to the accompanying drawings wherein like reference numerals refer to like parts throughout the several views, and wherein:

FIG. **1** is a perspective view of a first example of a screw-in LED bulb;

FIG. **2** is a top plan view of the screw-in LED bulb of FIG. **1**;

FIG. **3** is a bottom plan view of the screw-in LED bulb of FIG. **1** without its electrical connector and with its bulb shown in phantom;

FIG. **4** is a bottom plan view of a base of the screw-in LED bulb of FIG. **1** along with die pieces used to form the base; and

FIG. **5** is a perspective view of a second example of a screw-in LED bulb.

DESCRIPTION

Examples of LED-based light bulbs are discussed herein with reference to FIGS. **1**-**5**. A first example of a screw-in LED bulb **10** shown in FIG. **1** can include an electrical connector **12**, a base **14** attached to the electrical connector **12**, a circuit board **16** attached to the base **14**, a plurality of LEDs **18** mounted on the circuit board **16**, and a bulb **19** connected to the base **14** and covering the LEDs **18**.

The electrical connector **12** can be of the screw-in type, also referred to as an Edison connector. The electrical connector **12** can alternatively be of another type such as a bayonet connector or pin connector. The electrical connector **12** can serve as an electrical and physical connection between the bulb **10** and a fixture, such as a desk lamp or an overhead fixture. The electrical connector **12** can be screwed, snap-fit, glued, or otherwise attached to a first end **15** of the base **14**.

Referring still to FIG. **1**, the base **14** can act as a heat sink for dissipating heat produced by the LEDs **18**. The base **14** can be made from a highly thermally conductive metal such as aluminum, a highly thermally conductive plastic, or another highly thermally conductive material. How thermally conductive the material from which the base **14** is constructed should be can be determined based on, for example, the amount of heat that is to be dissipated and the geometry of the base **14**. The base **14** can be painted, powder-coated, or anodized to improve its thermal emissivity. For example, a thermally conductive, high emissivity paint (e.g., a paint having an emissivity of greater than 0.5) can be applied to at least a portion of an exterior of the base **14**.

The base **14** can define a plurality of raised nodes **20** projecting radially outward from an exterior surface **21** of the base **14**. The nodes **20** can have a generally rectangular shape as shown in FIG. **1**, a diamond shape as shown in FIG. **5**, or some other shape (e.g., oval, triangular, or polygonal). The nodes **20** can be arranged generally in rows and columns as shown in FIG. **1** to define channels **22** and **24**. While the channels **22** and **24** extend generally circumferentially and axially, respectively, relative to the base **14** as shown in FIG. **1**, the channels **22** and **24** can be oriented differently depending on the shape and position of the nodes **20**. For example, as shown in FIG. **5**, the channels **22** and **24** are angled approximately forty five degrees relative the circumferential and axial directions, respectively. The nodes **20** can have rounded edges at the junctions of proximal ends of the nodes **20** and the surface **21**, at the junctions between different sides of the nodes **20** that extend between the proximal and distal ends of the nodes **20**, and at the junctions between the sides of the nodes **20** and the distal ends of the nodes **20**. The rounded edges of the nodes **20** can encourage airflow over the base **14**, as rounded edges can enable greater airflow compared to sharp edges by reducing the tendency of air to stall.

Referring now to FIG. **2**, a second end **17** of the base **14** axially opposite the first end **15** can define a platform **26** for receiving the circuit board **16**. The platform **26** can be generally planar and can define an aperture **28** through which wiring **27** that is in electrical communication with the electrical connector **12** and the circuit board **16** can pass. A wall **30** can extend circumferentially around the platform **26**. While the wall **30** is shown as continuous, the wall **30** can alternatively be discontinuous. The wall **30** can be obtusely angled relative to the platform **26** such that an angle between, for example, 90 and 135 degrees is formed therebetween. The wall **30** can enhance an attachment between the base **14** and bulb **19** by providing a surface to which the bulb **19** can be attached. A recessed groove **31** can be defined by the second end **17** of the base **14** about the platform **26** and radially inward of the wall **30**.

Referring again to FIG. **1**, a ridge **34** can extend radially outward and axially toward the nodes **20** from the second end **17** of the base **14**. The length of the ridge **34** in the axial direction of the base **12** can vary circumferentially around the base **12** as shown in FIG. **1**. For example, the axial length of the ridge **34** can vary such that the distance between the ridge **34** and adjacent nodes **20** remains substantially constant around the base **14** even if the positions of the nodes **20** are staggered in the axial direction. A fillet **36** can be included between the ridge **34** and the surface **21** of the base **14** as shown in FIG. **1**. The fillet **36** can improve airflow between the ridge **34** and the nodes **20** and surface **21**.

The base **14** can also define a cavity **32** as shown in FIG. **3**. The cavity **32** can be sized to receive electronics **33** that, as an example, convert AC power received from the electrical connector **12** to DC power that is supplied to the LEDs **18**. The electronics **33** can be electrically coupled to the electric connector **12**, and the wiring **27** can extend from the electronics **33** to the circuit board **16**. The electronics **33** can include, for example, a rectifier, a filtering capacitor, and DC to DC conversion circuitry. The electronics **33** can be loosely inserted into the cavity **32** and held in place as a result of the electric connector **12** enclosing the cavity **32**. Alternatively, the electronics **33** can be adhered, clipped, or otherwise attached to the base **14**. While the illustrated cavity **32** is cylindrical, the cavity **32** can have an alternative shape, such as a conical shape or an oval shape.

Currently, the size of the electronics **33** can be a constraint on the size of the base **14**. As an example, a minimum diameter of the base **14** can be constrained such that the base **14** is of sufficient size to define the cavity **32** that in turn is of sufficient size for receiving the electronics **33**. Additionally, a maximum size of the base **14**, both in terms of its axial length and diameter, can be constrained by a size of a fixture in which the screw-in LED bulb **10** may be installed in. For example, the screw-in LED bulb **10** can be constrained not to exceed the length and diameter of an incandescent light bulb that the screw-in LED bulb **10** is intended to replace. Further, the maximum size of the base **14**, also both in terms of its axial length and diameter, can be constrained to achieve a distribution of light that closely replicates a distribution of light from an incandescent bulb as is explained below in greater detail with respect to the ratio between the dimensions of the base **14** and the dimensions of the bulb **19**. Whether or not the distribution of light from the screw-in LED bulb **10** closely replicates the distribution of light from an incandescent bulb can be judged by luminosity measuring tools, by the preferences of ordinary users, or in another manner. In addition to the above mentioned constraints, other factor can be taken into consideration when determining the geometry of the base **14**, such as the expected amount of heat output by the LEDs **18**, a maximum temperature at which the LEDs **18** operate safely, and the material of from which the base **14** is constructed.

Also, when determining the geometry of the base **14**, both conductive and convective heat dissipation can be considered. The base **14**, or certain portions therefore, can become hotter than ambient air during operation, and as a result air adjacent to hot portions of the base **14** can become hotter than air spaced from the base **14**. A temperature gradient between air adjacent to the base **14** and air spaced from the base **14** can result in airflow, which in turn can provide convective heat dissipation that can aid in the dissipation of heat from the base **14**. Multiple aspects of convective heat dissipation can be considered when determining the geometry of the base **14**, including air speed and airflow direction. Additionally, airflow generated by the temperature gradients explained above can be considered at different time periods when determining the geometry of the base **14**, such as when the screw-in LED bulb **10** is turned on, a dynamic period when the screw-in LED bulb **10** is increasing in temperature after being turned on but before reaching a steady state temperature, and when the screw-in LED bulb **10** reaches a steady state temperature. The channels **22** and **24** formed between the nodes **20** can greatly improve convective heat dissipation by allowing airflow in different directions, and the orientation of the channels **22** and **24** can be selected to encourage airflow.

Working under the above-mentioned constraints and considerations, the geometry of the base **14** can be determined such that the base **14** can dissipate a sufficient amount of heat for safe operation of the LEDs **18** at a specified power level (e.g., a power level at which the LEDs **18** produce a sufficient amount of light for the screw-in LED bulb **10** to replicate a certain incandescent bulb, such as a 60 W or 100 W incandescent bulb, that the bulb **10** is to replace). These determinations can be carried out with the use of fluid dynamics software, though hand calculations, experimentation and other manners of making the determinations can be used. If certain areas of the base **14** are determined to become hotter than surrounding areas, more material can be added to the hotter portions of the base **14** within the above mentioned constraints.

In one example in which the bulb **10** was configured to output the same amount of light as a 60 W incandescent bulb, ten columns of nodes **20** are spaced circumferentially around the base **14** and three rows of nodes **20** are spaced axially in each column to achieve sufficient heat dissipation for LEDs **18** of the surface-mountable type available from Nichia to use 11 W of power. Continuing with the example, the nodes **20** occupy approximately 70% of the circumferential surface area of the base **14** excluding the ridge **34**, with the surface **21** and ridge **34** occupying the remaining approximately 30% of the circumferential surface area. The nodes **20** have a height of approximately 3 mm from the surface **21**. The three nodes **20** in each column have different axial lengths, with the nodes **20** nearest to the platform **26** having an axial length of approximately 10 mm, the middle row of nodes **20** having an axial length of approximately 7 mm, and the nodes **20** nearest the electrical connector **12** having an axial length of approximately 4 mm. The circumferential spacing between the columns of nodes **20** and the axial spacing between the rows of nodes **20** are both approximately 4 mm. The thickness of the base **14** between the surface **21** and the cavity **32** is approximately 2 mm. The diameter of the cavity **32** is approximately 35 mm. Additional geometrical aspects of the base **14** are discussed below in respect of the ratio between the dimensions of the base **14** and the dimensions of the bulb **19**. The base **14** can alternatively have a different geometry and still be suitable for use with LEDs **18** of the surface-mountable type available from Nichia that produce 11 W in the aggregate, and the base **14** can have a different geometry if it is intended to replace an incandescent light other than the 60 W incandescent bulb.

The base **14** can be manufactured by die casting, machining (e.g., milling or lathing), or using another process. Referring now to FIG. **4**, when die casting the base **14**, a die made from die pieces **50***a-d* that collectively define a mold cavity in the shape of the base **14** when assembled can be used. Each die piece **50***a-d* can have a respective face **52***a-d* corresponding to a shape of a portion of the base **14**, such as a portion of the base **14** extending the entire axial length of the base **14** and circumferentially approximately a quarter of the circumference of the base **14**. Each face **52***a-d* can define a plurality of indentations **54** in the shapes of nodes **20** and can define protrusions **56** that form the channels **22** and **24**. Some of the indentations **54** and protrusions **56** can be partially defined by adjacent die pieces **50***a-d* such that those indentations **54** and protrusions **56** are fully defined when the die pieces **50***a-d* are assembled. Molten material can be inserted into the mold cavity and allowed to cool to form the base **14**, and the die pieces **50***a-d* can be removed from the base **14** once the molten material is sufficiently cooled.

The geometry of the base **14** can allow for easy removal of the die pieces **50***a-d* from the base **14**. For example, as shown in FIG. **4**, the die pieces **50***a-d* can meet at junction lines **44***a-d* when assembled to form the complete mold cavity. Each die piece **50***a-d* can have two opposing sides **58***a* and **58***b*, and side **58***a* of each die piece **50***a-d* can contact the side **58***b* of an adjacent die piece **50***a-d* when the die pieces **50***a-d* are assembled. The die pieces **50***a-d* can be removed from the base **14** along respective pull lines **42***a-d* after the molten material poured into the mold cavity has sufficiently cooled to allow removal of the die pieces **50***a-d*.

To allow for removal of the die pieces **50***a-d* after formation of the base **14** without interference from the base **14**, at least some of the nodes **20** can project from the surface **21** at an angle relative to radii of the base **14**. For example, as shown in FIG. **4**, three types of nodes **20***a*, **20***b* and **20***c* can be included on the base **14**. Columns of the nodes **20***a* can be included on the base **14** in pairs that are circumferentially adjacent to one another. Two pairs of columns of nodes **20***a* are disposed on the example of the base **14** shown in FIG. **4**, with the two pairs of nodes **20***a* being radially opposite one another about the base **14**. Sides **20***d* on the circumferential outside of each pair of columns of nodes **20***a* can be angled by an angle α relative to radii **38** of the base **14** that pass through proximal ends of the sides **20***d*. The angles α can be large enough such that sides **20** are parallel to their respective pull lines **42***a* and **42***c* or larger. Sides **20***e* on the circumferential inside of each pair of columns of nodes **20***a* can be parallel to their respective sides **20***d*, or angled toward their respective sides **20***d* to form an acute angle with its vertex radially outward of the nodes **20***a*. Thus, the sides **20***d* and **20***e* of the nodes **20***a* allow die pieces **50***a* and **50***c* to be pulled away along pull lines **42***a* and **42***c*, respectively, without interference from the nodes **20***a*.

Still referring to the example shown in FIG. **4**, two columns of nodes **20***b* are included on the base **14** at positions spaced by approximately ninety degrees from the pairs of columns of nodes **20***a*, with the two columns of nodes **20***b* being radially opposite one another relative to the base **14**. The nodes **20***b* can have sides **20***f* and **20***g* that are parallel to one another and parallel to radii **40** of the base **14** passing through the circumferential centers of the nodes **20***b*. Sides **20***f* and **20***g* of each node **20***b* can extend generally parallel to a radius **40** of the base **14** passing through the circumferential center of the respective node. Sides **20***f* and **20***g* can be perpendicular to sides **20***d* of the nodes **20***a*. The angles of sides **20***f* and **20***g* allow for die pieces **50***b* and **50***d* to be removed along pull lines **42***b* and **42***d*, respectively, without interference from the nodes **20***b*.

Also in the example shown in FIG. **4**, four columns of nodes **20***c* are included on the base **14**, with each column of nodes **20***c* positioned circumferentially between one of the columns of nodes **20***a* and one of the columns of nodes **20***b*. Each node **20***c* can have sides **20***h* and **20***i*, with side **20***h* parallel to the nearest side **20***f* or **20***g* of the neighboring node **20***b* or angled away from that nearest side **20***f* or **20***g* as side **20***h* extends radially outward. Similarly, side **20***i* can be parallel to the side **20***d* of its neighboring node **20***a* or angled away from that side **20***d* as side **20***i* extends radially outward. The angles of sides **20***i* and **20***h* can allow die pieces **50***a-d* to be removed from the base **14** without interferences from the nodes **20***b*.

The die section boundaries **44***a*-**44***d* can vary from the positions shown in FIG. **4** even if the geometry of the base **14** remains the same. For example, the boundary **44***a* could be moved circumferentially to almost the side **20***i* of the node **20***c* without detrimentally affecting removal of the die pieces **50***a-d*. Also, the angles of the sides **20***d*-**20***i* of the nodes **20***a*, **20***b* and **20***c* can vary from as shown in FIG. **3**, and the types of nodes **20***a*, **20***b* and **20***c* and number of each type of node **20***a*, **20***b* and **20***c* can vary depending on, for example, the number of columns of nodes **20***a*, **20***b* and **20***c* positioned about the base **14**. Also, the number of die pieces **50***a-d* can vary and can be as few as two.

Referring back to FIGS. **1** and **2**, the circuit board **16** can be of the type in which metalized conductor patterns are formed in a process known as "printing" to provide electrical connections between the wiring **27** and the LEDs **18** and between the LEDs **18** themselves. The metalized conductor pattern can be printed onto an electrically insulating board or, depending on the material of the base **14**, directly onto the base **14**. Alternatively, another type of circuit board **16** can be used. The circuit board **16** can be made from one piece or from multiple pieces joined by, for example, bridge connectors. The circuit board **16** can be annular shaped and can extend about the aperture **28** defined by the base **14**, though the circuit board **16** can alternatively have a different shape (e.g., a pair of rectangular circuit boards **16** can be attached to the base **14** on radially opposite sides of the aperture **28**). The circuit board **16** can be attached to the platform **26** using thermally conductive tape, screws, or another type of connector.

The LEDs **18** can be mounted on the circuit board **16** for electrical communication with the wiring **27**. The LEDs **18** can be oriented to produce light centered about axes perpendicular to the platform **26** of the base **14**. However, LEDs **18** can additionally or alternatively be oriented at other angles relative to the platform **26**. The LEDs **18** can be high-power, white light emitting diodes, such as surface-mount devices of a type available from Nichia. The term "high-power" as used herein refers to LEDs **18** having power ratings of 0.25 watts or more. Indeed, the LEDs **18** can have power ratings of one watt or more. However, LEDs **18** with other power ratings, e.g., 0.05 W, 0.10 W, or 0.25 W, can alternatively be used. The number of LEDs **18** can depend on the intended use of the screw-in LED bulb **10**. For example, if the screw-in LED bulb **10** is intended to replace a 60 W incandescent bulb, LEDs **18** with an aggregate power of 11 W can be used to produce a similar luminosity as the 60 W incandescent bulb. Although the LEDs **18** are shown as surface-mounted components, the LEDs **18** can be discrete components. Also, one or more organic LEDs can be used in place of or in addition to the surface-mounted LEDs **18**. LEDs **18** that emit blue light, ultra-violet light or other wavelengths of light, such as wavelengths with a frequency of 400-790 THz corresponding to the spectrum of visible light, can alternatively or additionally be included.

The bulb **19** can be attached to the wall **30** of the base **14** using adhesive, though in other examples the bulb **19** can be screwed, snap-fit, or otherwise attached to the base **14**. The bulb **19** can be made from a transparent or translucent material such as polycarbonate, acrylic, or glass. The bulb **19** can include a coating **23** to modify the transmissiveness of the bulb **19** by altering paths of light produced by the LEDs **18**. The coating **23** can be a reflective coating, a diffusive coating, or another light path altering coating. The coating **23** can be denser on an area of the bulb **19** toward which a large amount of light is directed, such as a portion of the bulb **19** about a line extending axially from a center of the platform **26**, compared to areas of the bulb **19** toward which a small amount of light is direct, such as portions of the bulb **19** near the wall **30**. The coating **23** can prevent the appearance of a bright spot or a beam of light by scattering light rays and reducing the concentration of light rates in the bright spot area. The coating **23** can direct light in toward directions such as an area of the bulb **19** through which a low amount of light would pass were it not for the coating **23**, e.g., an area of the bulb **19** near the wall **30**. Alternatively to the coating **23**, other types light diffracting structures, such as bumps, ridges, or dimples, can be formed in the bulb **19** at locations where bright spots are present.

Referring still to FIG. **1**, the shape of the bulb **19** can affect the distribution of light from the screw-in LED bulb **10**. For example, the shape of the bulb **19** can allow the screw-in LED bulb **10** to distribute light relatively evenly in most directions in order for the screw-in LED bulb **10** to closely replicate the appearance of an incandescent bulb. A diameter or width **46** of the bulb **19** measured perpendicularly to the axial direction of the base **14** can be about 120% or more of a maximum diameter **48** of the base **14**, which is the diameter of the end **17** of the base **14** as shown in FIG. **1**, and a height **53** of the bulb **19** measured along the axial direction of the base **14** from the platform **26** or end **17** of the base **14** can be about equal to the width **46** of the bulb **19** (e.g., the height **53** can be within 10% of the width **46** of the bulb **19**) or greater than the width **46** of the bulb **19**. Having the bulb **19** extend further than the base **14** in the radial direction as described above allows the bulb **19** to reflect light in directions that would otherwise be blocked by the base **14**, such as in a direction toward the electrical connector **12**. Having the height **53** of the bulb **19** set about equal to the width **46** of the bulb **19** or greater allows light a sufficient distance to spread out before encountering the bulb **19**, which can aid in evening the distribution of light produced by the LEDs **18**. Note that these dimensional ratios between the base **14** and the bulb **19** are also affected by the size constraints of the entire screw-in LED bulb **10** mentioned above. The dimensional ratios between the base **14** and bulb **19** can allow the screw-in LED bulb **10** to be positioned, for example, with the bulb **19** above the base **14** in a fixture such as a desk lamp, and the screw-in LED bulb **10** can produce light in a direction toward a desk on which the desk lamp sits.

In one example in which the screw-in LED bulb **10** is intended to replace a 60 W incandescent bulb, the maximum width **46** of the bulb **19** is 67.5 mm and the height of the bulb **19** is 68.5, while the maximum diameter **48** of the base **14** is 54.3 mm. The bulb **19** can have other dimensions when the screw-in LED bulb **10** is intended to replace the 60 W incandescent bulb, or when the screw-in LED bulb **10** is intended to replace some other bulb.

In another example of a screw-in LED bulb **60** shown in FIG. **5** having the same electric connector **12**, circuit board **16**, LEDs **18**, and bulb **19** as the screw-in LED bulb **10**, a base **62** defines diamond shaped nodes **20**. The diamond shaped nodes **20** on the base **62** define channels **22** and **24** angled approximately forty five degrees relative to the axial and circumferential directions, respectively. The channels **22** and **24** allow airflow to travel in multiple directions, and the base **62** can dissipate a sufficient amount of heat for the LEDs **18** to produce an equivalent amount of light as a 60 W incandescent bulb.

The above-described examples have been described in order to allow easy understanding of the invention and do not limit the invention. On the contrary, the invention is intended to cover various modifications and equivalent arrangements, whose scope is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structure as is permitted under the law.

What is claimed:

1. An LED-based light comprising:

a highly thermally conductive base defining multiple radially outward projecting nodes, the nodes spaced apart in axial and circumferential directions of the base, the base including recessed channels between the nodes to enable airflow in multiple directions about the base, wherein the nodes project from a surface of the base, and wherein the nodes have filleted edges at junctions between sides of the nodes and the surface and have rounded edges at junctions between sides of the nodes and distal ends of the nodes;

an electrical connector attached to the base;

at least one LED attached to the base; and

a light transmitting bulb attached to the base and covering the at least one LED.

2. The LED-based light of claim **1**, wherein groups of more than one adjacent nodes are associated with respective imaginary radial pull lines, and wherein sides of each node are angled as the node extends radially outward such that each side extends parallel to its respective pull line or is angled further toward an opposing side of the node than its respective pull line.

3. The LED-based light of claim **1**, wherein the nodes are arranged in rows extending circumferentially about the base and in columns extending axially along the base.

4. The LED-based light of claim **1**, wherein the channels include a first group of axially extending channels and a second ground of circumferentially extending channels.

5. The LED-based light of claim **1**, wherein a width of the bulb in a radial direction perpendicular to the axial direction of the base is at least 20% greater than a width of the base in the radial direction.

6. The LED-based light of claim **1**, wherein the width of the bulb is at least 20% greater than a maximum width of the base in the radial direction.

7. The LED-based light of claim **6**, wherein a height of the bulb in the axial direction of the base is as at least as great as the width of the bulb.

8. The LED-based light of claim **1**, wherein the electrical connector is an Edison-type screw-in connector in electrical communication with the at least one LED.

9. The LED-based light of claim **1**, wherein the base defines a cavity for housing electronics configured to convert a power received from the electrical connector to a power suitable for powering the at least one LED.

10. An LED-based light comprising:

a highly thermally conductive base defining multiple radially outward projecting nodes, the nodes spaced apart in axial and circumferential directions of the base, the base including recessed channels between the nodes to enable airflow in multiple directions about the base, wherein the nodes are arranged in rows extending circumferentially about the base and in columns extending axially along the base and wherein the nodes of each row are axially staggered;

an electrical connector attached to the base;

at least one LED attached to the base; and

a light transmitting bulb attached to the base and covering the at least one LED.

11. The LED-based light of claim **10**, wherein groups of more than one adjacent nodes are associated with respective imaginary radial pull lines, and wherein sides of each node are angled as the node extends radially outward such that each side extends parallel to its respective pull line or is angled further toward an opposing side of the node than its respective pull line.

12. The LED-based light of claim **10**, wherein the channels include a first group of axially extending channels and a second ground of circumferentially extending channels.

13. New The LED-based light of claim **10**, wherein a width of the bulb in a radial direction perpendicular to the axial direction of the base is at least 20% greater than a width of the base in the radial direction.

14. The LED-based light of claim **13**, wherein the width of the bulb is at least 20% greater than a maximum width of the base in the radial direction.

15. The LED-based light of claim **13**, wherein a height of the bulb in the axial direction of the base is as at least as great as the width of the bulb.

16. The LED-based light of claim **10**, wherein the electrical connector is an Edison-type screw-in connector in electrical communication with the at least one LED.

17. The LED-based light of claim **10**, wherein the base defines a cavity for housing electronics configured to convert a power received from the electrical connector to a power suitable for powering the at least one LED.

18. The LED-based light of claim **10**, wherein the nodes of each column have different axial lengths.

19. An LED-based light comprising:

a highly thermally conductive base defining multiple radially outward projecting nodes, the nodes spaced apart in axial and circumferential directions of the base, the base including recessed channels between the nodes to enable airflow in multiple directions about the base, wherein the nodes are arranged in rows extending circumferentially about the base and in columns extending axially along the base and wherein the nodes of each column have different axial lengths;

an electrical connector attached to the base;

at least one LED attached to the base; and

a light transmitting bulb attached to the base and covering the at least one LED.

20. The LED-based light of claim **19**, wherein groups of more than one adjacent nodes are associated with respective imaginary radial pull lines, and wherein sides of each node are angled as the node extends radially outward such that each side extends parallel to its respective pull line or is angled further toward an opposing side of the node than its respective pull line.

21. The LED-based light of claim **19**, wherein the channels include a first group of axially extending channels and a second ground of circumferentially extending channels.

22. The LED-based light of claim **19**, wherein a width of the bulb in a radial direction perpendicular to the axial direction of the base is at least 20% greater than a width of the base in the radial direction.

23. The LED-based light of claim **22**, wherein the width of the bulb is at least 20% greater than a maximum width of the base in the radial direction.

24. The LED-based light of claim **22**, wherein a height of the bulb in the axial direction of the base is as at least as great as the width of the bulb.

25. The LED-based light of claim **19**, wherein the electrical connector is an Edison-type screw-in connector in electrical communication with the at least one LED.

26. The LED-based light of claim **19**, wherein the base defines a cavity for housing electronics configured to convert a power received from the electrical connector to a power suitable for powering the at least one LED.

27. The LED-based light of claim **19**, wherein the nodes of each row are axially staggered.

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