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(54) Title: LIGHT EMITTING DEVICES, SYSTEMS, AND METHODS

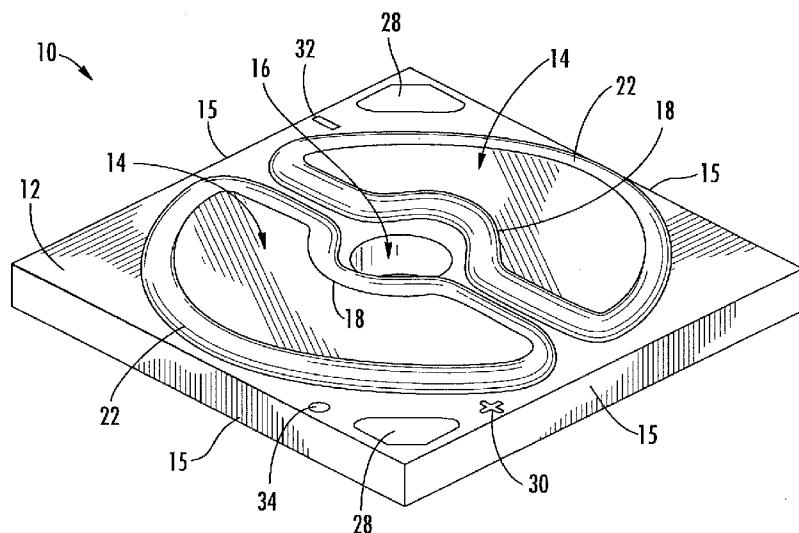


FIG. 1

(57) Abstract: Light emitting devices, systems, and methods are disclosed. In one embodiment a light emitting device can include an emission area having one or more light emitting diodes (LEDs) mounted over an irregularly shaped mounting area. The light emitting device can further include a retention material disposed about the emission area. The retention material can also be irregularly shaped, and can be dispensed. Light emitting device can include more than one emission area per device.

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DESCRIPTION
LIGHT EMITTING DEVICES, SYSTEMS, AND METHODS

CROSS REFERENCE TO RELATED APPLICATIONS

5 This application claims priority to U.S. Continuation-in-Part Patent Application Serial No. 13/224,850 filed September 2, 2011, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

10 The subject matter disclosed herein relates generally to light emitting devices, systems, and methods. More particularly, the subject matter disclosed herein relates to light emitting devices, systems, and methods comprising one or more irregularly shaped LED mounting areas for increasing the utilization of area available to produce light emission
15 dimensionally restricted devices.

BACKGROUND

Light emitting devices, such as light emitting diodes (LEDs), are currently used in many different general lighting applications and systems, 20 for example, in products targeting replacement of incandescent, fluorescent, and metal halide high-intensity discharge (HID) products. As the number of LED lighting applications increase, lighting device manufacturers and/or designers increasingly face tighter dimensional restrictions while being required to maintain or increase brightness and light output levels from the 25 devices. For example, manufacturers may be required to produce a given light output from a device which has a restricted amount of LED mounting area available on the device. Conventional designs used in lighting devices may arrange LEDs in very regular and/or symmetrically shaped arrays, e.g. a square or circle. The regular or symmetrically shaped arrays are often 30 positioned in the middle of the lighting device, and do not efficiently utilize all of the available space.

Accordingly, a need remains for increasing the utilization of the limited area available for mounting LEDs by providing LED mounting arrangements that can be irregular or asymmetrical in shape while promoting ease of manufacture.

5

SUMMARY

In accordance with this disclosure, novel light emitting devices, systems, and methods are provided that are well suited for a variety of applications, including industrial and commercial lighting products. It is, 10 therefore, an object of the present disclosure herein to provide easy to manufacture light emitting devices, systems, and methods adapted to increase the utilization of LED mounting area available by providing LED mounting arrangements that are irregular or asymmetrical in shape.

These and other objects of the present disclosure as can become 15 apparent from the disclosure herein are achieved, at least in whole or in part, by the subject matter disclosed herein.

BRIEF DESCRIPTION OF THE DRAWINGS

A full and enabling disclosure of the present subject matter including 20 the best mode thereof to one of ordinary skill in the art is set forth more particularly in the remainder of the specification, including reference to the accompanying figures, in which:

Figure 1 is a perspective view of a light emitting diode (LED) device according to the disclosure herein;

25 Figure 2 is a top plan view of an embodiment of an LED device according to the disclosure herein;

Figure 3 is a top plan view of an embodiment of an LED device according to the disclosure herein;

30 Figure 4 is a schematic illustration of an embodiment LED device according to the disclosure herein;

Figure 5 if a top plan view of an embodiment of an LED device according to the disclosure herein;

Figure 6 is a perspective view of one embodiment of an LED system according to the disclosure herein;

Figures 7A and 7B are cross-sectional views of an embodiment of an LED device according to the disclosure herein;

5 Figure 8 is a top plan view of an embodiment of an LED device according to the disclosure herein;

Figure 9 is a perspective side view of an embodiment of an LED system according to the disclosure herein; and

10 Figure 10 is a perspective view of an embodiment of an LED device according to the disclosure herein.

DETAILED DESCRIPTION

Reference will now be made in detail to possible aspects or embodiments of the subject matter herein, one or more examples of which 15 are shown in the figures. Each example is provided to explain the subject matter and not as a limitation. In fact, features illustrated or described as part of one embodiment can be used in another embodiment to yield still a further embodiment. It is intended that the subject matter disclosed and envisioned herein covers such modifications and variations.

20 As illustrated in the various figures, some sizes of structures or portions are exaggerated relative to other structures or portions for illustrative purposes and, thus, are provided to illustrate the general structures of the present subject matter. Furthermore, various aspects of the present subject matter are described with reference to a structure or a 25 portion being formed on other structures, portions, or both. As will be appreciated by those of skill in the art, references to a structure being formed "on" or "above" another structure or portion contemplates that additional structure, portion, or both may intervene. References to a structure or a portion being formed "on" another structure or portion without an intervening 30 structure or portion are described herein as being formed "directly on" the structure or portion. Similarly, it will be understood that when an element is referred to as being "connected", "attached", or "coupled" to another

element, it can be directly connected, attached, or coupled to the other element, or intervening elements may be present. In contrast, when an element is referred to as being "directly connected", "directly attached", or "directly coupled" to another element, no intervening elements are present.

5 Furthermore, relative terms such as "on", "above", "upper", "top", "lower", or "bottom" are used herein to describe one structure's or portion's relationship to another structure or portion as illustrated in the figures. It will be understood that relative terms such as "on", "above", "upper", "top", "lower" or "bottom" are intended to encompass different orientations of the
10 device in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, structure or portion described as "above" other structures or portions would now be oriented "below" the other structures or portions. Likewise, if devices in the figures are rotated along an axis, structure or portion described as "above", other structures or portions
15 would now be oriented "next to" or "left of" the other structures or portions. Like numbers refer to like elements throughout.

Light emitting devices according to embodiments described herein may comprise group III-V nitride (e.g., gallium nitride) based light emitting diodes (LEDs) or lasers fabricated on a growth substrate, for example, a
20 silicon carbide substrate, such as those devices manufactured and sold by Cree, Inc. of Durham, North Carolina. For example, Silicon carbide (SiC) substrates/layers discussed herein may be 4H polytype silicon carbide substrates /layers. Other silicon carbide candidate polytypes, such as 3C, 6H, and 15R polytypes, however, may be used. Appropriate SiC substrates
25 are available from Cree, Inc., of Durham, N.C., the assignee of the present subject matter, and the methods for producing such substrates are set forth in the scientific literature as well as in a number of commonly assigned U.S. patents, including but not limited to U.S. Patent No. Re. 34,861; U.S. Patent No. 4,946,547; and U.S. Patent No. 5,200,022, the disclosures of which are
30 incorporated by reference herein in their entireties. Any other suitable growth substrates are contemplated herein. For example, sapphire and

gallium arsenide can be utilized as growth substrates for fabricating LEDs or lasers as described herein.

As used herein, the term "Group III nitride" refers to those semiconducting compounds formed between nitrogen and one or more elements in Group III of the periodic table, usually aluminum (Al), gallium (Ga), and indium (In). The term also refers to binary, ternary, and quaternary compounds such as GaN, AlGaN and AlInGaN. The Group III elements can combine with nitrogen to form binary (e.g., GaN), ternary (e.g., AlGaN), and quaternary (e.g., AlInGaN) compounds. These compounds may have empirical formulas in which one mole of nitrogen is combined with a total of one mole of the Group III elements. Accordingly, formulas such as Al_xGa_{1-x}N where 1>x>0 are often used to describe these compounds. Techniques for epitaxial growth of Group III nitrides have become reasonably well developed and reported in the appropriate scientific literature.

Although various embodiments of LEDs disclosed herein comprise a growth substrate, it will be understood by those skilled in the art that the crystalline epitaxial growth substrate on which the epitaxial layers comprising an LED are grown may be removed, and the freestanding epitaxial layers may be mounted on a substitute carrier substrate or substrate which may have different thermal, electrical, structural and/or optical characteristics than the original substrate. The subject matter described herein is not limited to structures having crystalline epitaxial growth substrates and may be used in connection with structures in which the epitaxial layers have been removed from their original growth substrates and bonded to substitute carrier substrates.

Group III nitride based LEDs according to some embodiments of the present subject matter, for example, may be fabricated on growth substrates (such as a silicon carbide substrates) to provide horizontal devices (with both electrical contacts on a same side of the LED) or vertical devices (with electrical contacts on opposite sides of the LED). Moreover, the growth substrate may be maintained on the LED after fabrication or removed (e.g.,

by etching, grinding, polishing, etc.). The growth substrate may be removed, for example, to reduce a thickness of the resulting LED and/or to reduce a forward voltage through a vertical LED. A horizontal device (with or without the growth substrate), for example, may be flip chip bonded (e.g., using solder) to a carrier substrate or printed circuit board (PCB), or wire bonded. A vertical device (without or without the growth substrate) may have a first terminal solder bonded to a carrier substrate, mounting pad, or PCB and a second terminal wire bonded to the carrier substrate, electrical element, or PCB. Examples of vertical and horizontal LED chip structures are discussed 5 by way of example in U.S. Publication No. 2008/0258130 to Bergmann et al. and in U.S. Publication No. 2006/0186418 to Edmond et al., the disclosures 10 of which are hereby incorporated by reference herein in their entireties.

As described further, one or more LEDs can be coated, at least partially, with one or more phosphors with the phosphors absorbing at least 15 a portion of the LED light and emitting a different wavelength of light such that the LED emits a combination of light from the LED and the phosphor. In one embodiment, the LED emits a white light combination of LED and phosphor light. One or more LEDs can be coated and fabricated using many different methods, with one suitable method being described in U.S. Patent 20 Application Serial Nos. 11/656,759 and 11/899,790, both entitled "Wafer Level Phosphor Coating Method and Devices Fabricated Utilizing Method", and both of which are incorporated herein by reference in their entireties. Other suitable methods for coating one or more LEDs are described in U.S. Patent Application Serial No. 12/014,404 entitled "Phosphor Coating 25 Systems and Methods for Light Emitting Structures and Packaged Light Emitting Diodes Including Phosphor Coating" and the continuation-in-part application U.S. Patent Application Serial No. 12/717,048 entitled "Systems and Methods for Application of Optical Materials to Optical Elements", the disclosures of which are hereby incorporated by reference herein in their 30 entireties. LEDs can also be coated using other methods such as electrophoretic deposition (EPD), with a suitable EPD method described in U.S. patent Application Serial No. 11/473,089 entitled "Close Loop

Electrophoretic Deposition of Semiconductor Devices", which is also incorporated herein by reference in its entirety. It is understood that LED devices, systems, and methods according to the present subject matter can also have multiple LEDs of different colors, one or more of which may be 5 white emitting.

Referring now to Figures 1 to 9, Figure 1 is a top perspective view of a light emitting device or package, or LED device, generally designated **10**. LED device **10** can comprise a submount **12** over which one or more emission areas, generally designated **14**, can be disposed. In one aspect, 10 emission area **14** can be disposed at any suitable location over LED device **10**, for example, approximately a center location and/or an off-center location (Figure 8). In one aspect, LED device **10** can comprise two or more emission areas **14** disposed about an attachment area, generally designated **16**. Attachment area **16** can comprise an opening disposed through or at 15 least partially through submount **12** for facilitating attachment of LED device **10** to an external submount or surface. For example, attachment area **16** can comprise an area for receiving screws, clips, pins, or other fasteners inserted through and/or attached to the at least one attachment area **16** for securing device **10** to another member, structure, substrate or submount. In 20 another aspect, instead of comprising a hole or opening, attachment area **16** can comprise an actual attachment member such as a pin, clip, or other any other suitable fastener, for example, a spring clip.

Emission area **14** can have a substantially irregular shape. Irregular or asymmetrical shape in accordance with the disclosure herein is meant to 25 be interpreted broadly and without limitation and can be any shape or configuration that is not considered regular or symmetrical. For example and without limitation, irregular can mean any shape that does not have all sides of an equal length or that does not have all angles equal. An irregular shape is not a regular shape such as, for example and without limitation, a square, 30 circle, oval, equilateral triangle, regular pentagon, regular hexagon, regular octagon or any other regular shapes having all sides and all angles equal. Regular shapes can comprise many lines of symmetry as opposed to an

irregular shape which generally does not have more than two lines of symmetry. Irregular shapes having more than two lines of symmetry are contemplated, however. A line of symmetry comprises an imaginary line where the image could be folded such that both halves match exactly (line **S**, Figures 6, 10). For example, a rectangle can be categorized as an irregular shape as it does not have all sides equal, and the rectangle has at most two lines of symmetry. In one aspect, irregular shapes can have no more than one line of symmetry. In one aspect, irregular shapes can have no or zero lines of symmetry as the shape is so irregular that it is asymmetric (Figure 10). Even where a shape or configuration may have all sides the same length, such as with an equilateral polygon, the shape or configuration can still be irregular as the angles between segments can be different making it irregular.

In other aspects, irregular can be any irregular or asymmetrical shape or configuration regardless of lines of symmetry and regardless as to whether all sides and all angles equal. For example and without limitation, an irregular shape or configuration can be any shape or configuration lacking uniformity or symmetry, uneven in shape, position, or arrangement, and/or having at least some or all portions that do not occur or are not disposed at expected or equal intervals or positions. An irregular shape or configuration can in another aspect be a shape or configuration with one or more curved portions or without any curved portions. An irregular shape or configuration can be a shape or configuration with or without one or more protrusion areas that can bring irregularity to the shape or configuration. Irregular in accordance with this disclosure can also be a shape or configuration that includes an aspect ratio between portions that is skewed slightly or drastically such that the shape or configuration is no longer deemed regular. An irregular shape or configuration can also have some portions that may be regular or no portion that is regular.

Emission area **14** can comprise any suitable irregular and/or asymmetrical shape having one or more curved, convex, or concave portions **18**. Notably, irregularly shaped emission area **14** can comprise

irregularly shaped mounting areas (Figure 4) over which one or more LEDs may become mounted. Thus, irregular shapes can advantageously utilize more area over which LEDs may become mounted. In one aspect, irregularly shaped emission area **14** can curve proximate and/or adjacent to

5 attachment area **16** thereby eliminating the need for more than one attachment area. This can advantageously allow more space for emission area **14** to expand and occupy on LED device **10**. Thus, as LED devices become dimensionally smaller, one or more irregularly shaped emission areas **14** comprising irregularly shaped mounting surfaces can efficiently

10 utilize space by expanding via different sides and/or angles to curve and fit about other features of LED device, for example, attachment areas **16**, to create more space from which LEDs may emit light. For example, emission area **14** can expand such that it is proximate one or more edges **15** of submount **12**. Submount **12** can comprise more than one edge **15**,

15 depending on its shape. For example, submount **12** can comprise a square having four edges **15** of equal length. Or, submount **12** can comprise a circle having one edge **15**, or circumference. Any submount **12** shape is contemplated. In other embodiments, a submount may not be necessary. (Figure 7B)

20 LED device **10** can comprise a single emission area **14** or more than one emission area **14**. Notably, each emission area **14** can comprise a uniform, undivided optical source that can have one or more LEDs disposed therein, which can simplify the manufacturing process for manufacturers of light products requiring a single component. Each emission area **14** can for

25 example comprise a uniform, undivided mounting area for the one or more LEDs. LED device **10** can further comprise a retention material **22** disposed at least partially about emission area **14** where retention material **22** can be referred to as a dam. Retention material **22** can also be disposed over one or more electrostatic discharge (ESD) protection devices, such as a Zener

30 diode **62** (Figure 4). In some aspects, retention material can be disposed over two Zener diodes **62** connected in series between two electrical elements.

Submount 12 can comprise any suitable mounting substrate, for example, a printed circuit board (PCB), a metal core printed circuit board (MCPCB), an external circuit, or any other suitable submount over which lighting devices such as LEDs may mount and/or attach. In one aspect, 5 submount 12 can comprise a composite submount comprising one or more LEDs mounted on a thermally conductive material and a separate attachment area 16 that is free of LEDs and the material on which they are mounted. Emission area 14 can be in electrical and/or thermal communication with submount 12. In one aspect, one or more intervening 10 layers can be disposed between emission area 14 and submount 12 such that emission area 14 is indirectly disposed over submount 12 thereby indirectly electrically and/or thermally communicating with submount 12. In the alternative, emission area 14 can directly mount over submount 12 thereby directly electrically and/or thermally communicating, or connecting, 15 with submount 12. In one aspect and for example only and without limitation, submount 12 can comprise a compact dimension of 22 millimeter (mm) x 22-mm square footprint. In other aspects, submount 12 can comprise any suitable dimension and/or shape, for example, a circular or rectangular shape.

20 Emission area 14 can comprise a single LED or a plurality of LED chips, or LEDs, generally designated 24 disposed within and/or below a filling material 26 such as illustrated in Figures 7A and 7B. LEDs 24 can comprise a high density array of LEDs mounted on a thermally conductive material or mounting area 36. LEDs 24 can comprise any suitable size, 25 shape, and/or chip structure. For example, LEDs 24 can comprise a rectangle, square, or any other suitable shape. LEDs 24 can comprise horizontal or vertical chip structures with or without bond pads. In one aspect, filling material 26 can comprise an encapsulant having a predetermined, or selective, amount of phosphors and/or lumiphors in an 30 amount suitable for any desired light emission, for example, suitable for white light conversion. Filling material 26 can interact with light emitted from the plurality of LEDs 24 such that a perceived white light, or any suitable

and/or desirable wavelength of light, can be observed. Any suitable combination of encapsulant and/or phosphors can be used, and combinations of different phosphors for resulting in desired light emission can be used. In other aspects, filling material **26** can comprise a molded lens material. Filling material **26** can be substantially opaque such that emission area **14** can be substantially opaque (as illustrated in Figure 1), transparent, or semi-transparent depending upon, for example, the amount and type of phosphor used. Retention material **22** can be adapted for dispensing, or placing, about at least a portion of emission area **14**. After placement of retention material **22**, filling material **26** can be selectively filled to any suitable level within the space disposed between one or more inner walls of retention material **22**. For example, filling material **26** can be filled to a level equal to the height of retention material **22** or to any level above or below retention material. The level of filling material **26** can be planar or curved in any suitable manner, such as concave or convex. In some aspects, the retention material or dam can be offset from an edge of the LED device or package. In other aspects, the retention material or dam can be aligned with an edge of the LED device or package.

LED device **10** can also comprise one or more electrical attachment surfaces **28** disposed outside of emission area **14**. In one aspect, attachment surfaces **28** comprise electrical contacts such as solder contacts. Attachment surfaces **28** can be any suitable configuration, size, shape and/or location and can comprise positive and negative electrode terminals through which an electrical current or signal can pass when connected to an external power source. One or more conducting wires (not shown) can be attached and electrically connected to attachment surfaces **28** when welded, soldered, or any other suitable attachment method known. Electrical current or signal can pass into LED device **10** from the external wires electrically connected to the attachment surfaces **28** and into the emission area **14** to facilitate light output. Attachment surfaces **28** can electrically communicate with emission area **14** which can comprise one or more LEDs **24**. Attachment surfaces **28** can electrically communicate with one or more

electrically conductive traces as described further below (see Figure 4) to which LEDs **24** may be electrically connected using electrical connectors. Electrical connectors can comprise wirebonds or other suitable members for electrically connecting LEDs **24** to one or more conductive traces.

5 LED device **10** can further comprise one or more indicator signs or symbols for denoting the electrical polarity for a given portion of LED device **10**. For example, a first symbol **30** can comprise a "+" sign denoting the side of LED device **10** comprising the positive electrode terminal. A second symbol **32** can comprise a "-" sign denoting the side of LED device **10** comprising the negative electrode terminal. Either first or second symbol **30** or **32** may be used alone. One or more test points **34** can be located adjacent either a positive or negative side of the device for testing the electrical and/or thermal properties of the LED device **10**. In one aspect, test point **34** can be disposed adjacent the positive side, or terminal of LED device **10**.

Figure 2 is a top plan view of a first embodiment of LED device **10** where emission area **14** does not yet contain filling material **26**. Retention material **22** can be disposed about an irregularly shaped LED mounting area **36** upon which one or more LEDs **24** are mounted and/or attached. In one aspect, mounting area **36** can comprise an irregular shape substantially corresponding to the shape of retention material **22**. In one aspect, retention material **22** can be disposed about and generally follow the shape of irregularly shaped mounting area **36**. In other aspects, retention material **22** can comprise any other irregular shape either the same and/or different than that of mounting area **36**. For example, retention material **22** could extend in any other irregular configuration about mounting area **36**. Mounting area **36** can comprise any electrically and/or thermally conductive material. In one aspect, mounting area **36** can comprise a thermally conductive material such as aluminum nitride (AlN) which can have a coefficient of thermal expansion similar to that of the one or more LEDs **24**. Mounting area **36** can comprise a reflective material and/or be coated with a reflective material, for example and without limitation, white reflective material or titanium dioxide (TiO₂).

Retention material **22** can further be disposed about at least a portion of emission area **14**. Retention material **22** can comprise an irregular shape having both straight and curved sides. Retention material **22** can comprise a thickness that can vary to any suitable height for retaining an encapsulant or

5 filling material **26** (Figures 7A and 7B). Figure 2 illustrates, for example and without limitation, retention material **22** comprising at least one curved side **38** that can curve to extend at least proximate to one or more edges **15** of submount **12**. In one aspect, curved side **38** can oppose one or more concave portions **18**. One or more straight sides **40** can be disposed

10 between opposing curved side **38** and concave portion, for example, and can be disposed at an angle with respect to curved side **38**. However, any configuration of irregularly shaped retention material **22** and mounting area **36** are hereby contemplated, so long as the shape does not have all sides and all angles equal.

15 Retention material **22** can be dispensed, positioned or otherwise placed over submount **12** and can comprise any suitable size and/or shape. Retention material **22** can comprise any suitable reflective material and can comprise a clear or opaque white material such as, for example, a silicone or epoxy material. Filler particles such as titanium dioxide (TiO₂), for example,

20 can be used and added to retention material **22** for providing an opaque material. Retention material **22** can be dispensed or deposited about mounting area **36** using any suitable dispensing technique, for example, by using an automated dispensing machine where any suitable size and/or shape of dam can be formed. Any combination of desired shape and cross-

25 sectional shape of retention material **22** is contemplated. In one aspect, retention material **22** can comprise a rounded cross-sectional shape such that the upper surface of retention material **22** opposite submount **12** is rounded. A rounded or curved cross-section of retention material **22** may further improve the amount of light reflected by LED device **10**.

30 Retention material **22** can comprise any material known in the art, for example, a silicone material comprising 7% fumed silica + 3% TiO₂ + methyl silicone. As illustrated in Figure 2, retention material **22** can be dispensed

after wirebonding of the one or more LEDs **24** such that retention material **22** is disposed over and at least partially covers wirebonds **42** to contain at least a portion, such as one end of each of wirebonds **42** within retention material **22**. Wirebonds **42** connecting the first and last, or outermost edge LEDs **44** for a given set or string of LEDs can be disposed within retention material **22**. That is, in one aspect, each of the one or more emission areas **14** can comprise a single, undivided LED mounting area **36** in which outermost LEDs **44** may be wirebonded to electrical elements disposed under retention material **22**. Outermost wirebonds **42** can thereby be at least partially disposed within retention material **22**. In one aspect, mounting area **36** can comprise a thermally conductive but electrically insulating material. In other aspects, mounting area **36** can comprise a thermally conductive and electrically conductive material. Wirebonding LEDs **24** is not necessary, however, as described further regarding Figure 3. Retention material **22** can be “planed” during dispersion at room temperature for accurate volume and/or height control. The addition of TiO₂ can increase reflection about the emission area **14** to further optimize light emission of LED device **10**. Fumed silica can be added as a thixotropic agent. Dispersing retention material **22** can allow for irregular shapes which can extend, curve, or otherwise conform to any shape over a submount or mounting surface thereby increasing the amount of space available to emit light. Dispensing retention material **22** may also allow LED device **10** to withstand higher voltages.

Still referring to Figure 2, LEDs **24** can be arranged, disposed, or mounted over a thermally conductive LED mounting area or pad **36**. LEDs **24** can be arranged or disposed in strings of LEDs **24** that can comprise LEDs electrically connected in series or any other suitable configuration. More than one string of LEDs **24** can be provided, and each string of LEDs **24** can be arranged in parallel to one or more other strings of LEDs **24**. LEDs **24** in any given string of LEDs **24** can be arranged in any suitable pattern or configuration, and even LEDs **24** within a given set or string of LEDs can be arranged or disposed in one or more different patterns or

configurations. Such patterns may include LEDs **24** arranged in series or parallel configurations, or combinations thereof. For LEDs **24** comprising bond pads, retention material **22** can at least partially cover one or more wirebonds **42** of outermost LEDs **44**. Figure 2 illustrates at least three 5 strings of LEDs **24** arranged in each emission area **14**. LEDs **24** can be arranged in more than one different pattern. For example, a first string of LEDs **24**, generally designated **S1**, can comprise a straight line of LEDs **24** electrically connected in series. Each LED **24** in string **S1** can be spaced equidistance from neighboring LEDs **24**. A longitudinal axis for each of the 10 LEDs **24** in string **S1** can be at least substantially parallel. The longitudinal axis for each of the LEDs **24** can be substantially perpendicular the direction of wirebonds **42**. A second string of LEDs **24**, generally designated **S2**, can comprise the same or a different pattern than string **S1**. Figure 2 illustrates string **S2** having the same pattern as string **S1**, however the LEDs **24** of 15 string **S2** can be staggered with respect to the LEDs **24** in string **S1**. That is, LEDs **24** of string **S2** can be offset in alignment to LEDs **24** of string **S1**. The staggered arrangement between strings can optimize light extraction from emission area **14** and reduce the amount of light absorbed or blocked by neighboring LEDs **24** and/or LEDs **24** of adjacent strings.

20 A third string generally designated **S3** of a given emission area **14** can comprise a combination of more than one pattern. For example, string **S3** can comprise a substantially checkerboard pattern consisting of more than one row of LEDs **24** electrically connected in series. The rows can comprise a staggered, substantially checkerboard pattern. String **S3** can 25 comprise a different pattern adjacent concave portion **18** of retaining material **22** thereby adjusting to the irregular shaped LED mounting area **36** and retention material **22**. The pattern of string **S3** adjacent concave portion **18** can comprise a straight line pattern design where each LED **24** is spaced substantially parallel and equidistance apart from neighboring LEDs **24**.

30 The longitudinal axis of each LED **24** can be substantially parallel to the direction of the wirebonds **42**. Each string **S1**, **S2**, and **S3** can comprise any suitable number of LEDs **24**, for example, greater than two LEDs **24**. For

example, string **S1** can as shown comprise five LEDs **24** electrically connected in series, string **S2** can comprise seven LEDs **24** electrically connected in series, and string **S3** can comprise 14 LEDs **24** electrically connected in series. Each emission area **14** can comprise any suitable number of total LEDs **24**. In one aspect, the more than one emission areas **14** can comprise mirror images having the same shape, number of LEDs **24**, number of strings, pattern designs, and total number of LEDs **24**. In the alternative, different emission areas **14** can comprise a different shape, different number of LEDs **24** per string and per area, different number of strings of LEDs **24**, and different pattern designs of LEDs **24**. For illustration purposes, string **S3** is illustrated as comprising a combination of two patterns, when in fact, a given string of LEDs **24** can comprise a combination of having more than two patterns. Any suitable number of patterns per emission area **14** and/or per string of LEDs **24** can be utilized.

15 Spacing between strings and/or combination of patterns within strings of LEDs **24** can optimize light emission and device brightness. Alternating, or staggered LEDs **24** between strings can optimize light output by ensuring uniform coverage and spatial alignment over conducting pad **36** such that light emission is uniform and improved. Strings of LEDs **24** can comprise 20 diodes of the same and/or different colors, or wavelength bins, and different colors of phosphors can be used in the filling material **26** (Figures 7A and 7B) in order to achieve emitted light of a desired wavelength. The one or more patterns of LEDs **24** can comprise an array of LEDs **24** within each emission area **14**. Each string of LEDs **24** can comprise any suitable 25 number of LEDs **24** electrically connected between outermost LEDs **44** which can connect to respective electrical elements. The arrangements, patterns, and/or combination of multiple patterns herein can comprise an array for optimizing color uniformity and brightness of light emitted from LED device **10**. Care must be taken when connecting LEDs **24** in series such 30 that the positive or negative electrode of a preceding LED electrically connects to an electrode of opposite electrical polarity for a subsequent LED for allowing electrical current to flow properly through the string of LEDs **24**.

As described further below, outermost LEDs **44** can electrically connect to first and second electrical elements, such as conductive traces for receiving and transmitting electrical current or signal through and illuminating a given string of LEDs **24** (Figure 4).

5 Figure 3 is a top plan view of a second embodiment of LED device, generally designated **50**, where emission area **14** does not yet contain filling material **26**. LED device **50** can be similar in form and function to LED device **10**, however the LEDs **24** do not have bond pads and are not electrically connected in series via wirebonds **42**. Rather, LED mounting area **36** can further comprise an isolating layer **52** which can be form integral with mounting area **36**. As described earlier, LEDs **24** can comprise vertical or horizontal chip structures. Here, LEDs **24** can comprise a horizontal chip structure with each of the p- and n-type layers disposed on the bottom of the chip. The p- and n-type layers can electrically communicate with LED mounting area **36** to receive electrical current. Isolating layer **52** can electrically isolate electrically conductive portions of mounting area **36** such that first portions **P1** of mounting area **36** comprise a cathode and second portions **P2** of mounting area **36** serve as an anode which can supply electrical current to the one or more LEDs **24** thereby illuminating the LEDs.

20 Isolating layer **52** can comprise any suitable material capable of electrically and thermally isolating portions of mounting area **36**. For example, isolating layer **52** can comprise an insulating or dielectric layer which can be configured to electrically and thermally isolate more than one portion of mounting area **36**. For example, upon isolation, the one or more portions of mounting area **36** disposed on either side of isolating area, **P1** and **P2** can comprise an anode and/or cathode for illuminating LEDs **24**. Isolating layer **52** can be formed by using any suitable process known in the art, for example by subjecting at least a portion of mounting area **36** to an anodizing, oxidizing, or a passivation process capable of forming an isolating layer in mounting area **36**. In one aspect, mounting area **36** can be formed integral as a portion of submount **12** and submount **12** can undergo one or more of these processes to create isolating layer **52** prior to, upon, or after

formation of the submount 12. In other aspects, mounting area 36 is attached to submount 12 after undergoing a process which forms insulating portion 52, for example, passivation.

In one aspect, mounting area 36 and isolating layer 52 can comprise 5 the same material, wherein isolating layer 52 forms by an anodizing, oxidizing, or a passivation process. By having mounting area 36 and isolating layer 52 formed from the same submount of material, manufacturing costs can be decreased by eliminating extraneous components such as separately formed conductive traces. Eliminating 10 conductive traces can also maximize mounting area 36 thereby further increasing size of emission area 14 and better utilizing space on submounts 12 subjected to tight dimensional requirements. Just as in LED device 10, LED device 50 can comprise more than one emission area 14 wherein the corresponding mounting area 36 comprises an irregular shape. This can 15 further utilize space and allow emission areas 14 to be larger on submounts 12 having tight dimensional requirements as emission areas 14 can extend around attachment areas 16. Retention material 22 which can be dispensed about mounting area 36 can also comprise an irregular shape. LED device 50 can also comprise one or more attachment surfaces 28 adapted to supply 20 power to the one or more LEDs 12. For example, attachment surfaces 28 may comprise solder pads or surfaces adapted to receive electrical current from external sources such as electrical wires (not shown). Attachment surfaces 28 can electrically communicate with portions mounting area 36 to supply the electrical current to LEDs 24 when mounting area 36 is isolated 25 via isolating layer 52.

As Figure 3 illustrates, LEDs 24 can be positioned or arranged in an array. Each LED 24 can be electrically connected in parallel, as the LEDs receive electrical current from first and second portions P1 and P2 of mounting area 36. The array can comprise a reticulated array wherein each 30 subsequent row is staggered or offset from the previous row. This can increase the uniformity of light emitted from emission area and can minimize the amount of light absorbed or blocked from adjacent LEDs 24. Each

emission area **14** can comprise a single, undivided area having at least two electrically and/or thermally isolated portions. Emission area **14** can comprise any shape, and can comprise any suitable number of LEDs **24**.

Figure 4 illustrates LED device **10** comprising submount **12** prior to arranging, dispensing, or otherwise placing retention material **22** about at least a portion of one or more emission areas **14**. For illustration purposes, only a first string of LEDs **24** is illustrated, however, as noted earlier, emission area can comprise more than one strings of LEDs **24** electrically connected in series. As illustrated, an electrostatic discharge (ESD) protection device, for example, at least one Zener diode **62** can be positioned on a mounting area between conductive traces and can be reversed biased with respect to the strings of LEDs **24**. Zener diode **62** can protect against ESD failures. As Zener diodes **62** can comprise black chips, they typically absorb light. Placing the at least one Zener diode **62** below retention material **44** is advantageous as it can further improve light intensity from LED device. In one aspect, two Zener diodes **62** can be electrically connected in series using one or more wirebonds **42** between first and second conductive traces **64** and **66** for higher voltage applications. Each emission area **14** can be disposed between first and second conductive traces **64** and **66** of submount **12**. First conductive traces **64** can correspond to the negative portion of LED device **10** as designated by symbol **32**. Second conductive traces **66** can correspond to the positive terminal of LED device **10** as designated by symbol **30**. Conductive traces can, for example and without limitation, be arranged in a substantially semi-circular arrangement about mounting area **36** such that outermost LEDs **24** arranged in strings over mounting area **36** can electrically communicate to each trace by wirebonding via wirebonds **42** or by any other suitable attachment method. As illustrated, outermost LEDs **44** for a respective string of LEDs **24** can electrically connect to conductive traces **64** and **66**.

Broken lines **68** illustrate one possible aspect of the size and/or shape of the electrically conductive material comprising the conductive traces **33** and **34**. The lines are broken to illustrate how the material can be disposed

under a solder mask **102** (Figure 7A). Thus, attachment surfaces **28** can electrically and/or thermally communicate with respective conductive traces **64** and **66** and can comprise the same layer of material. External, conductive wires (not shown) can electrically connect to attachment surfaces **28**, and electrical current or signal can flow from the attachment surfaces **28** to the respective conductive traces **64** and **66**. The electrical current can flow along the conducting material designated by broken lines **68** disposed below the layer of solder mask **102**. The electrical current can flow into and/or out of the conductive traces **64** and **66** and therefore into and out of respective strings of LEDs **24** mounted over mounting area **36**. Mounting area **36** can comprise an irregular shape that can extend around various feature of LED device **10**, for example, attachment area **16** to thereby expand the size of emission area **14**. Figure 4 also illustrates one possible location for mounting area **36**. That is, mounting area **36** can comprise an off-centered location with respect to submount **12**, but a substantially centrally located semi-circular pad disposed between conductive traces **64** and **66**. Solder mask **102** (Figure 7A) can be disposed at least partially between respective conductive traces **64** and **66** mounting area **36**, such that the solder mask **32** comprises a substantially semi-circular arrangement about mounting area **36**. Solder mask **32** can also be disposed in areas outside of the conductive traces, for example, between the respective conductive traces and one or more attachment surfaces **28**.

Figure 5 illustrates a further embodiment of an LED device, generally designated **70** prior to placement of filling material **26**. LED device **70** illustrates another example of a device having an irregularly shaped mounting area **36** and retention material **22** disposed about mounting area **36**. LED device **70** comprises a rounded submount **12** over which an irregularly shaped emission area **14** can be disposed. Emission area **14** can comprise an irregularly shaped mounting area **36**, one or more LEDs **24** and filling material **26** (not shown). Filling material **26** can react with light emitted from the one or more LEDs **24** such that light of a desired wavelength is emitted. In one aspect, what is perceived as white light is emitted from

emission area **14** of LED device **70** and each device described herein. LED device **70** can comprise more than one attachment area **16**. Retention material **22** and emission area **14** can comprise one or more concave portions **18** for extending around attachment areas **16**. Irregularly shaping emission area **14** can maximize the space from which light can be emitted, for example, extending the area proximate edge **15** of submount.

One or more LEDs **24** may be disposed in an array over surface of submount **12**. LEDs **24** can comprise horizontal devices having the p- and n-contacts on the top surface such that the LEDs **24** can be electrically connected in series via wirebonds **42**. LEDs **24** that are wirebonded can comprise one or more strings of LEDs **24**. In the alternative, LEDs **24** can comprise horizontal devices having both the p- and n-contacts on the bottom in the so-called flip chip design and can be electrically connected in parallel over an electrically conductive mounting area **36** that has been electrically isolated into more than one portion by isolating layer **52**. For illustration purposes, both LED **24** connection methods and chip structures are indicated, however, any suitable connection method and chip structure is contemplated. Each LED **24** in emission area may be wirebonded in strings via wirebonds **42**, each may be flip chip oriented, or emission area **14** can comprise a combination of both. Strings of LEDs **24** may comprise one or more patterns of any orientation and design. Outermost LEDs **44** of wirebonded strings may comprise wirebonds **42** which become at least partially covered by retention material **22**.

Figure 6 illustrates one example of an LED system, generally designated **80**. LED system **80** can comprise an LED lighting product for any general lighting application. Here, LED system **80** comprises a standard A19 equivalent light bulb. However, any suitable lighting product for any suitable lighting application is contemplated. LED system **80** can comprise LED device **70** disposed over a device housing generally designated **82** which can house electrical components used to illuminate LED device **70**. LED device **70** can comprise an emission area **14** that is irregularly shaped, in some aspects LED device **70** can comprise more than one line of

symmetry **S**. In other aspects, LED device **70** can have no more than one line of symmetry **S** or can be asymmetric. Submount **12** of LED device **70** can be directly mounted over a thermally conductive portion **84** of housing **82**, or LED device **70** may not require a submount **12**, but could be formed directly on thermally conductive portion **84** of housing **82** (See Figure 7B). In one aspect, one or more connecting members (not shown) such as a clip or screw may be positioned with one or more attachment areas **16** of LED device **70** for connecting submount **12** to housing **82**. The connecting members could extend through device **70** and become mechanically retained by one or more coupling members **88** of housing **82**. In one aspect, coupling members **88** comprise openings through which the connecting member could extend thereby coupling device **70** to housing **82**. In another aspect, coupling member **88** comprises an electrically conductive pad or portion to which one or more LEDs **24** of device **70** can electrically couple to thereby electrically coupling device **70** to housing. Coupling members **88** can therefore represent portions of housing which could electrically, thermally, and/or mechanically couple device **70** to housing **82**.

Housing **82** further comprises an inner wall **86** disposed about thermally conductive portion **84**. Inner wall **86** can couple to a bulb for fitting with LED device **70**. Thermally conductive portion **84** can be disposed over an upper surface **88** of housing. One or more fins **90** can be disposed on housing **82**. Fins **90** can increase the surface area from which heat can dissipate when LED device **70** thermally couples to housing **82**. A bottom portion of housing, generally designated **100**, can comprise a socket which can receive electrical current from an external source, for example, a lamp socket when a power switch for the system is turned “on”. When “on”, electrical current can flow through housing **82** in any suitable configuration and be received by LED device **70**. LED device **70** can illuminate via emission area **14** which can transmit light through a bulb **92**. System **80** can further comprise a bulb **92** positioned over housing **82**, wherein a lower rim **94** of bulb **92** can be secured to inner wall **86** of housing **82**. Bulb **92** can be transparent, semitransparent, opaque, and/or any combination thereof. In

other embodiments, bulb 92 can comprise any suitable shape than the pear shape (A19 size/shape) as illustrated. Any size and/or shape of bulb 92 and LED system 80 is hereby contemplated.

Figures 7A and 7B illustrate cross-sectional views of LED device 70 5 both on and off a submount 12. Figure 7A illustrates a portion of a cross-section of Figure 5 with filling material 26 disposed over emission area 14. For illustration purposes, LEDs 24 that are wirebonded and electrically connected in series are illustrated. As noted, LEDs 24 could also comprise a chip structure that does not need bond pads and/or wirebonds 42. Such 10 structures may simply be mounted over electrically isolated portions of mounting area 36. As noted, each string, or pattern of LEDs 24 can comprise any suitable number of LEDs 24. LEDs 24 can be arranged over mounting area 36 and can thermally communicate directly with mounting area 36 or indirectly through one or more intervening layers. LEDs 24 can 15 attach to mounting area 36 or intervening layers using any attachment means known in art. In one aspect, LEDs 24 can attach using solder pastes, epoxies, or flux. Mounting area 36 can be formed integral as one piece of submount 12 or can comprise a separate layer disposed over submount 12. Mounting area 36 can dissipate heat generated by the one or more LEDs 24.

Figure 7A further illustrates outermost LEDs 44 electrically communicating with one or more electrical elements via wirebonds 42. Electrical elements can comprise first and second conductive traces 64 and 66 which are configured to flow, or supply electrical signal or current to the respective strings of LEDs 24. One of first and second conductive traces 64 25 and 66 can comprise an anode and the other a cathode. The electrical polarity can be denoted by first and second symbols 30 and 32 (Figure 1) as discussed earlier. Mounting area 36 and conductive traces 64 and 66 can comprise any suitable electrical and thermally conductive materials and can comprise either the same or different materials. In one aspect, mounting 30 area 36 and conductive traces can comprise a layer of copper (Cu) or aluminum (Al) metal or alloy material deposited over submount using any suitable technique. An electrically insulating solder mask 102 can be

disposed at least partially between mounting area **36** and respective conductive traces **64** and **66** such that when solder or other attachment material is used to attach one or more LEDs **24** over mounting area **36**, the attachment material cannot electrically communicate with the conductive traces **64** and **66** thereby causing one or more strings of LEDs **24** to become electrically shorted.

Figure 7A further illustrates various other portions of submount **12**. Submount **12** can comprise, for example, mounting area **36**, first and second conductive traces **64** and **66**, and solder mask **102** at least partially disposed between mounting area **36** and each of conductive traces **64** and/or **66**. Solder mask **102** can be disposed between conductive traces **64** and **66** and attachment surfaces **28** (Figure 4), the proximal edges of solder mask can be seen in Figure 7A adjacent an outer wall **108** of retention material **22**. Submount **12** can further comprise a dielectric layer **104**, and a core layer **106**. For illustration purposes, submount **12** can comprise a MCPCB, for example, those available and manufactured by The Bergquist Company of Chanhassan, MN. Any suitable submount **12** can be used, or in some aspect, no submount is necessary (Figure 7B). Core layer **106** can comprise a conductive metal layer or alloy, for example copper or aluminum. Dielectric layer **104** can comprise an electrically insulating but thermally conductive material to assist with heat dissipation through submount **12**. Retention material **22** can at least partially cover each of solder mask **32** and the wirebond **42** connecting outermost LEDs **44** to conductive traces **64** and **66**. Filling material **26** can be selectively filled to any suitable level higher, lower, or equal to the height of retention material **22**. Wirebonds **42** of the outermost LEDs **44** as shown can be at least partially disposed within retention material **22**.

Figure 7B illustrates LED device **70** without a submount **12**. For example, a string of one or more LEDs **24** can be directly disposed over a thermally conductive material, such as thermally conductive portion **84** of LED system **80** thereby eliminating the need for submount **12**. As noted earlier, coupling members **88** may comprise an area, such as an electrically

conductive pad which could electrically couple housing **82** to device **70**. Thus, LEDs **24** can be directly mounted over thermally conductive portion **84** and electrically communicate with coupling members **88**. LEDs **24** may be mounted over any suitable thermally conductive material and electrically coupled to any suitable electrically conductive material. Electrically and thermally conductive materials may be disposed on any suitable LED lighting system, product, or fixture. Retention material **22** can then be dispensed in an irregular shape about the LEDs **24** to maximize emission area **14**. Retention material **22** can at least partially cover wirebonds **42** of outermost LEDs **44** and thermally conductive portion **84**. Filling material **26** can then be filled to any suitable level with respect to thickness of retention material **22**. Filling material **26** may be filled to a level even with top of retention material **22** or to any suitable level concave or convex with respect to the top of retention material **22**. Notably, Figures 7A and 7B illustrate the rounded outer wall **108** of retention material **22**. This may be advantageous for further reflecting light emitted from emission area **14**.

Figure 8 illustrates another embodiment of an LED device, generally designated **110**. LED device **110** is illustrated without filling material **26** disposed in emission area **14**. LED device **110** is similar in form and function to other devices described herein, and can comprise one or more irregularly shaped light emission areas **14** having irregularly shaped retention material **22** at least partially disposed about each emission area **14**. LED device **110** illustrates a device comprising four emission areas **14** in an off-center location. Each emission area can comprise one or more LEDs **24** mounted to thermally conductive mounting area **36**. In one aspect, LEDs **24** may be electrically connected in series via wirebonds **42** and receive electrical current from electrical traces disposed outside mounting area **36**. In other aspects, LEDs **24** may be electrically connected in parallel and receive electrical current from portions of mounting area that have been isolated by isolating layer **52**. The four emission areas **14** can be disposed on a submount **12** and utilize an irregular shape to extend proximate edge **15** of submount **12** where a submount is desired. LED devices herein,

including LED device 110, may or may not have a submount such as submount 12. Emission areas 14 can be disposed about one or more attachment areas 16. Attachment areas 16 may or may not be centrally disposed with respect to submount. Another advantageous feature obtained 5 by using irregularly shaped emission areas is the ability to obtain certain sizes, shapes, location and pattern of light. For example, lighting applications typically differ by the position and pattern of light required. By using devices, systems, and methods disclosed herein, emission areas 14 can be created over virtually any thermally conductive surface or area by 10 mounting LEDs 24 in any desired irregular shape, dispensing retention material 22 about the LEDs 24, and providing filling material 26 within retention material 22. Electrical current can be supplied to the LEDs 24 using any suitable submount or other electrical configuration. Certain applications may need certain patterns or location of light, thus, any number 15 and pattern of emission areas 14 can then be provided to accommodate any number of applications.

Figure 9 illustrates another embodiment of an LED system, generally designated 120. System 120 can comprise any suitable lighting product or fixture. System 120 illustrates the ability of using one or more emission 20 areas 14 for establishing various light positions. System 120 illustrates a lighting application that requires light to be emitted in multiple directions, for example, outwardly from bulb 92 along all upper and lower surfaces within bulb 92. System 120 can comprise a three-dimensional LED device, generally designated 126. Device 126 comprises multiple portions 125 adapted to together emit light approximately 360° from inside bulb 92. Each 25 portion 125 can be adjacent another similarly shaped portion 125, and the portions can comprise a hexagonal arrangement to position light approximately 360° around bulb. The side view in Figure 9 illustrates three portions 125; however, the other three portions would be a mirror image 30 when viewed from the other side.

Each portion 125 of device 126 can comprise multiple surfaces over which emission areas 14 can be provided for emitting light from various

angles as indicated by the lines. For example, each portion **125** may comprise a first facet or surface **128**, a second surface **130**, and a third surface **132**. Each of first, second, and third surfaces **128**, **130**, and **132** can be disposed at different angles with respect to each other. Any suitable number of surfaces and arrangement of surfaces for obtaining any angle of light is hereby contemplated. Each of first, second, and third surfaces **128**, **130**, and **132**, respectively can comprise an irregularly shaped emission area **14** which can maximize the amount of surface from which light may be extracted. Each emission area **14** can comprise one or more LEDs **24** (not shown) disposed within filling material **26** for obtaining light of a desired wavelength. Retention material **22** can be disposed about emission area **14** for retaining filling material **26** over the one or more LEDs **24**. (See Figures 7A and 7B). Each portion **125** of device **126** can comprise a coupling end **134** for mechanically, electrically, and/or thermally connecting to housing **82**, previously described. Housing **82** can comprise one or more coupling members **88** for coupling to portions **125**. In one aspect, coupling member **88** comprises a solder pad for soldering to coupling end **134**. In other aspects, coupling member **88** comprises an opening for receiving at least a portion of coupling end **134**. Any method of electrically, mechanically, and/or thermally coupling housing **82** to device **126** is hereby contemplated.

System **120** may optionally comprise a diffuser **122**. A diffuser **122** may comprise an opening **124** through which device **126** may be inserted and/or surrounded to further affect light. Diffuser **122** may ensure even light extraction from bulb **92**. Bulb **92** can be disposed about each of device **126** and diffuser **122** where a diffuser is utilized. LED devices and systems disclosed herein can advantageously consume less energy while delivering equal or greater illumination. LED devices and systems disclosed herein can also advantageously maximize the amount of emission area available by utilizing irregularly shaped light emission areas. In addition, LED devices, systems, and methods disclosed herein can advantageously selectively position for a variety of lighting applications.

Figure 10 illustrates another example of an LED device over which one or more irregularly shaped emission areas **14** can be disposed. LED device can comprise a submount **12**. Retention material **22** can be disposed about each of the one or more emission areas **14** via a dispensing process 5 or other suitable process. Emission areas **14** can comprise one or more LEDs **24** disposed under filling material **26** (Figures 7A and 7B). A first irregularly shaped device **140** can comprise a parallelogram that is asymmetric. A second irregularly shaped device **150** has no more than one line of symmetry denoted **S**. A third irregularly shaped device **160** is also 10 asymmetric. Several irregular shapes have been illustrated herein, however, any irregular shape is contemplated and envisioned in accordance with the disclosure herein. As noted earlier, irregular shapes are shapes that do not have all lines and all angles equal.

Embodiments of the present disclosure shown in the drawings and 15 described above are exemplary of numerous embodiments that can be made within the scope of the appended claims. It is contemplated that the configurations of LED devices, systems, and methods of making the same can comprise numerous configurations other than those specifically disclosed.

CLAIMS

What is claimed is:

1. A light emitting device, comprising:
 - an emission area comprising one or more light emitting diodes (LEDs)
 - 5 mounted over an irregularly shaped mounting area; and
 - a retention material disposed about the irregularly shaped mounting area.
2. The device of claim 1, wherein the one or more light emitting diodes
10 are arranged in an array.
3. The device of claim 1, wherein the device comprises more than one
emission area.
- 15 4. The device of claim 1, wherein a portion of the emission area
comprises a concave portion adjacent an attachment area.
5. The device of claim 1, wherein the emission area is disposed over a
submount.
20
6. The device of claim 6, wherein the emission area is disposed off-
center on the submount.
7. The device of claim 1, wherein the retention material is dispensed.
25
8. The device of claim 1, wherein the emission area further comprises a
filling material disposed over the one or more LEDs, the filling material being
retained by the retention material.
- 30 9. The device of claim 1, wherein the device comprises a first emission
area disposed over a first surface and a second emission area disposed

over a second surface, wherein an angle is disposed between the first and second surfaces for emitting light at different angles.

10. The device of claim 1, wherein the emission area comprises a
5 plurality of LEDs electrically connected in series via wirebonds.

11. The device of claim 10, wherein the plurality of LEDs comprises one or more strings of LEDs arranged in more than one different pattern.

10 12. The device of claim 1, wherein the emission area comprises a plurality of LEDs electrically connected in parallel over one or more isolated portions of the mounting area.

13. The device of claim 1, wherein the device comprises four irregularly
15 shaped emission areas.

14. The device of claim 3, wherein the device further comprises an attachment area at least partially disposed between the more than one emission areas.

20

15. The device of claim 1, wherein the mounting area comprises a single, undivided mounting area.

16. The device of claim 15, wherein the device comprises more than one
25 mounting area.

17. The device of claim 1, wherein the device comprises no more than one line of symmetry.

30 18. The device of claim 1, wherein the device comprises no more than two lines of symmetry.

19. The device of claim 1, wherein the device is asymmetric.
20. A light emitting device, comprising:
 - an irregularly shaped emission area comprising one or more light emitting diodes (LEDs); and
 - an attachment area disposed outside of the irregularly shaped emission area.
21. The device of claim 20 comprising more than one emission area.
10
22. The device of claim 20 comprising more than one attachment area.
23. The device of claim 20, wherein the one or more LEDs are mounted over an irregularly shaped mounting area.
15
24. The device of claim 20, further comprising a retention material disposed about the irregularly shaped emission area.
25. The device of claim 20, wherein the emission area is disposed over a submount.
20
26. The device of claim 20, wherein the emission area is disposed off-center on the submount.
25
27. The device of claim 24, wherein the retention material is dispensed.
28. The device of claim 20, wherein the emission area further comprises a filling material disposed over the one or more LEDs, the filling material being retained by a retention material.
30
29. The device of claim 20, wherein the device comprises a first emission area disposed over a first surface and a second emission area disposed

over a second surface, wherein an angle is disposed between the first and second surfaces for emitting light at different angles.

30. The device of claim 20, wherein the emission area comprises a
5 plurality of LEDs electrically connected in series via wirebonds.

31. The device of claim 30, wherein the plurality of LEDs comprises one or more strings of LEDs arranged in more than one different pattern.

10 32. The device of claim 20, wherein the emission area comprises a plurality of LEDs electrically connected in parallel over one or more isolated portions of the mounting area.

15 33. The device of claim 20, wherein the device comprises four irregularly shaped emission areas.

34. The device of claim 20, wherein the device comprises no more than one line of symmetry.

20 35. The device of claim 20, wherein the device comprises no more than two lines of symmetry.

36. The device of claim 20, wherein the device is asymmetric.

25 37. The device of claim 20, wherein the attachment area comprises an opening.

38. The device of claim 20, wherein the attachment area comprises a clip fastener.

30

39. A light emitting system comprising:
a first surface

5 a second surface angled with respect to the first surface;
a first emission area disposed over the first surface; and
a second emission area disposed over the second surface;
wherein each of the first and second emission areas comprise one or
5 more light emitting diodes (LEDs) mounted over an irregularly shaped
mounting area;
a retention material dispensed about the irregularly shaped mounting
area.

10 40. The system of claim 39, further comprising a housing for electrically,
mechanically, and thermally connecting to the first and second surfaces.

41. The system of claim 39, further comprising a diffuser disposed about
the first and second surfaces.

15 42. The system of claim 39, further comprising a bulb disposed over the
first and second surfaces.

20 43. The system of claim 39, further comprising a third surface angled with
respect to the second surface, the third surface comprising a third emission
area.

25 44. The system of claim 39, wherein the one or more LEDs comprises a
plurality of LEDs electrically connected in series over the irregularly shaped
mounting area.

45. The system of claim 44, wherein the plurality of LEDs comprises one
or more strings of LEDs arranged in more than one different pattern.

30 46. The system of claim 39, wherein the first emission area comprises a
plurality of LEDs electrically connected in parallel over one or more isolated
portions of the mounting area.

47. The system of claim 39, wherein the first and second emission areas comprise irregularly shaped areas.

5 48. The system of claim 47, wherein the first and second emission areas comprise no more than one line of symmetry.

49. The system of claim 47, wherein the first and second emission areas comprise no more than two lines of symmetry.

10 50. The system of claim 47, wherein the first and second emission areas are asymmetric.

51. A method of providing a light emitting device, the method comprising:

15 providing one or more light emitting diodes (LEDs) mounted over an irregularly shaped mounting area, the LEDs comprising a first light emission area; and

20 providing a retention material disposed about the irregularly shaped mounting area.

52. The method of claim 51, further comprising providing a filling material within the retention material.

25 53. The method of claim 51, further comprising attaching the mounting area over a thermally conductive submount.

54. The method of claim 53, wherein the thermally conductive submount comprises a thermally conductive housing within an LED system.

30 55. The method of claim 51, wherein providing the one or more LEDs comprises providing an array of LEDs.

56. The method of claim 51, comprising providing multiple emission areas disposed over a thermally conductive submount.

57. The method of claim 51, comprising providing a first emission area 5 having one or more concave portions adjacent an attachment area.

58. The method of claim 51, wherein providing retention material comprises dispensing retention material.

10 59. The method of claim 51, further comprising providing the first emission area disposed over a first surface and a second emission area disposed over a second surface, where the second surface is angled with respect to the first surface.

15 60. The method of claim 51, wherein providing one or more LEDs comprises providing a plurality of LEDs electrically connected in series via wirebonds.

20 61. The method of claim 51, providing one or more LEDs comprises one or more strings of LEDs arranged in more than one different pattern.

62. The method of claim 51, further comprising providing an attachment area at least partially disposed between the more than one emission areas.

25 63. A method of providing a light emitting device, the method comprising:
providing an irregularly shaped emission area comprising one or more light emitting diodes (LEDs); and
providing an attachment area disposed outside of the irregularly shaped emission area providing a retention material disposed about the 30 irregularly shaped mounting area.

64. The method of claim 63, wherein the irregularly shaped emission area comprises no more than one line of symmetry.
65. The method of claim 63, wherein the irregularly shaped emission area comprises no more than two lines of symmetry.
66. The method of claim 63, wherein the irregularly shaped emission area is asymmetric.
- 10 67. The method of claim 63, further comprising dispensing a retention material about the emission area.
68. The method of claim 63, further comprising providing more than one irregularly shaped emission areas over a submount.

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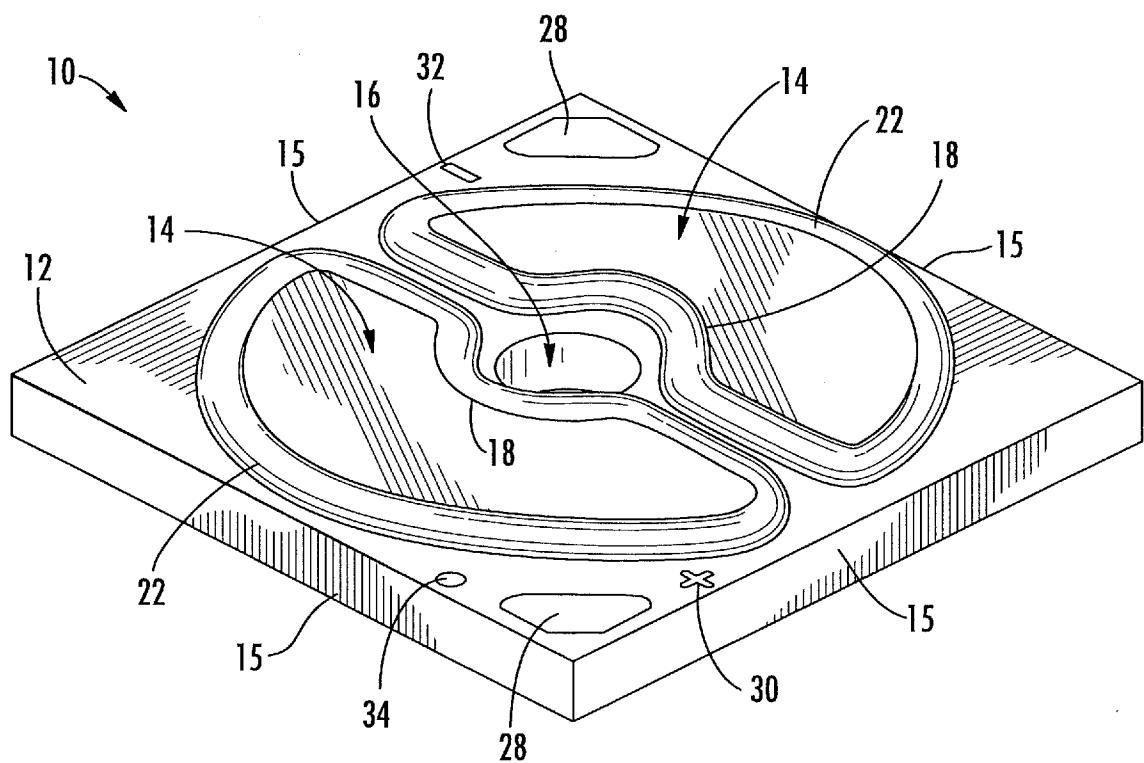


FIG. 1

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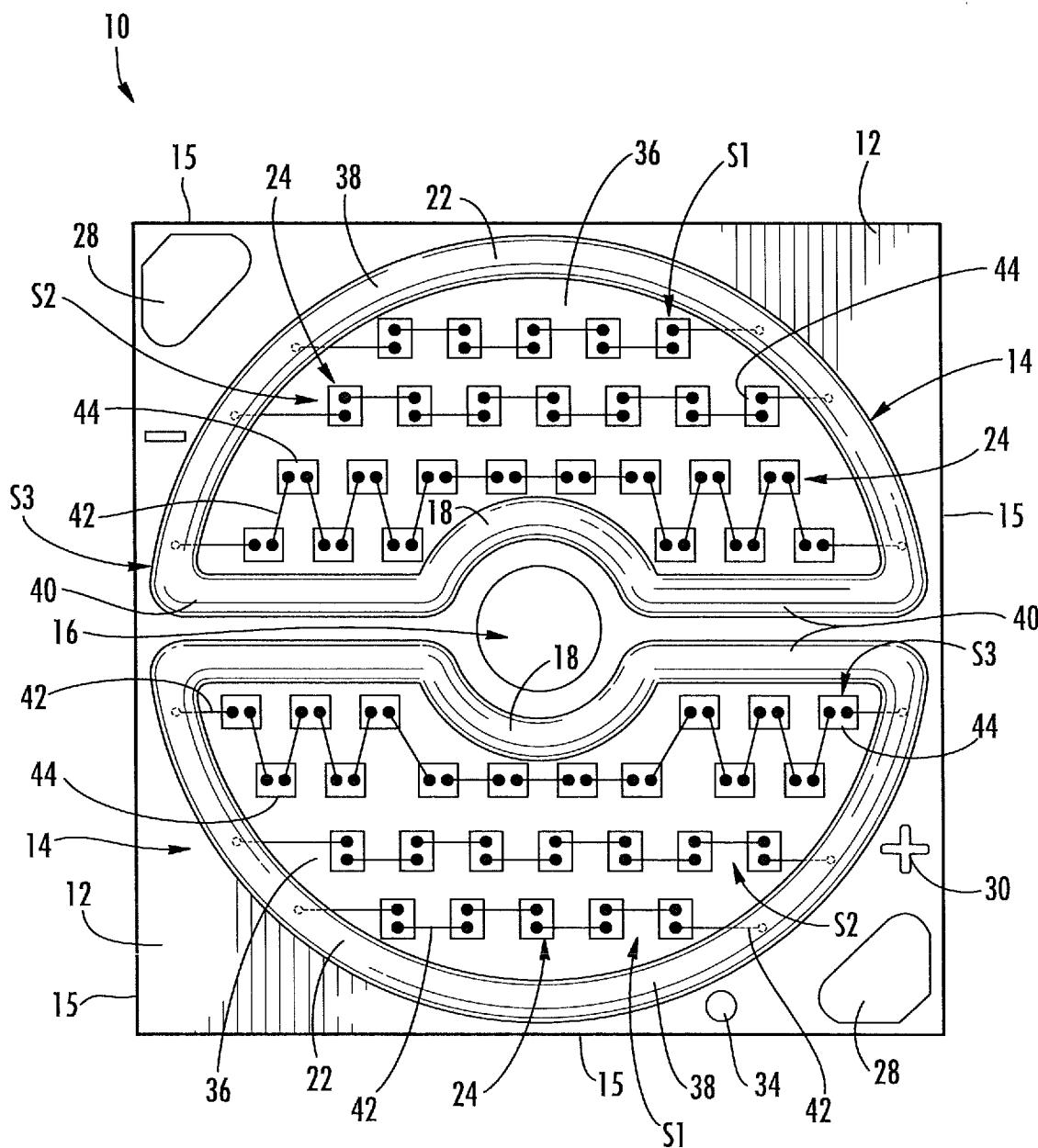


FIG. 2

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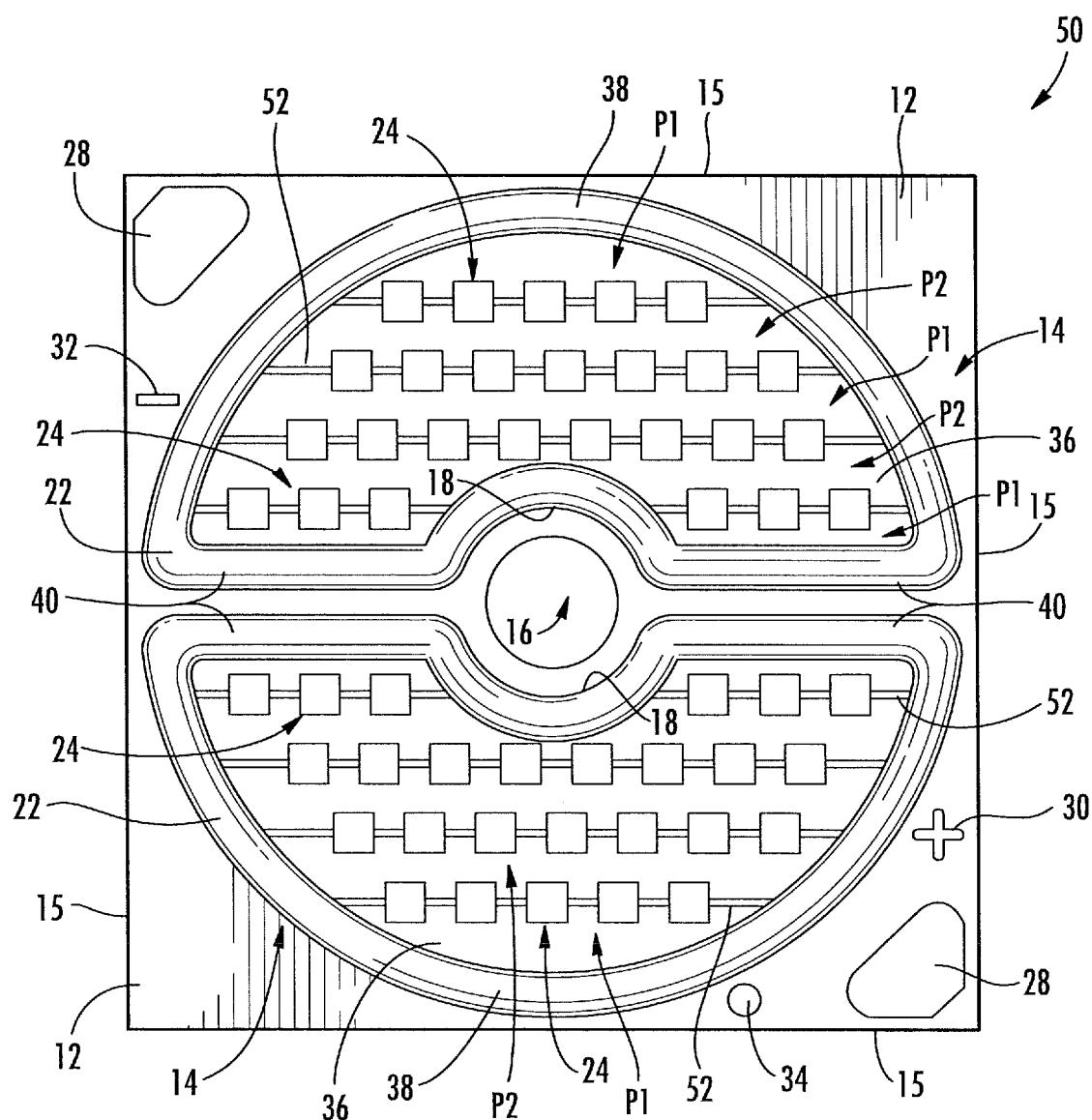


FIG. 3

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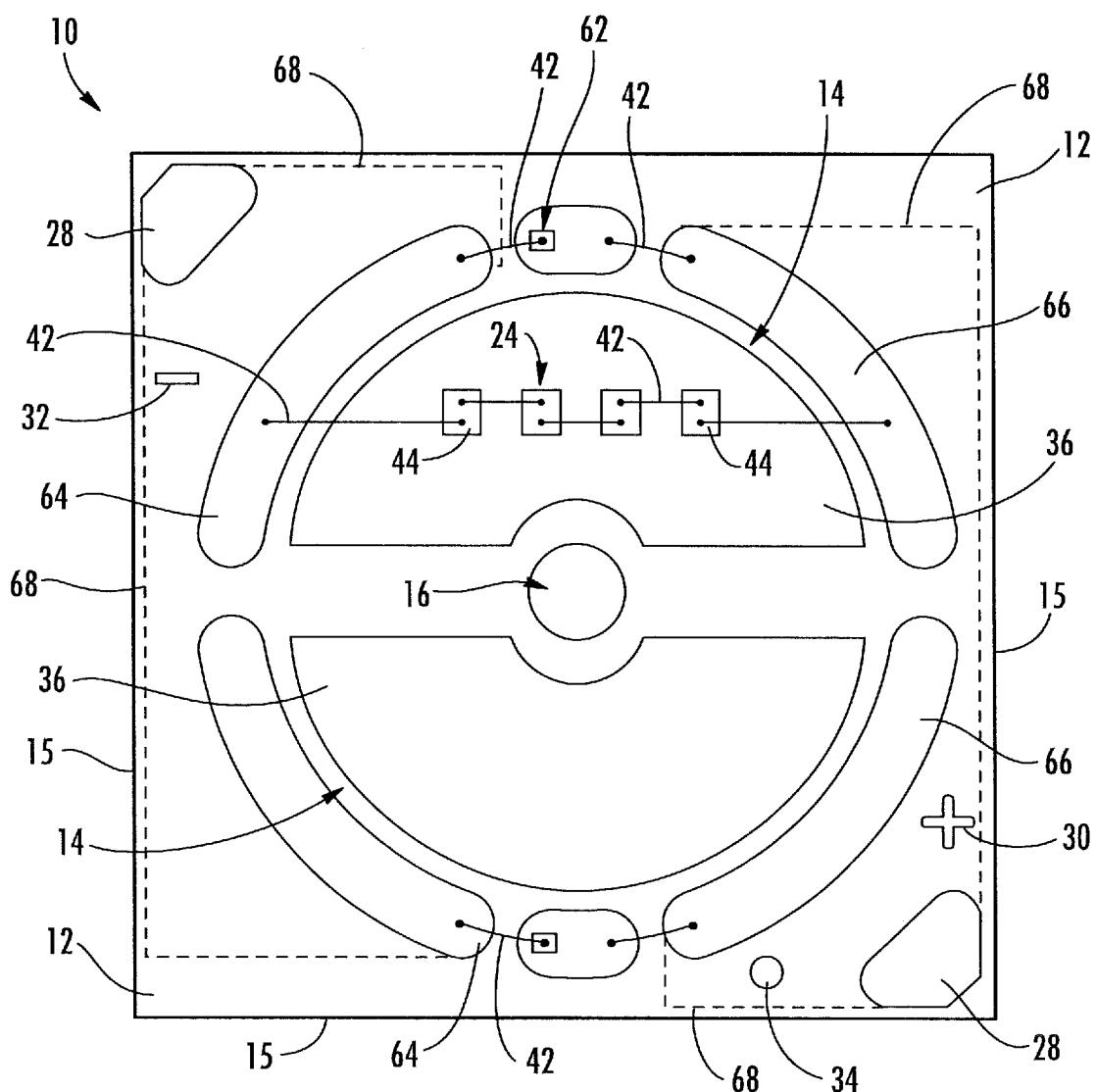


FIG. 4

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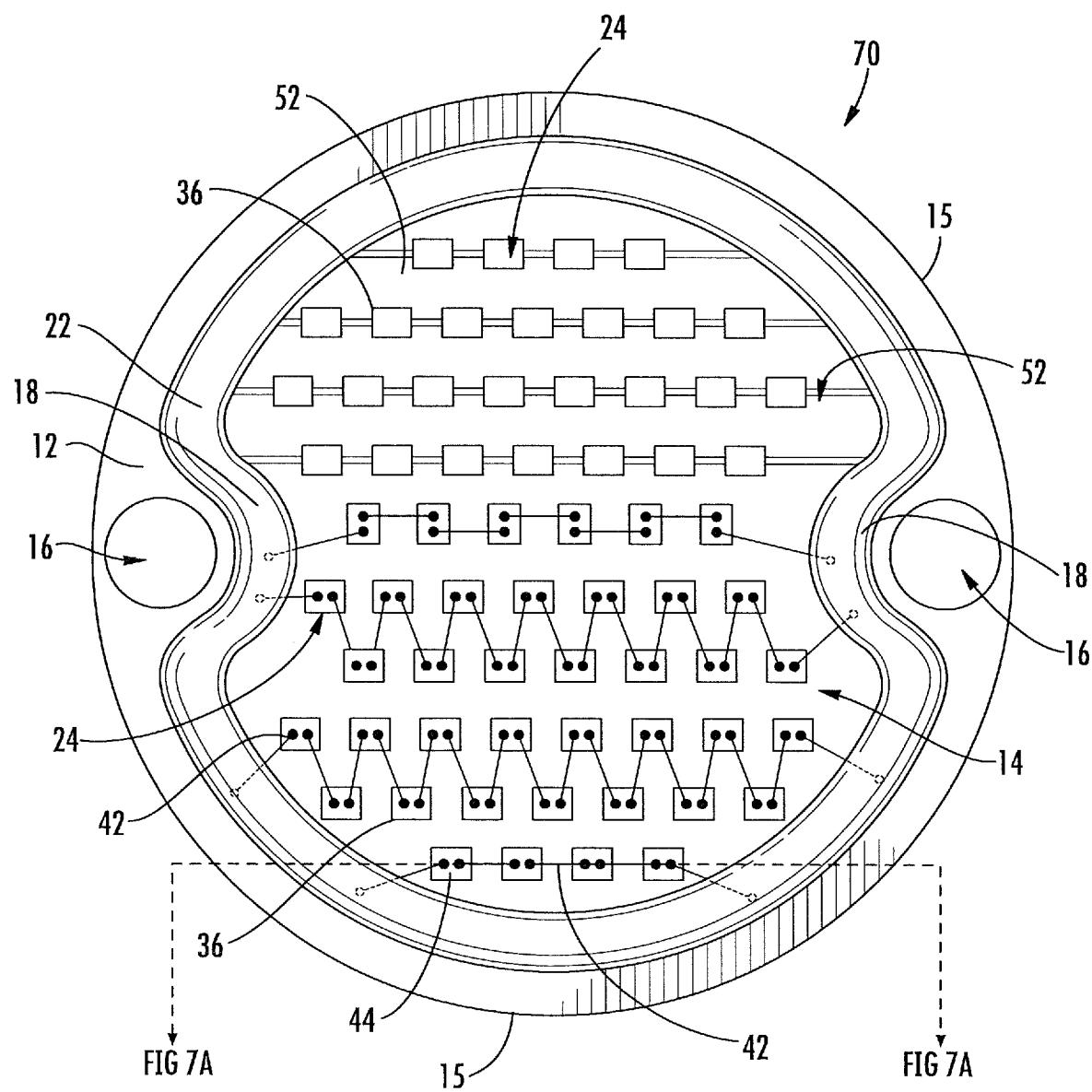


FIG. 5

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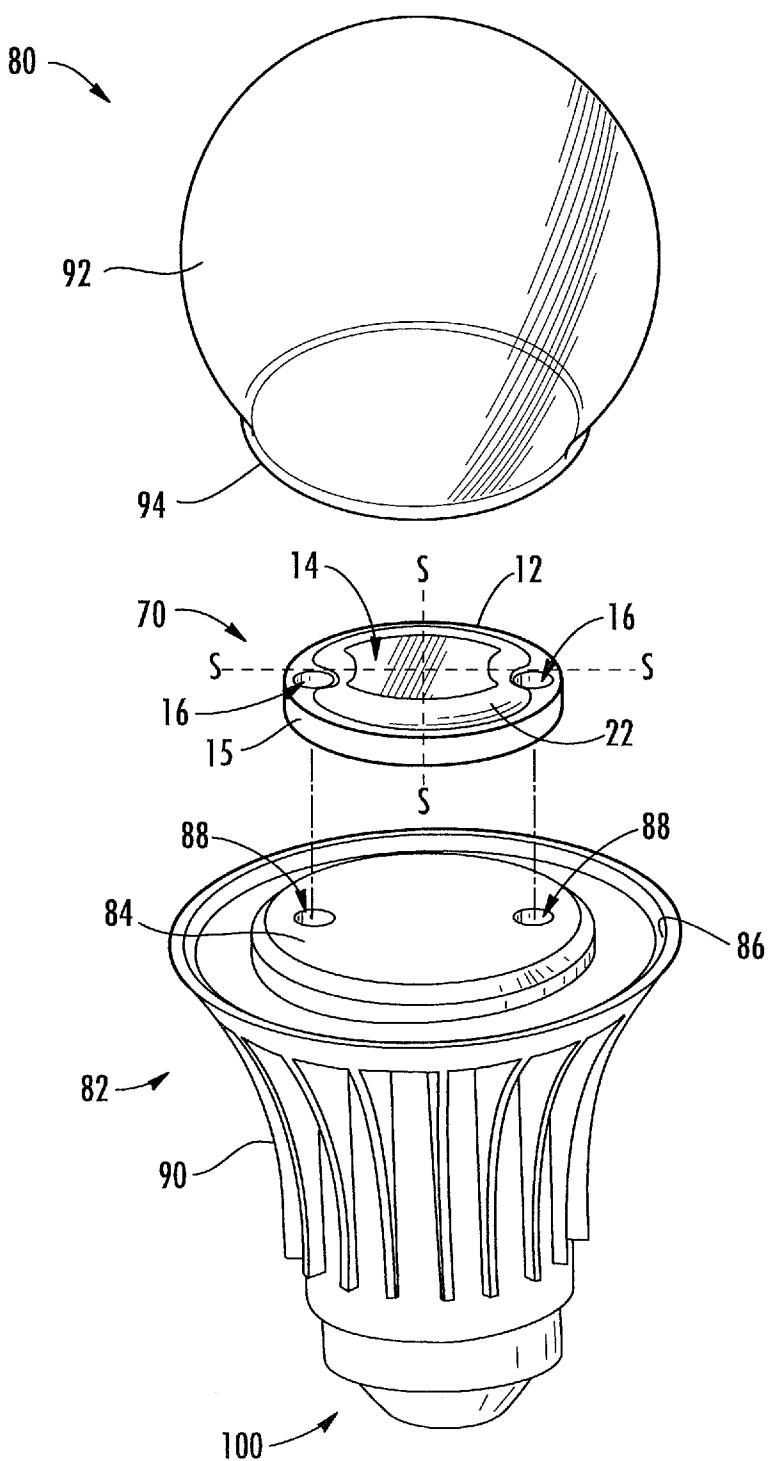


FIG. 6

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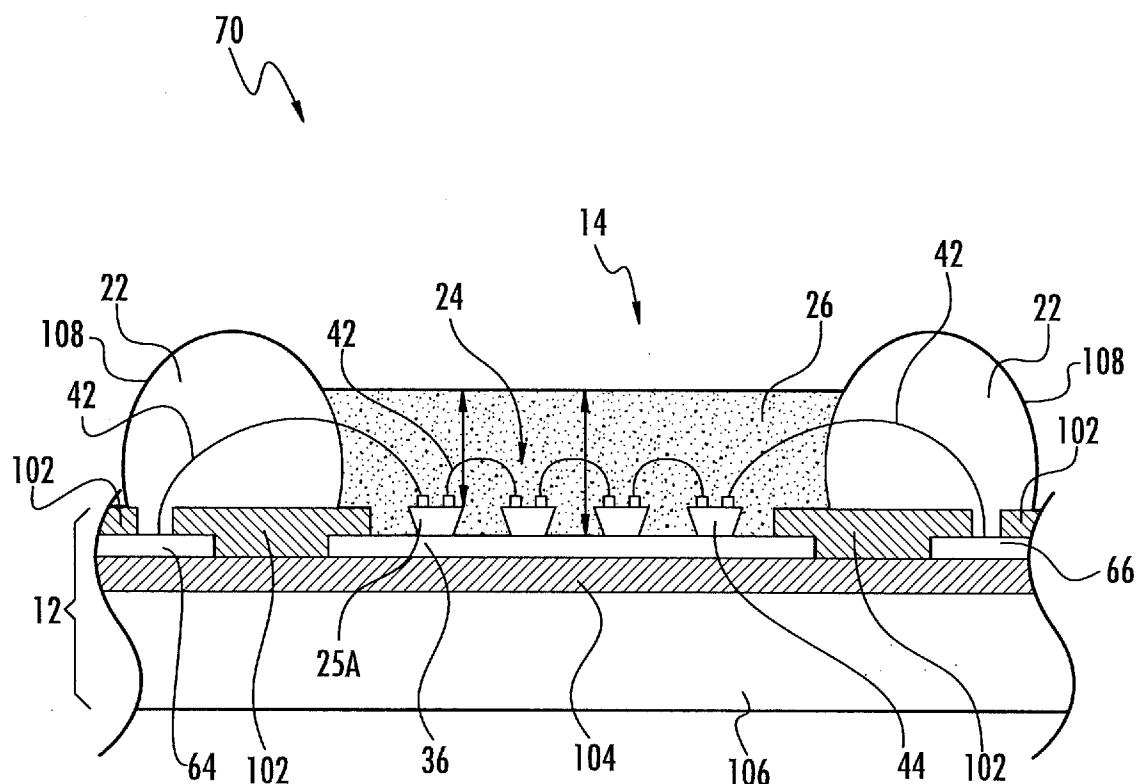


FIG. 7A

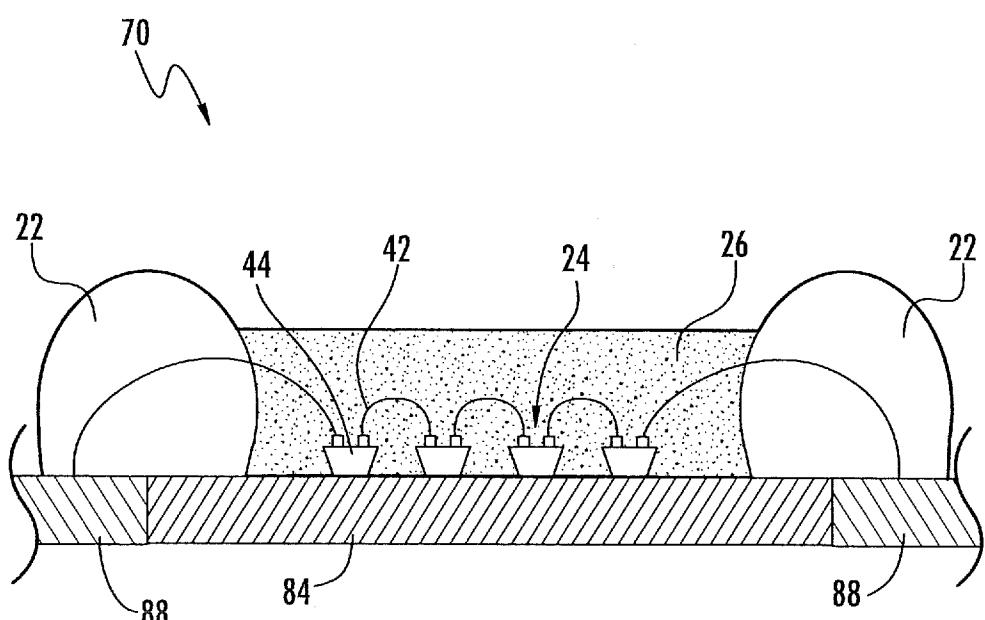


FIG. 7B

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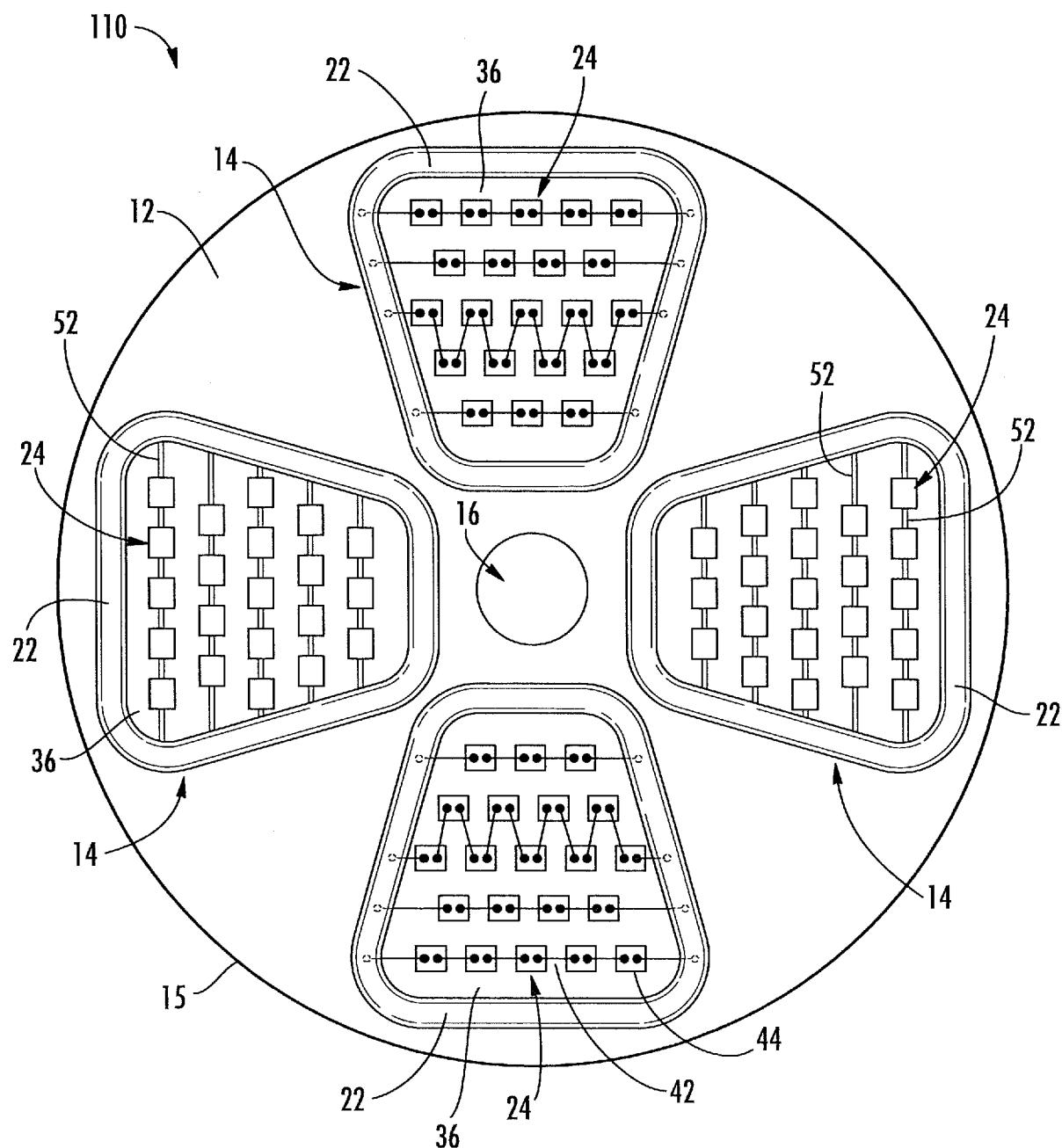
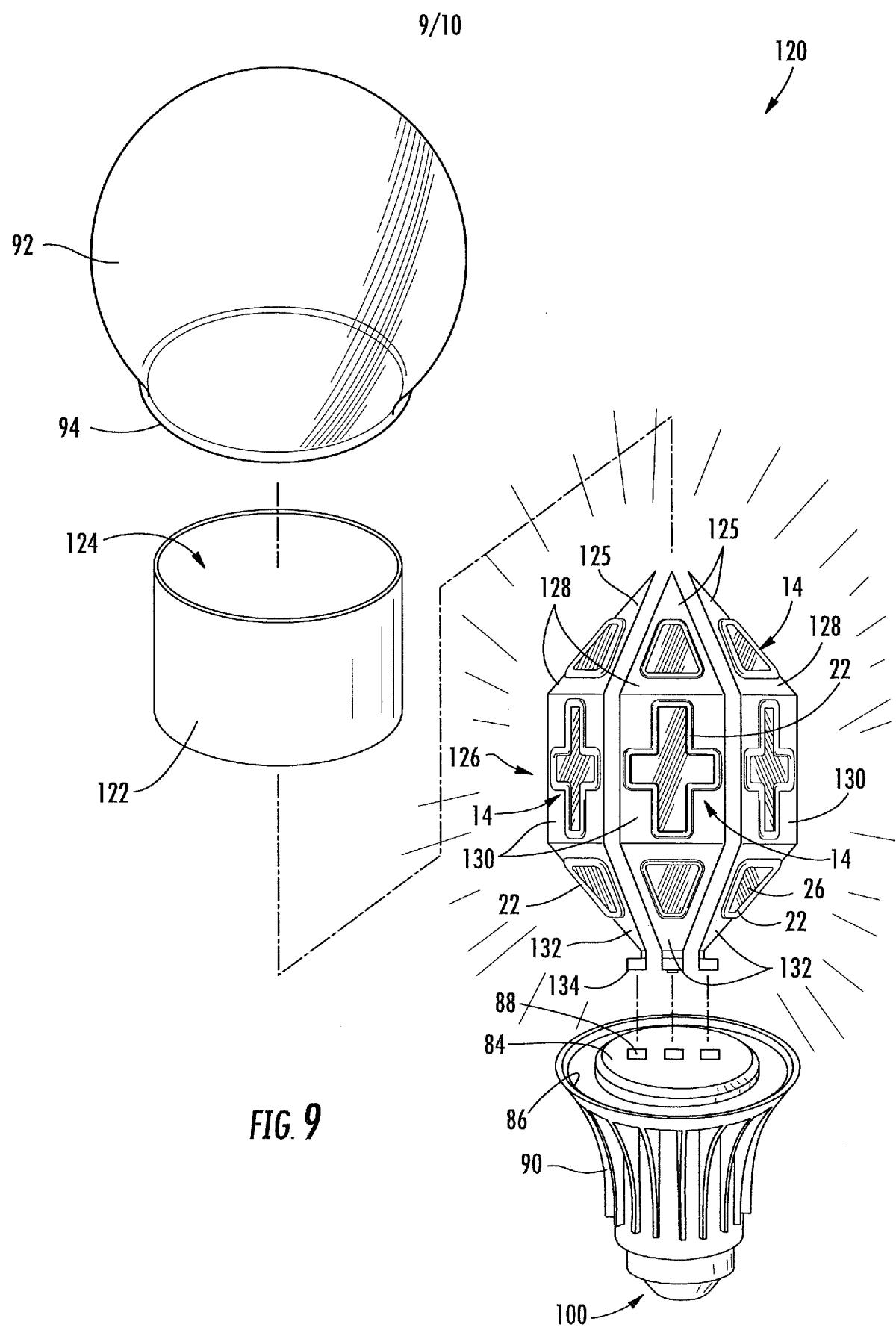


FIG. 8



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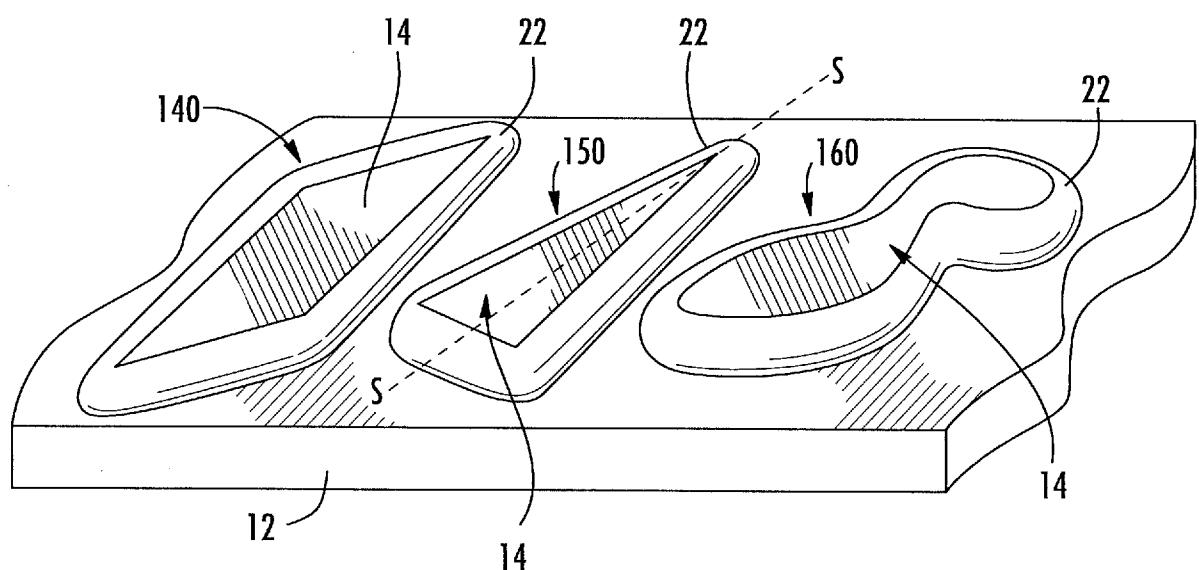


FIG. 10