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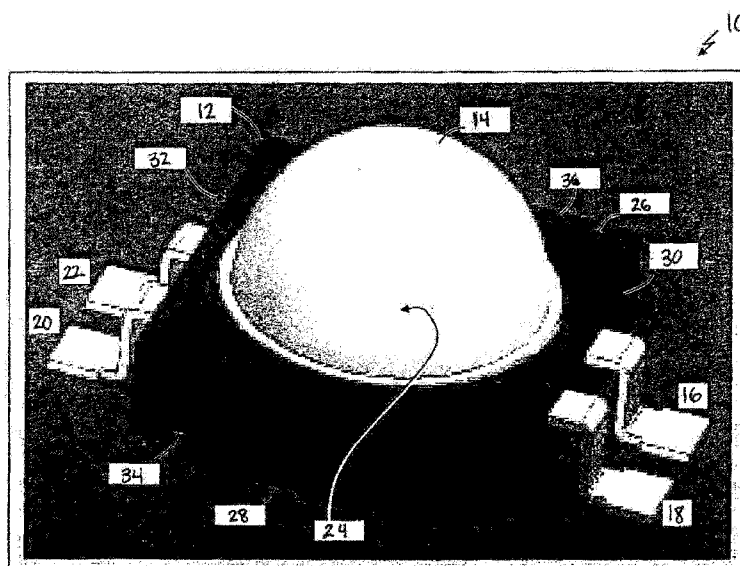


FIG. 1

(57) Abstract: A surface mount device and manufacturing method thereof are provided. The surface mount device comprises: a casing (12) with a first surface (26), a second surface (28), and at least one lateral side surface (30, 32, 34, 36); a recess formed in the first surface and extending into the casing; a plurality of leads (16, 18, 20, 22) partially encased by the casing; and one or more electronic devices coupled with at least one of the plurality of leads and at least partially exposed through the recess. A heat sink (24) may be included for heat dissipation.

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## SURFACE MOUNT DEVICE AND MANUFACTURING METHOD THEREOF

[0001] This application claims the benefit of provisional application Serial Number 60/889,532 to Jian-Hui Xie et al, which was filed on February 12, 2007.

BACKGROUND OF THE INVENTIONField of the Invention

[0002] The present invention generally relates to mounted electronic elements and/or devices, and more particularly to surface mount devices.

Background

[0003] In recent decades, there has been a dramatic increase in the number and types of devices utilizing circuit boards. The frequency with which devices and/or chips are mounted onto circuit boards has similarly grown. Improvements in the mounting of devices have helped advance the development of final products incorporating mounted devices and can significantly reduce the cost and complexity of the product.

[0004] The mounting of devices can be achieved through soldering, bonding and other similar methods. Further, devices can be mounted in many different configurations

and/or orientations and can be configured to allow one or more orientations for mounting. However, it can be difficult to mount some of these devices and/or mountings may deteriorate over time. As a result, the accuracy of the operation of the product incorporating these mounted devices can degrade and/or fail to operate.

#### SUMMARY OF THE INVENTION

[0005] The present invention provides apparatuses, systems, and methods of manufacturing surface mountable devices which allow for one or more mounting orientations while decreasing the difficulty of the mounting process and increasing the life of the mounting. One embodiment provides surface mount devices which comprise a casing with a first surface, second surface, and at least one lateral side surfaces. A recess is formed in the first surface of the casing and extends into the casing. A plurality of leads is partially encased by the casing, and one or more electronic devices are coupled with at least one of the plurality of leads and are at least partially exposed through the recess.

[0006] Another embodiment provides surface mount devices with a casing comprising a first surface and a recess formed in said first surface and extending at least partially into said casing. A plurality of leads at least partially encased by said casing and extending from the recess through the casing and exiting the casing. At least one electronic device coupled with at least one of the plurality of leads and at least partially exposed through the recess, and a heat sink proximate said plurality of leads and secured in said recess.

[0007] Another embodiment provides surface mount devices with a casing comprising a first surface and a second surface opposite said first surface. A recess is formed in said first surface and extends at least partially into said casing. A lens is positioned relative to and protruding from said first surface. A plurality of leads is at least partially encased by said casing and extends from the recess through the casing and exits the casing, and a heat sink is positioned proximate said plurality of leads and secured in said recess.

[0008] Another embodiment provides a method for use in manufacturing a surface mount device. A plurality of leads is positioned, proximate to which a heat sink is placed. The plurality of leads and the heat sink are secured with a casing such that the heat sink is maintained at a predefined position relative to the leads. An electronic device is mounted on the heat sink such that at least a portion of the electronic device is exposed through a recess in the casing.

[0009] These and other further features and advantages of the invention would be apparent to those skilled in the art from the following detailed description, taken together with the accompanying drawings, in which:

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is a perspective view of one embodiment of a surface mount device according to the present invention;

[0011] FIG. 2 is a top plan view of the embodiment shown in FIG. 1;

[0012] FIG. 3 is a side plan view of the embodiment shown in FIG. 1, with the opposite side being substantially similar;

[0013] FIG. 4 is a bottom plan view of the embodiment shown in FIG. 1;

[0014] FIG. 5 is a side plan view of the embodiment shown in FIG. 1, with the opposite side being substantially similar;

[0015] FIG. 6 is a perspective view of one embodiment of a heat sink according to the present invention;

[0016] FIG. 7 is a side plan view of the embodiment shown in FIG. 6, with the opposite side being substantially similar;

[0017] FIG. 8 is a top plan view of the embodiment shown in FIG. 6;

[0018] FIG. 9 is a bottom plan view of the embodiment shown in FIG. 6;

[0019] FIG. 10 is a sectional view of the embodiment shown in FIG. 6;

[0020] FIG. 11 is a perspective view of one embodiment of a lead assembly according to the present invention;

[0021] FIG. 12 is a top plan view of the embodiment shown in FIG. 11;

[0022] FIG. 13 is a side plan view of the embodiment shown in FIG. 11, with the opposite side being substantially similar;

[0023] FIG. 14 is a top plan view of a component of the embodiment shown in FIG. 1;

[0024] FIG. 15 is a perspective view of one embodiment of a heat sink according to the present invention;

[0025] FIG. 16 is a partial side plan view of the embodiment shown in FIG. 15, with the opposite side being substantially similar;

[0026] FIG. 17 is a top plan view of the embodiment shown in FIG. 15;

[0027] FIG. 18 is a bottom plan view of the embodiment shown in FIG. 15;

[0028] FIG. 19 is a top dimensional view of one embodiment of a surface mount device according to the present invention;

[0029] FIG. 20 is a side dimensional view of the embodiment shown in FIG. 19;

[0030] FIG. 21 is a side dimensional view of one embodiment of a heat sink according to the present invention;

[0031] FIG. 22 is a top dimensional view of the embodiment shown in FIG. 21;

[0032] FIG. 23 is a bottom dimensional view of the embodiment shown in FIG. 21;

[0033] FIG. 24 is a side dimensional view of one embodiment of a heat sink according to the present invention;

[0034] FIG. 25 is a top dimensional view of one embodiment of a lead assembly according to the present invention; and

[0035] FIG. 26 is a side dimensional view of the embodiment shown in FIG. 25.

#### DETAILED DESCRIPTION OF THE INVENTION

[0036] The present invention provides apparatuses, systems, methods of manufacturing and methods for mounting electronic devices. The methods for mounting may include, for example, mounting an electronic and/or optoelectronic device onto a circuit board. Some embodiments are particularly applicable to surface mount device (SMD) packages used to mount components such as optoelectronic elements that receive, emit, scatter and/or deflect light. The optoelectronic elements may include one or more light emitting diodes (LED), solar cells, photodiodes, laser diodes, and other such optoelectronic elements or combinations of optoelectronic elements. Some exemplary embodiments of the surface mount device packages are designed, at least in part, to stabilize the optoelectronic elements or combinations and/or dissipate heat from the optoelectronic element.

[0037] FIG. 1 shows a perspective view of one embodiment of a surface mount device (SMD) 10 according to the present invention that can be used to mount one or more



electronic devices, such as an optoelectronic element. The SMD 10 comprises a casing 12, a lens or dome 14, and a plurality of leads 16, 18, 20, and 22. In some embodiments, SMD 10 may additionally include a heat sink 24 upon which an electronic device such as an optoelectronic device may be mounted.

[0038] As depicted in FIG. 1, the casing in some embodiments can have a generally cubical shape, with a first surface 26 opposite a second surface 28. When the SMD 10 is mounted with an optoelectronic element such as a circuit board, the second surface 28 is positioned adjacent to and/or juxtaposed with the circuit board. The SMD 10 can be configured in numerous other relevant shapes without departing from the novel aspects of the SMD 10.

[0039] The casing 12 can also include four lateral side surfaces 30, 32, 34, and 36 when having a generally cubic shape. The lens 14 is positioned and typically secured relative to the first surface 26. In some embodiments, the lens 14 may extend and/or protrude from the first surface 26.

[0040] FIGs. 2-5 depict alternate views of the SMD 10 shown in FIG. 1. FIG. 2 shows an overhead view of the first surface 26 of the casing 12 sans lens 14. FIG. 3 shows a side view relative to side surface 34 of the casing 12. FIG. 4 shows the bottom of the second surface 28 of the casing 12, and FIG. 5 shows a side view of the side surface 30.

[0041] Referring to FIGs. 1-5, the leads 16, 18, 20, 22 are partially encased by the casing 12, with first and second leads 16, 18 extending through first side surface

30 of the casing 12 and third and fourth leads 20, 22 extending through second side surface 32 of the casing 12. Each lead 16, 18, 20, 22 has an opposite end separated by its exterior length, and portions of the leads 16, 18, 20, 22 extend through the casing 12 and/or are exposed at both ends. The leads 16, 18, 20, 22 exit the first and second side surfaces 30, 32 and are angled, bent, and/or otherwise configured such that they are generally aligned with a contact surface 38 of heat sink 24.

[0042] In some embodiments, the leads 16, 18, 20, 22 exit the first and second side surfaces 30, 32 in a generally perpendicular orientation to the side surfaces 30, 32 for a first exterior or exposed length 40, and are then bent to extend generally parallel with respect to the side surfaces 30, 32 for a second exterior length 42. They are then bent again to extend generally parallel with the contact surface 38 of the heat sink 24 for a third exterior length 44. Additionally, in some embodiments the leads 16, 18, 20, 22 increase in width along at least a portion of third exterior length 44 to increase the bonding surface area of the leads when coupling them with a circuit board or other relevant mounting surface.

[0043] The leads 16, 18, 20, 22 exit the casing 12 in a generally centered position along the first and second side surfaces 30, 32. However, it is noted that the leads 16, 18, 20, 22 can alternatively exit the casing 12 in a generally un-centered position with respect to side surfaces 30, 32. Further, in still other possible embodiments, leads 16, 18, 20, 22 can exit any or each of side surfaces 30, 32, 34, 36 in a variety of centered or

un-centered positions with respect to side surfaces 30, 32, 34, 36.

[0044] FIG. 6 depicts a heat sink 24 according to some embodiments. FIGs. 7-9 depict alternate views of the heat sink 24 of FIG. 6, with FIG. 7 showing heat 24 from the side, FIG. 8 showing heat sink 24 from the top, and FIG. 9 showing heat sink 24 from the bottom. Heat sink 24 is constructed, at least in part, of thermally conductive material. Suitable materials include, but are not limited to metals and/or metal alloys such as copper, nickel, and other relevant thermal material and/or combinations thereof.

[0045] Heat sink 24 can include a protruding or pedestal section 46, an extended section or plate 48, and a base 50. The extended plate 48 extends from and/or is thermally coupled with the base 50, and the pedestal section 46 extends from and/or is thermally coupled with the extended plate 48. While heat sink 24 is depicted as having a generally cylindrical shape with generally circular perimeters, it is understood that the heat sink 24 may be configured in any number of relevant shapes, such as a square, rectangular, or oval.

[0046] In some preferred embodiments, the extended plate 48 has a width or diameter 52 that is greater than the width or diameter 54 of the base 50. Further, the base 50 can include a laterally and circumferentially extending projection, ledge, shelf or ring 56. This shelf 56 extends a distance 58 from the base 50, which is typically less than the distance the extended plate 48 extends from the base 50. However, it is understood that the shelf 56 can extend as far as or beyond the extended

plate 48 without departing from the novelty of these embodiments.

[0047] The pedestal section 46 protrudes from the extended plate 48. In some embodiments, the pedestal section 46 is inclined and/or tapers toward a central axis 60 as it extends away from the extended plate 48 such that the base of the pedestal section 46 proximate to the extended plate 48 has a width or diameter 62 that is greater than the width or diameter 64 at a mounted surface 66. Further, diameter 62 at the base of the pedestal section 46 is typically less than the diameter 52 of the extended plate 48, and is also typically less than the diameter 54 of the base 50.

[0048] The mounting surface 66 provides a surface upon which one or more electronic and/or optoelectronic devices can be secured. Heat is dissipated from the mounted electronic and/or optoelectronic device(s) via the heat sink 24. When the SMD 10 is secured and/or mounted on a device such as a circuit board, the heat sink 24 can be positioned in and/or thermally coupled with a heat sink of the circuit board or other device for to further enhance heat dissipation from the mounted electronic and/or optoelectronic device(s).

[0049] An electronic and/or optoelectronic device can be mounted and/or secured with the mounting surface 66 of the heat sink 24 via soldering, bonding, and/or any other relevant mounting method or combinations of methods. However, in an exemplary embodiment, the mounting is implemented through a thermally conductive material. Additionally or alternatively, the electronic device

and/or optoelectronic device can include a heat sink that contacts the mounting surface 66.

[0050] FIG. 10 shows an enlarged, cross-sectional view of the base 50 and shelf 56 of the heat sink 24 depicted in FIGS. 6-9. In some embodiments, the shelf 56 can taper along a circumferential perimeter 68 toward a central axis 60 (see FIG. 7) of the heat sink 24 and toward the extended plate 48. Typically, the tapering is at such an angle so that a first surface 70 is defined between the tapered perimeter 68 and a lateral surface 72 of the base 50. The tapered circumferential perimeter 68, the first surface 70, and a second surface 74 of the shelf 56 aid in maintaining the positioning of the heat sink 24 relative to the casing 12 in that the shelf 56 and the surfaces 68, 70, and 74 are encased by the material of the casing 12.

[0051] Referring to FIGS. 4 and 6-9, in some embodiments the heat sink 24 further includes one or more bores or through-holes 76. These bores 76 extend through at least the extended plate 48 and the base 50 depending on the diameter 54 of the base. These bores 76 allow material of the casing 12 to extend through the bores 76 to at least in part further enhance the stability of the heat sink 24 and the electronic and/or optoelectronic device(s) mounted on the mounting surface 66 relative to the casing 12 and/or leads 16, 18, 20, 22.

[0052] The height 78 of the heat sink 24 is generally at least equal to the thickness 80 of the casing 12, and in many embodiments is greater than the thickness 80 of the casing 12. For example, the heat sink 24 can be secured within the casing 12 such that a portion of the base

section 50 extends below the second surface 28 of the casing 12 and a portion of the pedestal section 46 extends above the first surface 26 of the casing 12.

[0053] The dimensions of the heat sink 24 can depend on the one or more anticipated electronic and/or optoelectronic devices that are to be mounted on the mounting surface 66 of the heat sink 24, the dimensions of the casing 12, the expected implementation of the SMD 10, the amount of heat expected to be dissipated by the heat sink 24, the material of the heat sink 24 and/or other such factors. For example, according to some embodiments, the dimensions of the heat sink 24 can include a diameter 52 of the extended plate 48 of approximately 6.6 mm  $\pm$  0.5 mm, a height 78 of approximately 2.6 mm  $\pm$  0.3 mm, a diameter 62 of the pedestal section 46 of approximately 3.05 mm  $\pm$  0.3 mm, a diameter 64 of the pedestal section 46 proximate to the mount surface 66 of about 2.65 mm  $\pm$  0.3 mm, with a height of the pedestal section 46 of about 1.55 mm  $\pm$  0.3 mm, and the diameter of the bores 76 of about 0.8 mm  $\pm$  0.2 mm.

[0054] Additionally, in some embodiments the dimensions of the mounting surface 66 of the heat sink 24 are reduced and/or minimized. In some embodiments, the light emissions and/or reception are enhanced by reducing the exposed surface area of the heat sink 24. Further, the exposed area of the contact surface 38 of the base 50 is increased and/or maximized to provide increased heat dissipation.

[0055] FIG. 11 depicts a lead assembly 82 according to some embodiments that can be incorporated into SMD 10.

FIGs. 12-13 depict alternate views of the lead assembly 82 of FIG. 11, with FIG. 12 showing lead assembly 82 from the top, and FIG. 13 showing lead assembly 82 from the side. Referring to FIGs. 1 and 11-13, the lead assembly 82 includes four leads 16, 18, 20, 22. Each lead extends from a surface mount area 84, 86, 88, 90 at a first end of each lead to a contact or device coupling area or end 92, 94, 96, 98 at a respective opposite end of each lead. In some embodiments, the leads 16, 18, 20, 22 are further constructed of a thermally conductive as well as electrically conductive material. As introduced above, in some embodiments the leads 16, 18, 20, 22 exit the casing 12 on opposite sides 30, 32 and are generally centered on those sides. In some embodiments, the device coupling areas 92, 94, 96, 98 are equally distributed about a central point 100 along axis 102, 104. Further, the device coupling areas 92, 94, 96, 98 are at a height or distance 106 above the surface mount areas 84, 86, 88, 90.

[0056] In some embodiments, the surface mount areas 84, 86, 88, 90 are arranged generally parallel with the contact surface 38 of the heat sink 24, and typically with a surface upon which the SMD 10 is to be mounted and/or secured. The surface mount areas 84, 86, 88, 90 have a first width 106 and length 108 providing an area for an electronic couple with a conductive contact, trace and/or conductive area on the surface to which the SMD 10 is being couple (e.g. a circuit board).

[0057] Extended lead portions 110, 112, 114, 116 extend from the surface mount areas 84, 86, 88, 90 respectively, to provide a conductive path between the surface mount areas 84, 86, 88, 90 and the device coupling areas 92,

94, 96, 98. In some embodiments, the extended lead portions 110, 112, 114, 116 have a width 118 that is less than the width of the surface mount areas 84, 86, 88, 90. Each lead 16, 18, 20, 22 is bent about 90 degrees from being generally parallel with the contact surface 38 of the heat sink 24, extending along the first and second lateral surfaces 30, 32 of the casing 12. At a first height 120, each lead 16, 18, 20, 22 is bent again about 90 degrees to be generally parallel with the surface mount areas 84, 86, 88, 90 and the mounting surface 66 of the heat sink 24.

[0058] The extended lead portions 110, 112, 114, 116 are then angled to align the device coupling areas 92, 94, 96, 98 with perpendicular axes 102, 104. For example, a first and fourth lead 18, 22 extend from the second bend into the casing 12 a first distance 122 and can include a 90 degree horizontal turn that brings the respective extended lead portions 110, 116 into alignment with the first axis 102, and again includes a 90 degree horizontal turn. The extended leads 110, 116 continue to extend toward the center 100 at a reduced third width 124 that straddles the first axis 102. The extended lead portions 110, 116 of the first and fourth leads 18, 22 include a further 90 degree bend, and extend generally perpendicular to the contact surface 38 of the heat sink 24 a second height 126. At second height 126, a subsequent 90 degree bend defines the device coupling areas 92, 96 that extend generally parallel with the contact surface 38 of the heat sink 24 and are approximately equidistant from the center 100.

[0059] The second and third leads 16, 20 include similar turns and bends to position the second and third device



coupling areas 94, 98 in alignment with the second axis 104. For example, the second and third leads 16, 20 can extend into the casing 12 the first distance 122 and can then include a first horizontal turn that angles away from the first axis 102 at an angle of about 45 degrees. The extended lead portions 112, 114 include a second horizontal turn that is about 45 degrees such that the extended lead portions 112, 114 continued to extend generally parallel with the first axis 102 a second distance 128. The second and third extended lead portions 112, 114 further include perpendicular extensions that extend generally perpendicular from the extended lead portions 112, 114 along the second length approximately centered with the second length and straddling the second axis 104 with a width 130. The perpendicular extensions of the second and third leads 16, 20 include a further 90 degree bend and extend generally perpendicular to the contact surface 38 of the heat sink 24 to the second height 126, where a subsequent 90 degree bend defines the device coupling areas 94, 98 that extend generally parallel with the contact surface 38 of the heat sink 24 and are aligned with the second axis 104. They are also approximately equidistant from the center 100.

[0060] The lead assembly 82 and the heat sink 24 are positioned such that the contact surface 38 is positioned between the device coupling areas 92, 94, 96, 98. The casing 12 is positioned about the lead assembly 82 and heat sink 24 securing the positioning of the leads 16, 18, 20, 22 relative to the heat sink 24. In some embodiments, the casing 12 is formed using injection molding about the lead assembly 82 and heat sink 24. The

heat sink 24 extends beyond the second surface 28 of the casing to be exposed at the contact surface 38. One or more electronic and/or optoelectronic devices are mounted and/or secured with the heat sink 24 such that the heat sink 24 can dissipate heat from the electronic and/or optoelectronic device(s). An LED may then be electrically coupled with two or more of the device coupling areas using a coupling method such as jump wires, although any other suitable coupling method may be used.

[0061] The lens 14 is formed about the device coupling areas and the mounted electronic and/or optoelectronic device(s). The lens 14 may be formed from any relevant transparent and/or partially transparent, including but not limited to glass, silicon, plastic, and/or other suitable materials. In some embodiments, the lens 14 is injection molded directly onto the casing 12 about the electronic and/or optoelectronic device(s). A mold is positioned in contact with the first surface 26 of the casing 12, and is typically at least partially sealed with the casing 12. A liquid silicon or other suitable lens material is injected through a wall of the mold into the mold such that the lens can be formed using a single material through a single injection process.

[0062] Additionally or alternatively, in other embodiments the mold is positioned in contact with the first surface 26 of the casing 12. A liquid silicon or other suitable material is injected through one or both of the bores 76 of the heat sink 24. As described above, the bores 76 may extend through the base 50 of the extended plate 48. Further, in some embodiments the casing 12 may include corresponding bores that at least partially align with the bores 76 of the heat sink 24.

This provides a passage between the base 50 and the area about the mounting surface 66 of the heat sink 24. With the lens mold positioned in contact with the first surface 26, the liquid silicon and/or other suitable material can be injected into the mold and about the electronic and/or optoelectronic device(s) mounted on the mounting surface 66 of the heat sink 24.

[0063] FIG. 14 depicts a simplified top view of the SMD 10 depicted in FIG. 1, but without the lens 14. Referring to FIGs. 1, 6-7, and 14, the heat sink 24 is positioned within the casing 12 such that the mounting surface 66 is proximate to the device coupling areas 92, 94, 96, 98 (see FIG. 11) of the leads 16, 18, 20, 22. In some embodiments, the casing 12 is formed with recesses 132, 134, 136, 138 that at least partially expose the device coupling areas 92, 94, 96, 98. The casing 12 can further include bores 140 that correspond and/or at least partially align with the bores 76 of the heat sink 24.

[0064] In some embodiments, the liquid silicon and/or other suitable material is injected through one bore 76 when forming the lens 14. This allows air and/or other gases to escape through the second bore 76. By providing a gas exit the lens 14 can be formed with fewer bubbles within the lens or without any bubbles.

[0065] Additionally or alternatively, in some embodiments the lens 14 includes a lens cover (not shown) that forms the outer surface of the lens 14. This lens cover is secured with the casing 12, sealing the area within the lens cover. Silicon and/or other suitable materials can further be injected into the area within the volume of the lens cover to fill the area. In some instances, one

bore 76 is used to inject the silicon and/or other suitable material while the other bore 76 can be used to allow gas to escape the volume within the lens cover and about the electronic and/or optoelectronic device(s). The lens cover can be made from glass, plastic, silicon and/or other suitable transparent and/or substantially transparent materials.

[0066] FIG. 15 depicts a heat sink 142 according to some embodiments. FIGs. 16-18 depict alternate views of the heat sink 142 of FIG. 15, with FIG. 16 showing a partially transparent heat sink 142 from the side, FIG. 17 showing heat sink 142 from the top, and FIG. 18 showing heat sink 142 from the bottom. The heat sink 142 in some embodiments is similar to the heat sink 24 of FIGs. 6-9. However, the heat sink 142 of FIGs. 15-18 additionally or alternatively includes a recessed mounting surface 144 in the pedestal 146. One or more electronic and/or optoelectronic devices are mounted within the recess on the recessed mounting surface 144. Similar with the heat sink 24 of FIGs. 6-9, in some embodiments the area of the heat sink 142 that is exposed above the casing and within the lens is reduced and/or minimized.

[0067] The heat sink 142 further includes bores 148 that extend through at least the extended plate 150, and in some embodiments extend through the base 152 as well. In some embodiments, the base 152 can also include a laterally and circumferentially extending projection, ledge, shelf, or ring 154. This shelf 154 extends a distance 156 laterally from the base 152 that is typically less than the distance the extended plate 150 extends from the base 152 of the pedestal 146. However,

it is noted that the shelf 154 can extend as far as or beyond the extended plate 150 without departing from the novelty of these embodiments.

[0068] FIGs. 19 and 20 depict the dimensions of an SMD 160 according to some embodiments. As discussed above, the dimensions of an SMD can depend on many factors, including the number and/or size of the electronic and/or optoelectronic device(s), the amount of heat to be dissipated, the device and/or circuit board onto which the SMD is to be mounted, and/or other relevant factors. For example, in some embodiments, the casing 158 can be generally square-shaped with sides 162 of approximately 7.50 mm +/- 0.5 mm. The height 164 of the SMD 160 can be approximately 5.6 mm +/- 0.5 mm from the surface areas of the leads 166 to the peak of the lens 168. The width 170, including the leads and the surface mount areas of the leads, can be approximately 12.0 mm +/- 0.5 mm.

[0069] FIG. 21 depicts the dimensions of a heat sink 172 according to some embodiments. FIG. 24 depicts the dimensions of a heat sink 174 with a cup 176 according to some embodiments. FIGs. 22-23 depict the top and bottom dimensions of heat sinks 172, 174. The dimensions of a heat sink can similarly depend on a number of relevant factors, including: the one or more anticipated electronic and/or optoelectronic devices to be mounted on the mounting surface of the heat sink, the dimensions of the casing, the expected implementation of the SMD, the amount of heat expected to be dissipated by the heat sink, the material of the heat sink, and/or other relevant factors.

[0070] For example, in some embodiments and as shown in FIGS. 21-24, the dimensions of the heat sink 172 or 174 can be as follows: the width or diameter 178 of the extended plate 180 can be approximately 6.6 mm  $\pm$  0.5 mm, the height 182 can be about 2.6 mm  $\pm$  0.3 mm, the diameter of the pedestal section 184 proximate to the base 188 of the pedestal 186 can be about 3.05 mm  $\pm$  0.3 mm, the diameter of the pedestal section 190 extending above the recessed mount surface can be about 2.65  $\pm$  0.3 mm, the width or diameter of the recessed mounting surface 192 (shown in FIG. 24) can be about 2.1 mm  $\pm$  0.3 mm, the height of the pedestal section 194 can be approximately 1.55 mm  $\pm$  0.3 mm with a depth of the recess 196 (shown in FIG. 24) being about 0.30 mm  $\pm$  0.1 mm, and the width or diameter of the bores 198 can be about 0.8 mm  $\pm$  0.2 mm.

[0071] FIGS. 25-26 depict the dimensions of a lead assembly 200 according to some embodiments. The dimensions of a lead assembly can vary depending on implementation, the configuration of the contact areas and/or coupling areas, and/or other relevant factors. For example, in some embodiments of a lead assembly and as shown in FIGS. 25-26, the dimensions are as follows: the surface mount areas 202 of the leads 204 can have a first width 206 of about 1.3 mm  $\pm$  0.15 mm, a length 208 of about 1.0 mm  $\pm$  0.15 mm, the surface mount areas 202 can be separated by a distance 210 of about 0.9 mm  $\pm$  0.15 mm, the width 212 of the device coupling areas 214 can be about 0.6 mm  $\pm$  0.15 mm, the first height 216 can be about 1.7 mm  $\pm$  0.15 mm, the second height 218 can be about 0.8 mm  $\pm$  0.15 mm, and the leads 204 can have a thickness 220 of approximately 0.2 mm  $\pm$  0.05 mm.

[0072] Although the present invention has been described in considerable detail with reference to certain preferred configurations thereof, other versions are possible. The SMD, heat sink, and/or lead assembly can be used in many different devices. The SMD, heat sink, and lead assembly can also have many different shapes and can be interconnected with one another in many different ways. Accordingly, the spirit and scope of the invention should not be limited to the preferred versions of the invention described above.

## CLAIMS

## WE CLAIM:

1. A surface mount device comprising:
  - a casing comprising a first surface, a second surface opposite said first surface, and at least one lateral side surface;
  - a recess formed in said first surface and extending at least partially into said casing;
  - a plurality of leads at least partially encased by said casing; and
  - one or more electronic and/or optoelectronic devices coupled with at least one of the plurality of leads and at least partially exposed through the recess.
2. The surface mount device of claim 1, further comprising a lens positioned relative to and protruding from said first surface.
3. The surface mount device of claim 1, wherein at least one of said plurality of leads extends through at least one of said lateral sides surfaces, and at least one of another of said plurality of leads extends through at least one of another of said lateral side surfaces.
4. The surface mount device of claim 1, wherein at least a portion of each of said leads is exposed outside of said casing and/or within said recess.
5. The surface mount device of claim 1, further comprising a heat sink secured in said recess.



6. The surface mount device of claim 5, wherein said heat sink is positioned proximate to at least a portion of at least one of said plurality of leads.

7. The surface mount device of claim 5, wherein said heat sink is comprised of a thermally conductive material.

8. The surface mount device of claim 5, wherein said heat sink is generally cylindrically shaped.

9. The surface mount device of claim 5, wherein said heat sink comprises a pedestal portion comprising an extended plate and a base.

10. The surface mount device of claim 9, wherein the diameter of said extended plate is greater than the diameter of said base.

11. The surface mount device of claim 9, wherein said base comprises a laterally and circumferentially extending shelf.

12. The surface mount device of claim 9, wherein the diameter at the base of said pedestal portion is greater than the diameter at the top of said pedestal portion.

13. The surface mount device of claim 5, wherein said heat sink comprises a mounting surface coupled with at least one electronic and/or optoelectronic device.

14. The surface mount device of claim 5, wherein said heat sink comprises at least one through-hole.

15. A surface mount device comprising:

- a casing comprising a first surface and a recess formed in said first surface and extending at least partially into said casing;

- a plurality of leads at least partially encased by said casing and extending from the recess through the casing and exiting the casing;

- at least one electronic device coupled with at least one of the plurality of leads and at least partially exposed through the recess; and

- a heat sink proximate said plurality of leads and secured in said recess.

16. The surface mount device of claim 15, further comprising a lens positioned relative to and protruding from said first surface.

17. The surface mount device of claim 15, wherein said heat sink comprises:

- a pedestal portion with an extended plate and a base;

- a mounting surface coupled with at least one electronic device; and

- at least one through-hole.

18. The surface mount device of claim 17, wherein said heat sink is comprised of a thermally conductive material.

19. The surface mount device of claim 17, wherein said heat sink is coupled with at least one of said plurality of leads.

20. A surface mount device comprising:

- a casing comprising a first surface and a second surface opposite said first surface;

- a recess formed in said first surface and extending at least partially into said casing;

- a lens positioned relative to and protruding from said first surface;

- a plurality of leads at least partially encased by said casing and extending from the recess through the casing and exiting the casing; and

- a heat sink secured in said recess of said casing.

21. The surface mount device of claim 20, wherein one or more electronic and/or optoelectronic devices are coupled with at least one of said plurality of leads and are at least partially exposed through the recess.

22. A method for use in manufacturing a surface mount device, the method comprising:

- positioning a plurality of leads;

- positioning a heat sink proximate to at least a portion of said plurality of leads;

- securing said plurality of leads and heat sink with a casing such that the heat sink is maintained at a predefined position relative to said leads; and

- mounting an electronic device on said heat sink such that at least a portion of said electronic device is exposed through a recess in said casing.

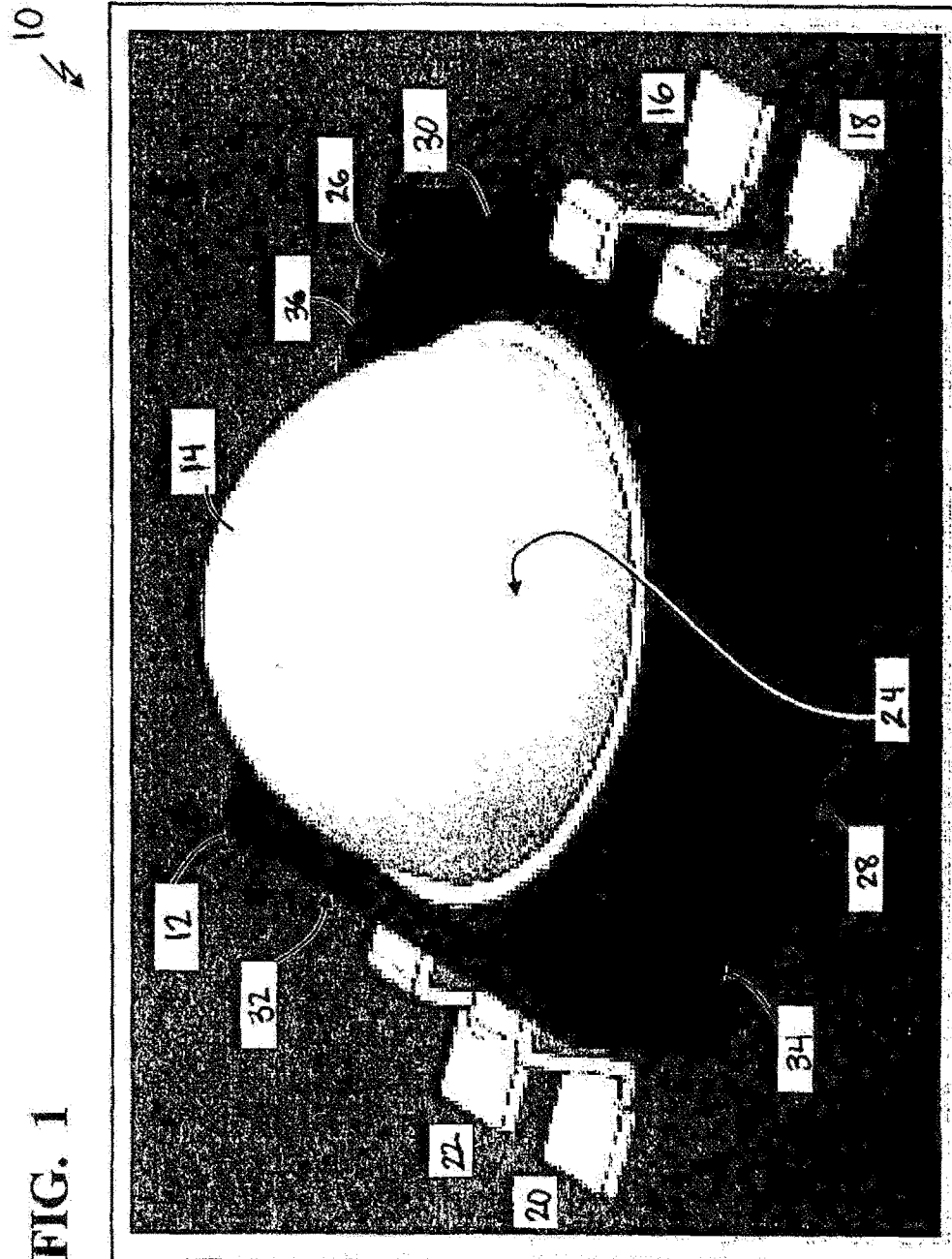
23. The method of claim 22, wherein securing said plurality of leads and heat sink with the casing comprises:

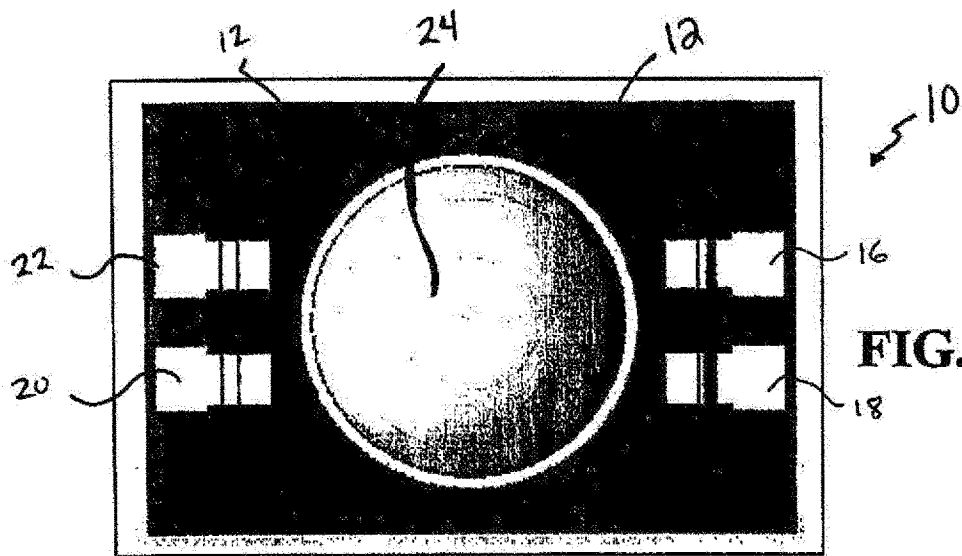
securing the plurality of leads with the casing such that at least a portion of at least one of the plurality of leads is exposed through said recess and at least a portion of at least one of the plurality of leads is exposed outside said casing; and

securing the heat sink with the casing such that at least a portion of a contact surface and at least a portion of a mounting surface of the heat sink are exposed through said casing.

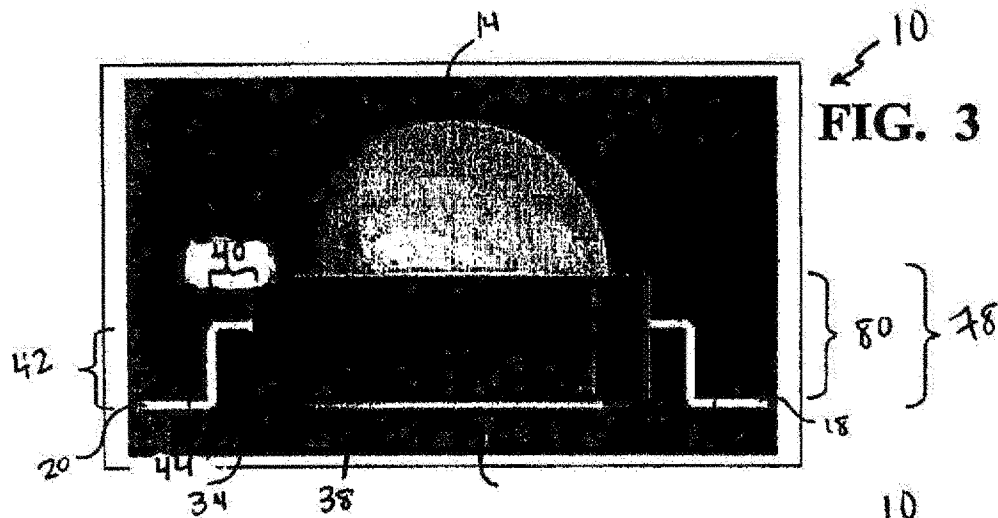
24. The method of claim 22, wherein a lens is formed about said recess effectively covering said exposed portion of the mounted device.

25. The method of claim 24, wherein said lens and casing are formed using injection molding.

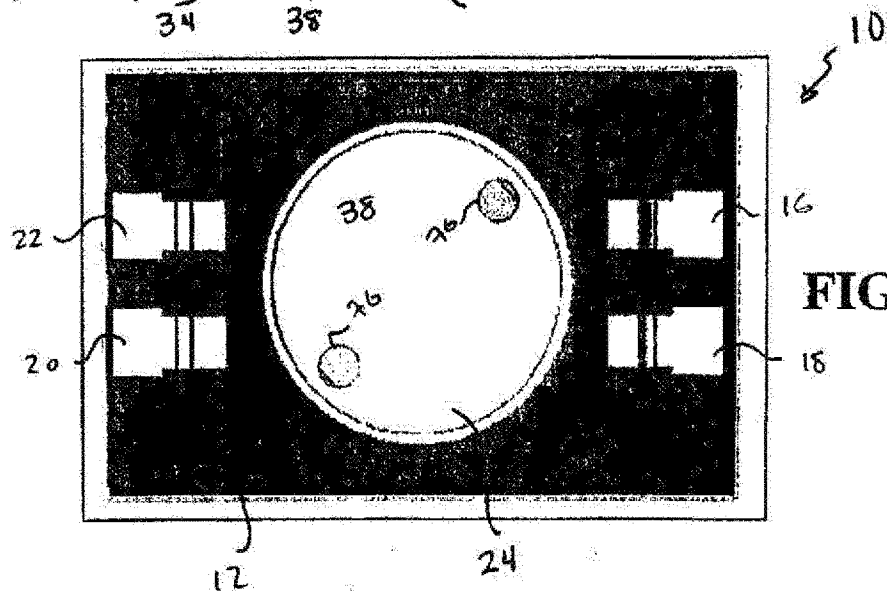




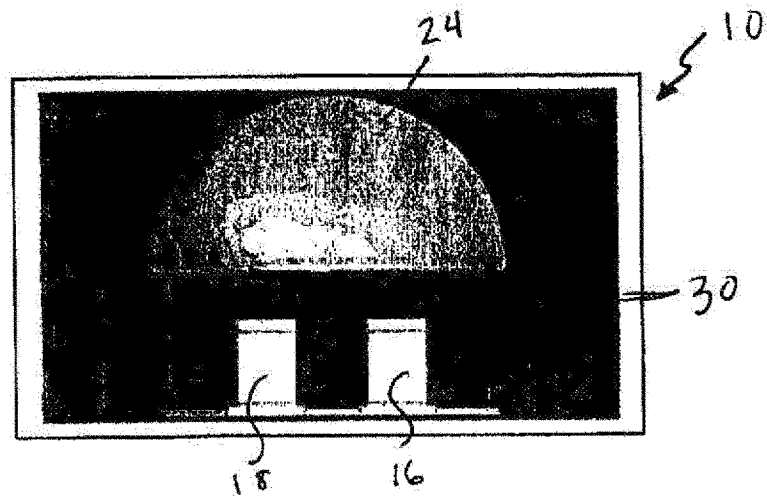
**FIG. 2**



**FIG. 3**



**FIG. 4**



**FIG. 5**

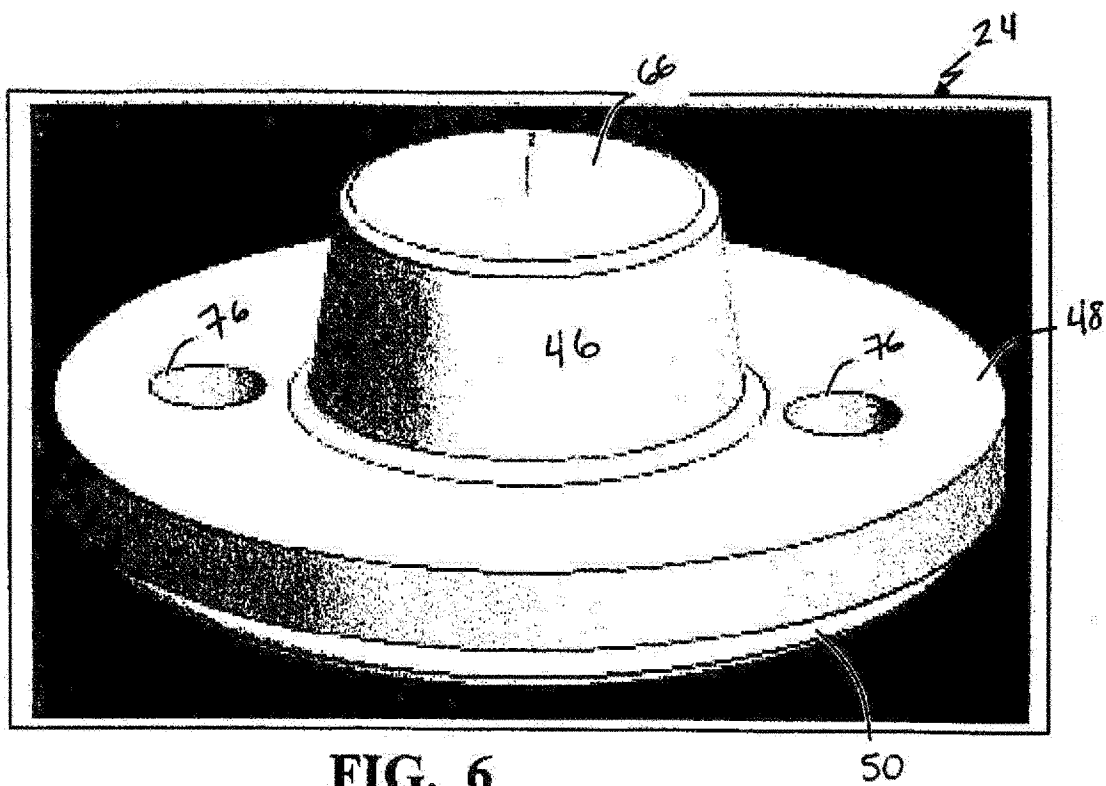


FIG. 6

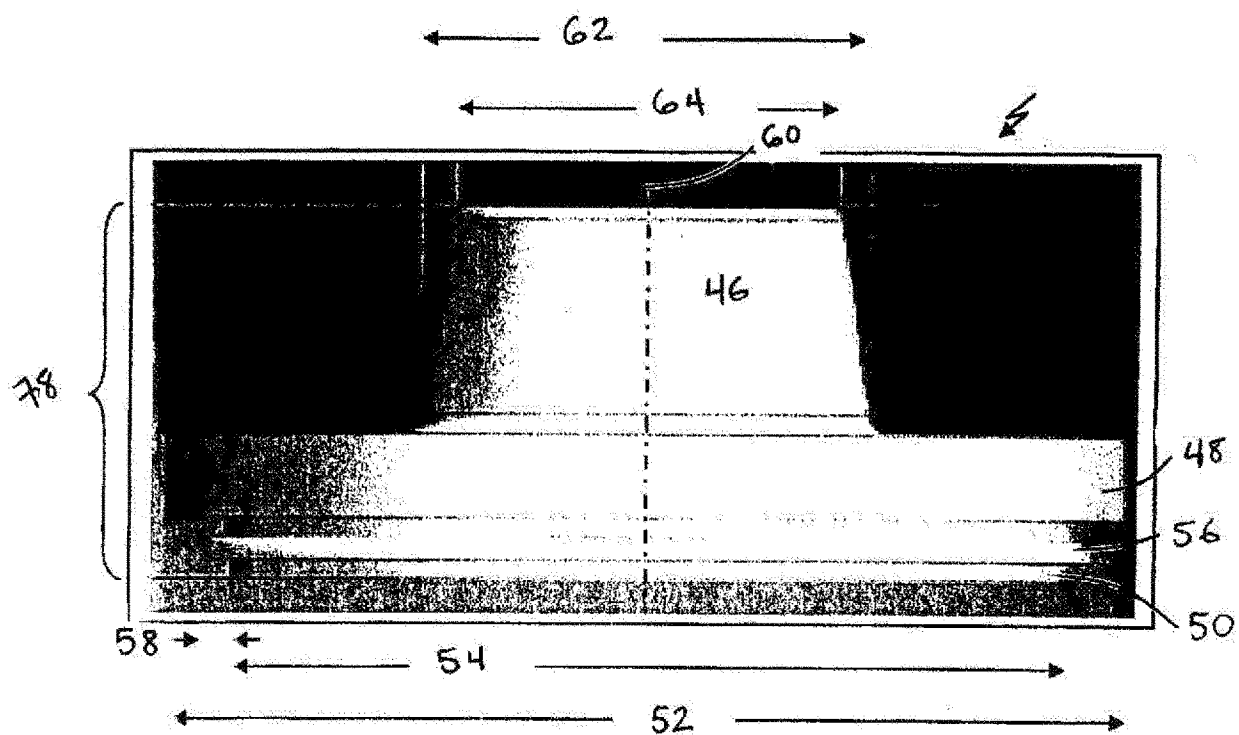
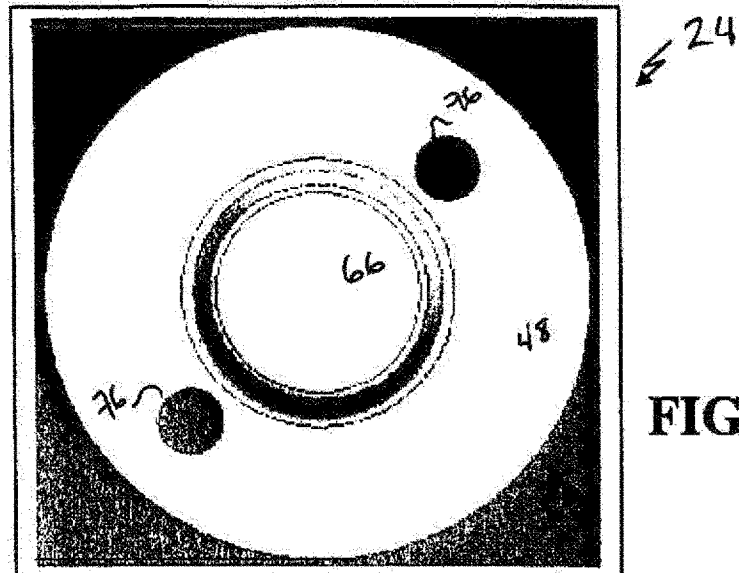
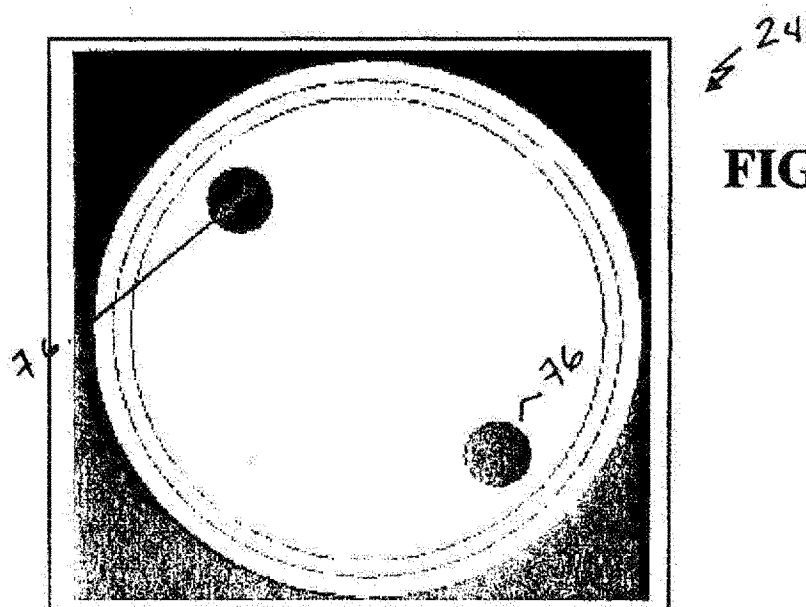


FIG. 7





**FIG. 8**



**FIG. 9**

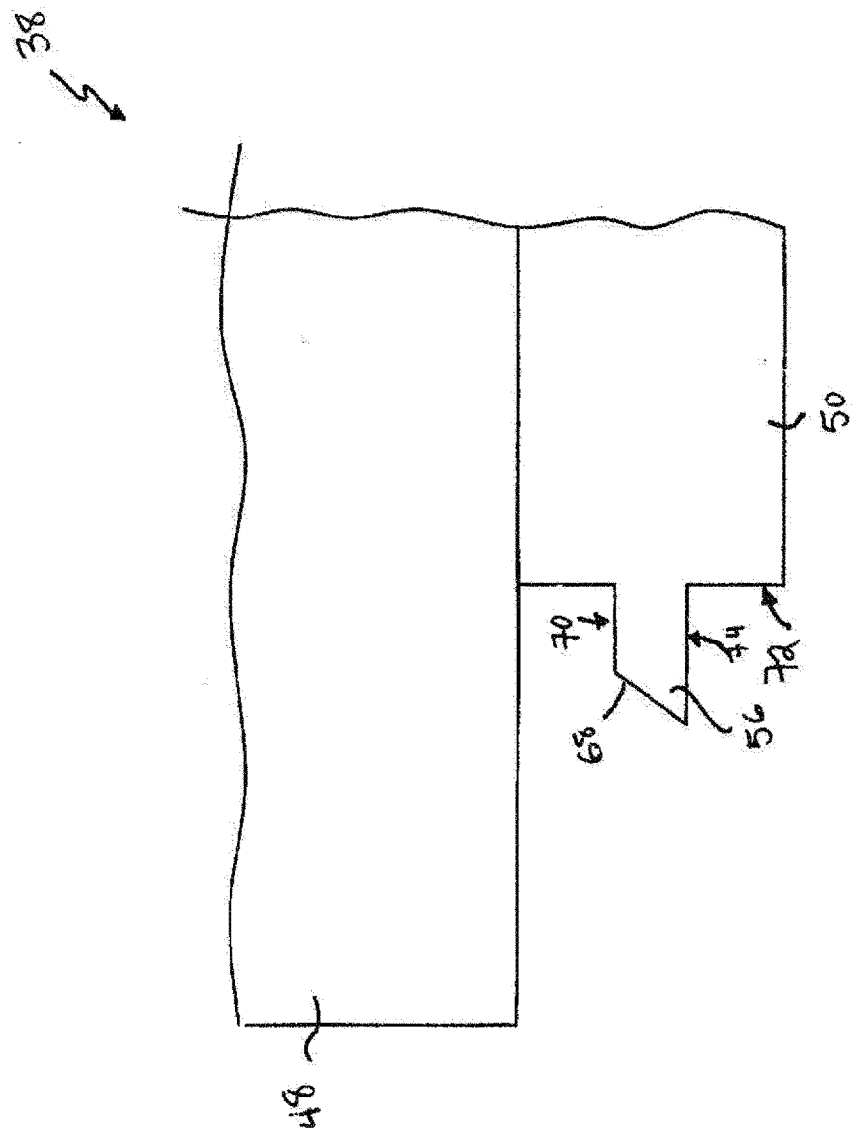
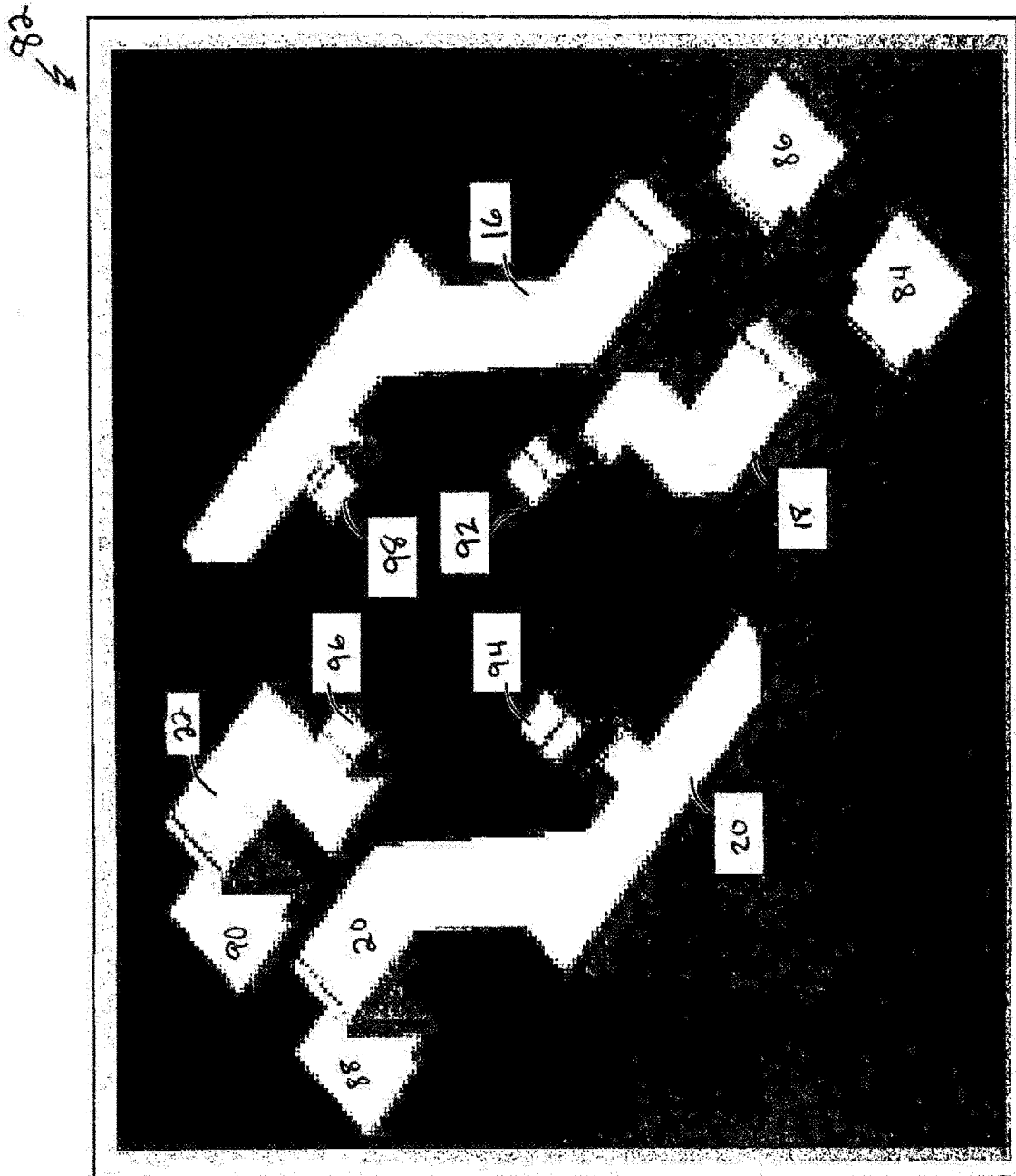


FIG. 10



**FIG. 11**

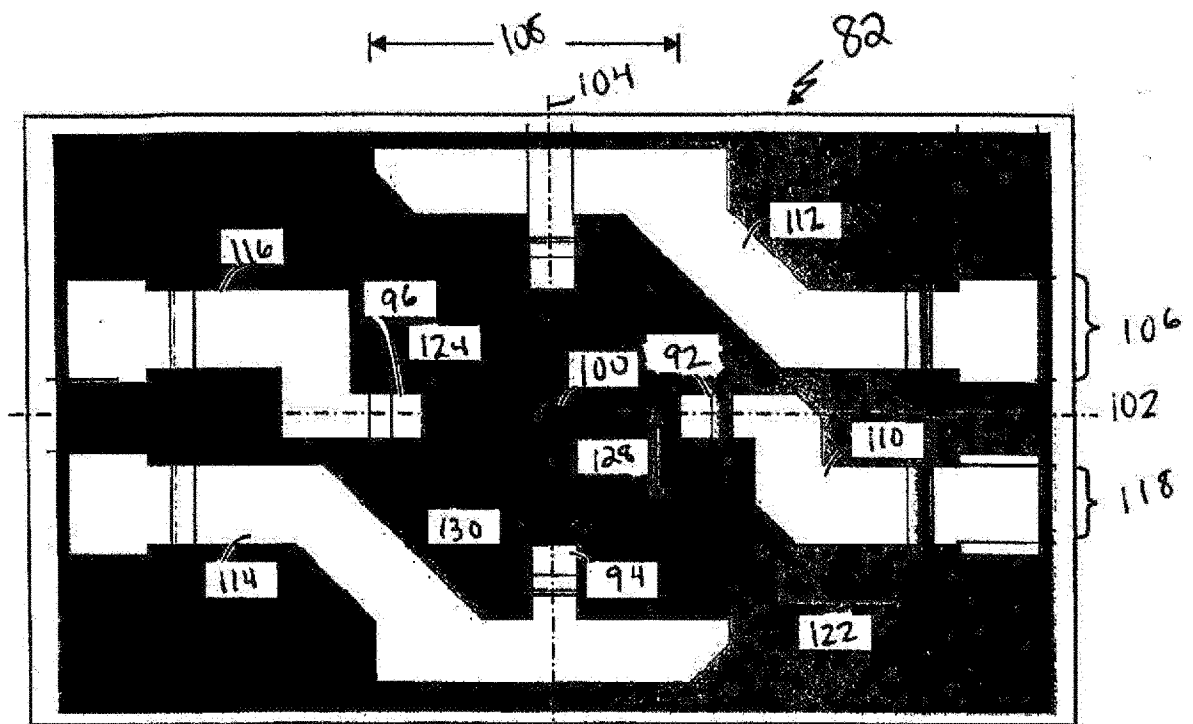


FIG. 12

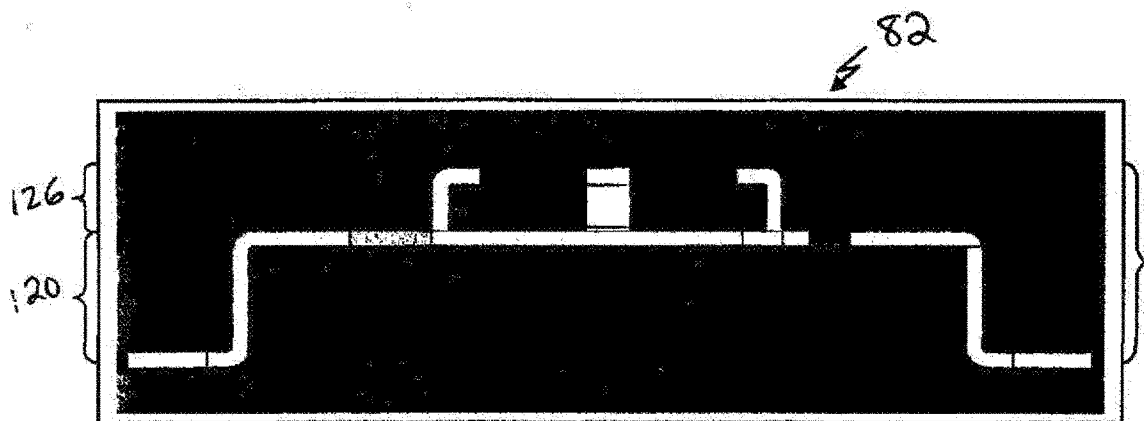
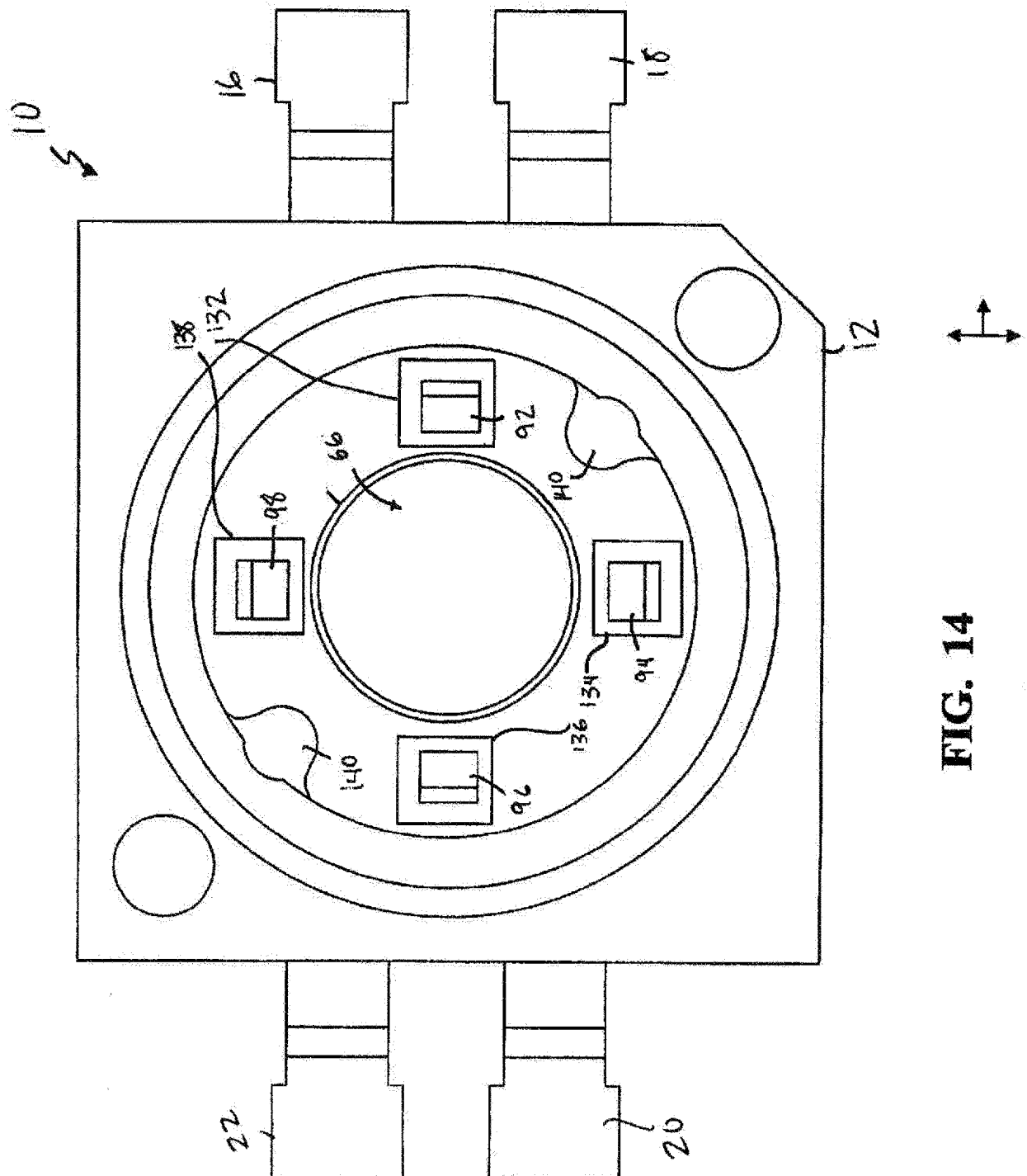


FIG. 13



**FIG. 14**

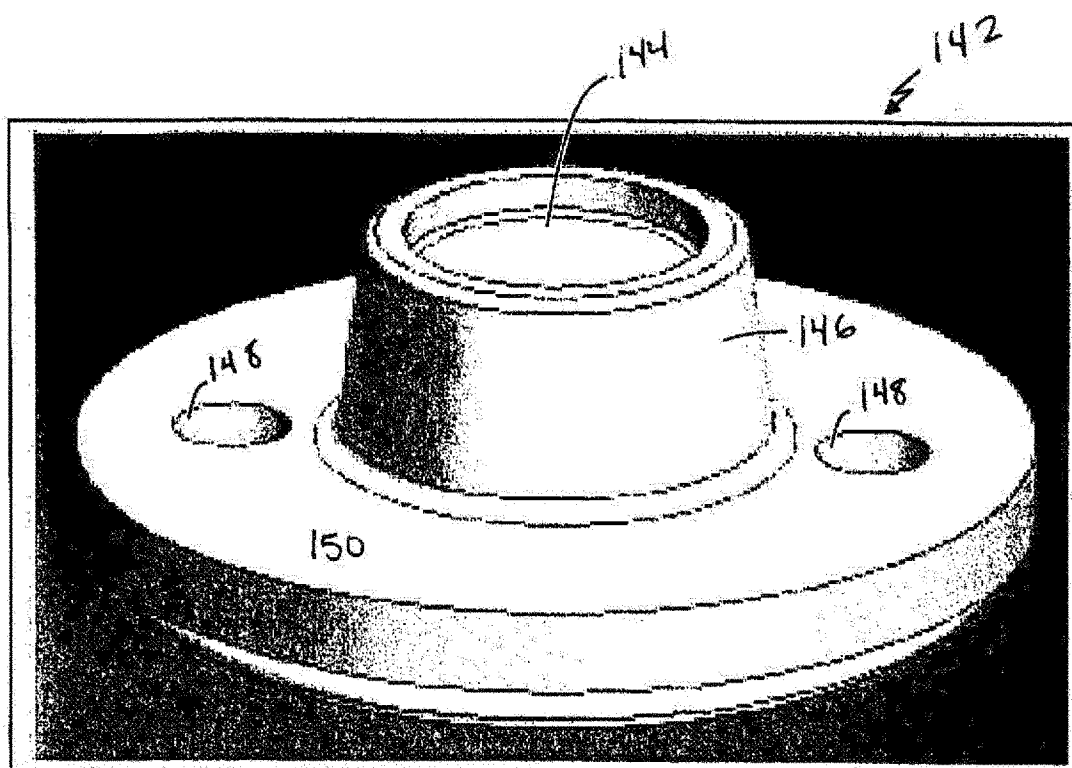


FIG. 15

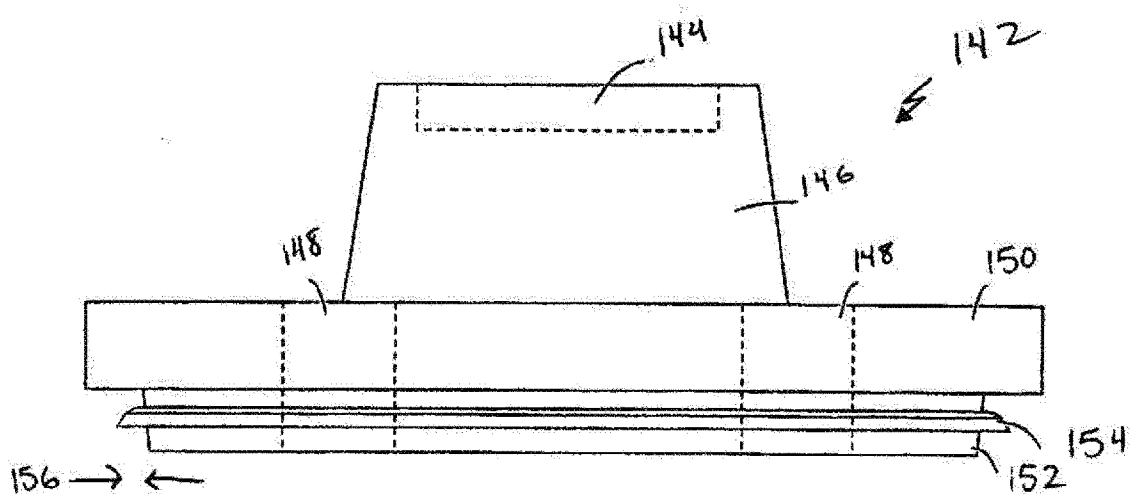
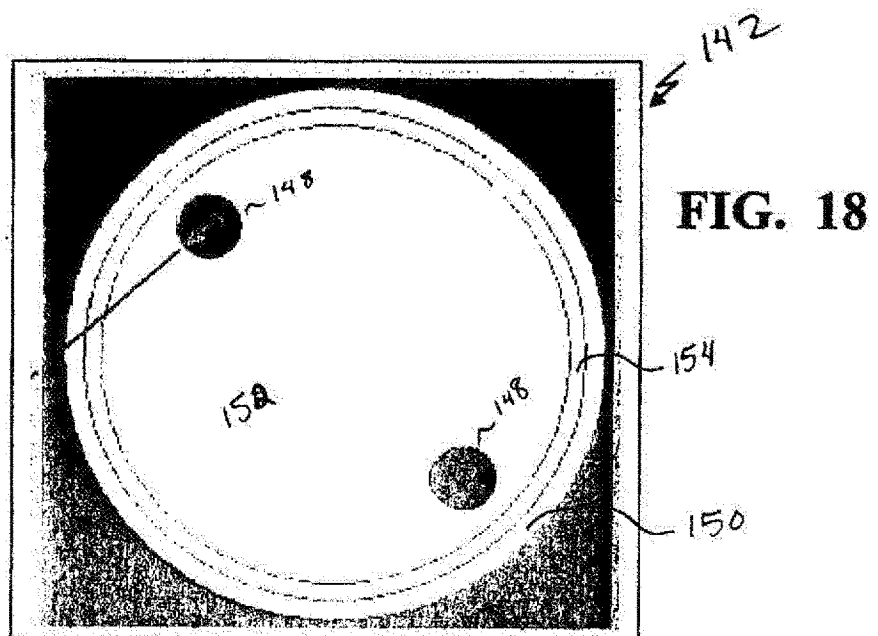
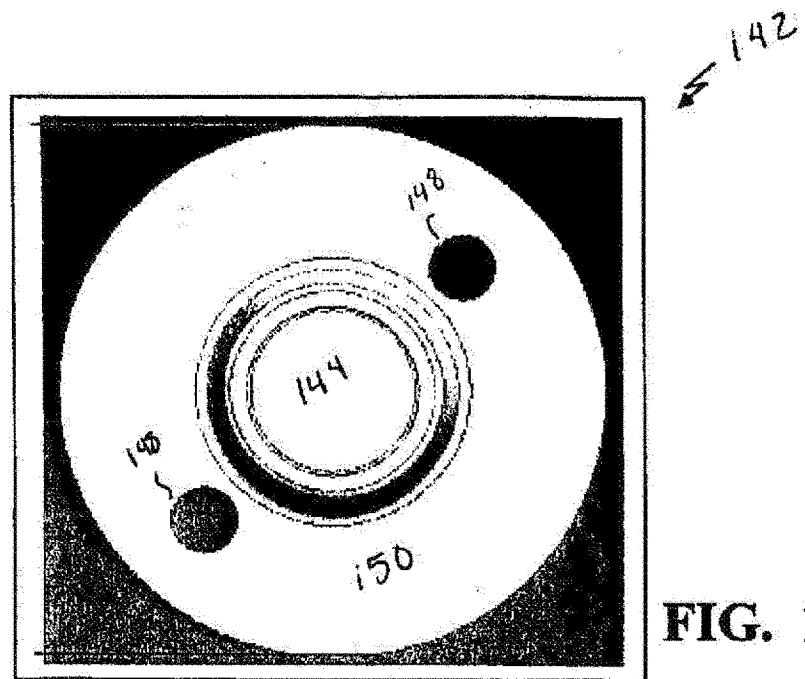


FIG. 16



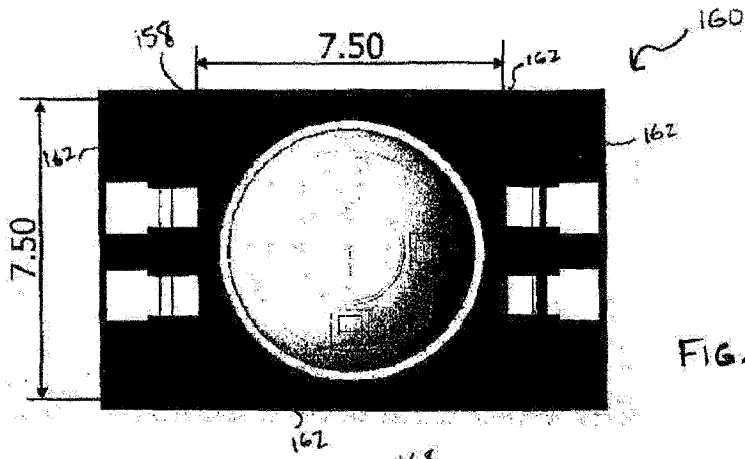


FIG. 19

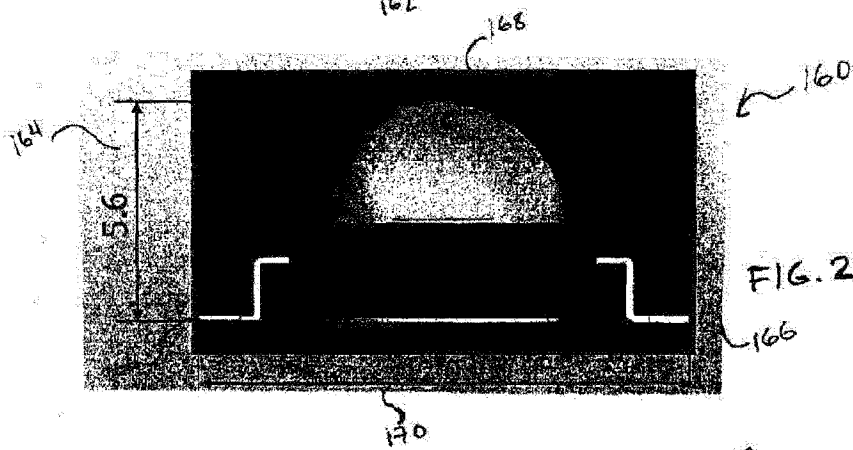


FIG. 20

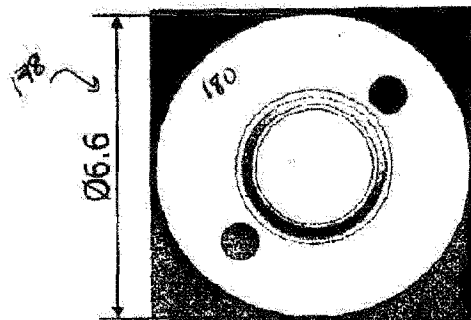


FIG. 22

~192

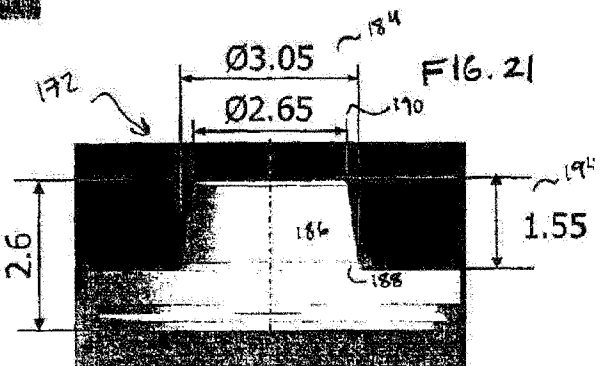


FIG. 21

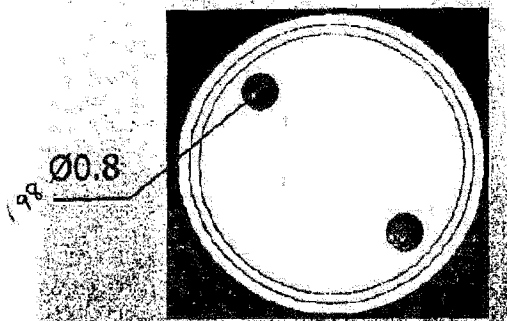


FIG. 23

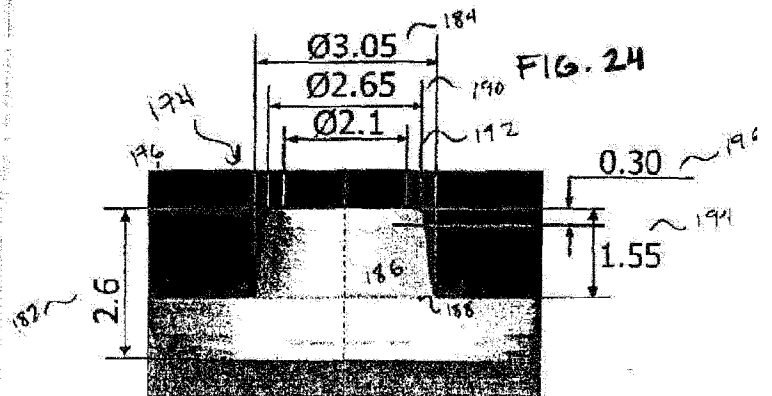


FIG. 24



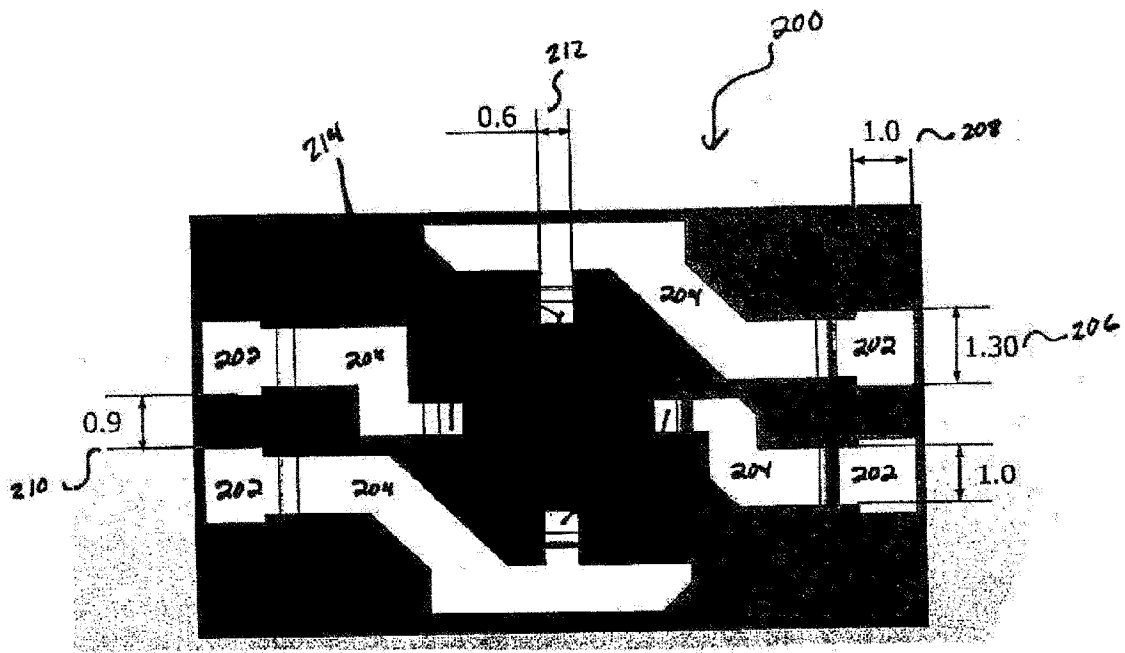


FIG. 25

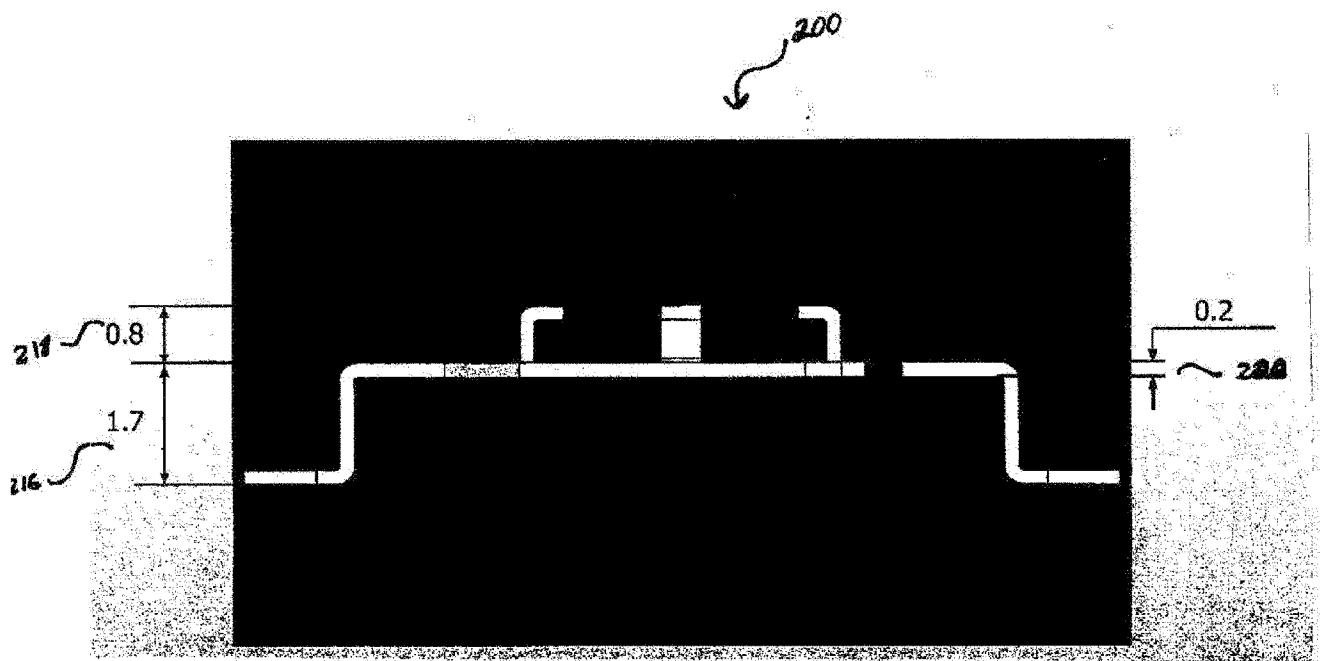


FIG. 26

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2008/070298

## A. CLASSIFICATION OF SUBJECT MATTER

H01L23/04(2006.01)i

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

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:H01L23/-,H01L21/-,H01L25/-,H01L33/-

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

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

CPRS,WPI,EPODOC,PAJ:surface w mount+,recess+,lead,sink,radial+,heat+,len?,dome,casing,encapsulat+

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US7119422B2(UNITY OPTO TECHNOLOGY CO., LTD)10 Oct.2006(10.10.2006),specification: column 2,line 47-column 3,line 45,Figs.2-9	1-25
X	CN1591924A(CITIZEN ELECTRONICS)09 Mar.2005(09.03.2005),specification:page 5,line 3-page 10,line 25,Figs.1-8	1-4
X	CN1679168A(CREE INC)05 Oct.2005(05.10.2005),specification:page 4,line 21-page 10,line 17,Figs.1A-6D	1-4
A	CN1581527A(CITIZEN ELECTRONICS)16 Feb.2005(16.02.2005),the whole document	1-25

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

\* Special categories of cited documents:

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“E” earlier application or patent but published on or after the international filing date

“L” document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&”document member of the same patent family

Date of the actual completion of the international search

10 May 2008(10.05.2008)

Date of mailing of the international search report

**26 Jun. 2008 (26.06.2008)**

Name and mailing address of the ISA/CN

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100088

Facsimile No. 86-10-62019451

Authorized officer

**ZHI Yue**

Telephone No. (86-10)62411788

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.

PCT/CN2008/070298

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