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(54) Title: REMOVABLE LED LIGHT ASSEMBLY FOR USE IN A LIGHT FIXTURE ASSEMBLY

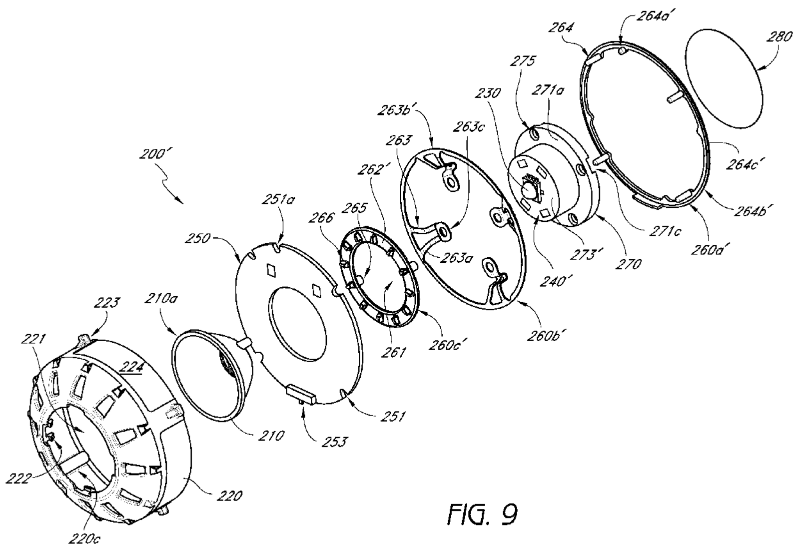

FIG. 9

(57) Abstract: A removable LED light assembly for use in a light fixture assembly includes an LED lighting element and one or more resilient members to maintain a compression force between the LED light assembly and a housing to provide effective heat transfer from the LED to the housing. The LED light assembly includes a plurality of electrical contact members to facilitate installation of the LED light assembly in the housing irrespective of the orientation of the LED light assembly relative to the housing.

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REMOVABLE LED LIGHT ASSEMBLY FOR USE IN A LIGHT FIXTURE ASSEMBLY

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention is directed to an LED light assembly that can be removably connected thermally and/or electrically to a light fixture assembly housing.

Description of the Related Art

[0002] Light fixture assemblies such as lamps, ceiling lights, and track lights are important fixtures in many homes and places of business. Such assemblies are used not only to illuminate an area, but often also to serve as a part of the decor of the area. However, it is often difficult to combine both form and function into a light fixture assembly without compromising one or the other.

[0003] Traditional light fixture assemblies typically use incandescent bulbs. Incandescent bulbs, while inexpensive, are not energy efficient, and have a poor luminous efficiency. To address the shortcomings of incandescent bulbs, a move is being made to use more energy-efficient and longer lasting sources of illumination, such as fluorescent bulbs, high-intensity discharge (HID) bulbs, and light emitting diodes (LEDs). Fluorescent bulbs and HID bulbs require a ballast to regulate the flow of power through the bulb, and thus can be difficult to incorporate into a standard light fixture assembly. Accordingly, LEDs, formerly reserved for special applications, are increasingly being considered as a light source for more conventional light fixtures assemblies.

[0004] LEDs offer a number of advantages over incandescent, fluorescent, and HID bulbs. For example, LEDs produce more light per watt than incandescent bulbs, LEDs do not change their color of illumination when dimmed, and LEDs can be constructed inside solid cases to provide increased protection and durability. LEDs also have an extremely long life span when conservatively run, sometimes over 100,000 hours, which is twice as long as the best fluorescent and HID bulbs and twenty times longer than the best incandescent bulbs. Moreover, LEDs generally fail by a gradual dimming over time, rather than abruptly burning out, as do incandescent, fluorescent, and HID bulbs. LEDs are also desirable over fluorescent bulbs due to their decreased size and lack of need of a ballast, and can be mass produced to be very small and easily mounted onto printed circuit boards.

[0005] While LEDs have various advantages over incandescent, fluorescent, and HID bulbs, the widespread adoption of LEDs has been hindered by the challenge of how to properly manage and disperse the heat that LEDs emit. The performance of an LED often depends on the ambient temperature of the operating environment, such that operating an LED in an environment having a moderately high ambient temperature can result in overheating the LED, and premature failure of the LED. Moreover, operation of an LED for extended period of time at an intensity sufficient to fully illuminate an area may also cause an LED to overheat and prematurely fail.

[0006] Accordingly, high-output LEDs require direct thermal coupling to a heat sink device in order to achieve the advertised life expectancies from LED manufacturers. This often results in the creation of a light fixture assembly that is not upgradeable or replaceable within a given light fixture. For example, LEDs are traditionally permanently coupled to a heat-dissipating fixture housing, requiring the end-user to discard the entire assembly after the end of the LED's lifespan.

[0007] Accordingly, there is a need for an improved LED light assembly that is replaceable and easily removable from engagement with the light fixture assembly.

SUMMARY OF THE INVENTION

[0008] In accordance with one embodiment, an LED light assembly removably coupleable to a light fixture assembly is provided. The LED light assembly comprises an LED lighting element and a thermal interface member coupled to the LED lighting element and configured to resiliently contact the light fixture assembly when the LED light assembly is coupled to the light fixture assembly. The thermal interface member is configured to thermally couple the LED lighting element and the light fixture assembly. The LED light assembly further comprises one or more resilient members operatively coupled to the thermal interface member, the resilient members configured to generate a compression force when the LED light assembly is installed in the light fixture assembly to maintain a compressive contact force between the thermal interface member and the thermally conductive housing. The LED light assembly also comprises a plurality of electrical contact members electrically connected to the LED lighting element, at least one of the electrical contact members configured to releasably contact an electrical contact on the light fixture assembly when the LED light assembly is coupled to the light fixture assembly irrespective of the orientation of the LED light assembly during installation.

[0009] In accordance with another embodiment, an LED light assembly removably coupleable to a light fixture assembly is provided. The LED light assembly comprises an LED lighting element and a thermal interface member coupled to the LED lighting element and configured to resiliently contact a thermally conductive housing of the light fixture assembly when the LED light assembly is coupled to the housing. The thermal interface member is configured to thermally couple the LED lighting element and the thermally conductive housing. The LED light assembly also comprises a plurality of resilient members operatively coupled to the thermal interface member, the resilient members movable to a compressed state when the LED light assembly is coupled to the housing to generate a compression force between the thermal interface member and the thermally conductive housing to establish a thermal connection between the LED light assembly and the housing. The LED light assembly further comprises a plurality of electrical contact members electrically connected to the LED lighting element, at least one of the electrical contact members configured to releasably contact an electrical contact on the light fixture assembly when the LED light assembly is coupled to the housing irrespective of the orientation of the LED light assembly during installation.

[0010] In accordance with still another embodiment, a light fixture assembly is provided, comprising a thermally-conductive housing and an LED assembly removably coupleable to the thermally-conductive housing. The LED assembly comprises an LED lighting element and a thermal interface member coupled to the LED lighting element and configured to resiliently contact the thermally conductive housing when the LED light assembly is installed in the light fixture assembly to establish a thermal contact between the LED lighting element and the thermally conductive housing. The LED assembly also comprises one or more resilient members operatively coupled to the thermal interface member, the resilient members movable between an uncompressed state and a compressed state when the LED light assembly is coupled to the thermally-conductive housing to generate a compression force between the thermal interface member and the thermally conductive housing. The LED assembly further comprises a plurality of electrical contact members electrically connected to the LED lighting element and configured to releasably contact an electrical contact on the housing when the LED light assembly is coupled thereto to establish an electrical connection between the LED lighting element and the housing irrespective of the orientation of the LED light assembly during installation.

[0011] In some embodiments, the LED light assembly can have multiple sets of electrical contact members (e.g., four sets), which may be shaped as strips or pads. In certain embodiments, the electrical contact member can be gold plated or comprise other materials with high electrical conductivity.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] These and other features, aspects and advantages of the present inventions will now be described in connection with preferred embodiments, in reference to the accompanying drawings. The illustrated embodiments, however, are merely examples and are not intended to limit the inventions. The drawings include the following 13 figures

[0013] FIGURE 1 is a schematic perspective top view of one embodiment of an LED light assembly.

[0014] FIGURE 2 is a schematic perspective top view of the LED light assembly of FIG. 1.

[0015] FIGURE 3 is a schematic top view of the LED light assembly of FIG. 1

[0016] FIGURE 4 is a schematic bottom view of the LED light assembly of FIG. 1.

[0017] FIGURE 5 is a schematic exploded perspective view of the LED light assembly of FIG. 1.

[0018] FIGURE 6 is a schematic exploded view of one embodiment of an LED light fixture that can incorporate the LED light assembly of FIG. 1.

[0019] FIGURE 7 is a schematic perspective top view of the socket in FIG. 6.

[0020] FIGURES 8A-B are schematic perspective bottom and top views, respectively, of another embodiment of a socket.

[0021] FIGURE 9 is a schematic exploded perspective view of another embodiment of an LED light assembly.

[0022] FIGURE 10 is a perspective top view of a component of the LED light assembly of FIG. 9.

[0023] FIGURES 11A-B are a schematic exploded perspective bottom view and an assembled perspective top view, respectively, of another embodiment of an LED light fixture that can incorporate the LED light assembly of FIGS. 1 and 9.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] FIGS. 1-5 show one embodiment of an LED light assembly 200. The LED assembly 200 can include a reflector, or optic, 210; a first shell 220; a lighting element, such as an LED 230; a thermally conductive material 240; a printed circuit board 250; a second shell 260; a thermal interface member 270; and a thermal pad 280.

[0025] First shell 220 may include an opening 221 sized to receive the optic 210 therein, which can be removably fixed to the first shell 220 via one or more fasteners 222. In the illustrated embodiment, the first shell 220 includes four fasteners 222 for releasably securing the optic 210 to the first shell 220. However, in other embodiments, the first shell 220 can include fewer than, or more than, four fasteners 222. In the illustrated embodiment, the fasteners 222 are hook-like members that can contact an underside of a rim 210a of the optic 210, so that the rim 210a is held between the fasteners 222 and one or more lip portions 220a of the first shell 220. However, in other embodiments, the fasteners 222 can have other suitable configurations. Additionally, recessed portions 220b in the opening 221 and adjacent the one or more lip portions 220a advantageously allow the optic 210 to be readily disengaged from the first shell 210 and removed from the LED light assembly 200 through the opening 221 without having to disconnect the first and second shells 220, 260. Accordingly, the optic 210 can be easily removed and replaced with another optic 210, for example, to provide a different angle of illumination (e.g., narrow or wide) for the LED light assembly 200. In another embodiment, the optic can be excluded from the LED light assembly 200.

[0026] First shell 220 may also include one or more apertures 225 to facilitate air flow into the LED light assembly 200 to, for example, ventilate the printed circuit board 250, LED 230, and/or a thermally-conductive housing 400 of a light assembly 10 with which the LED light assembly 200 is coupled (see FIG. 6). Additionally, the number, shape and/or location of the apertures 225 can also be varied in other embodiments. Further, in certain applications, the airflow apertures 225 can be omitted (e.g., where ventilation of the LED light assembly 200 is not required).

[0027] First shell 220 may also include one or more engaging members 223, such as protrusions or tabs, on its outer surface 224. In the illustrated embodiment, the first shell 220 has four engaging members 223. However, in other embodiments the first shell 220 can include fewer or more engaging members 223. In the illustrated embodiment, the engaging members 223 are shown as being "t-shaped" tabs, but the engaging members 223 can have any suitable shape (e.g., L-shaped, J-shaped), and can be positioned on other surfaces of the LED light assembly 200, such as the bottom surface of the assembly 200.

[0028] With continued reference to FIGURE 2, the second shell 260 can include one or more resilient members 263, which can include resilient ribs or springs 263a. In the illustrated embodiment, the second shell 260 includes four resilient members 263. However, in other embodiments, the second shell 260 can include more or fewer resilient members 263. Additionally, in the illustrated embodiment, the resilient member 263 has a wishbone-like shape. However the resilient member 263 can have other suitable shapes in other embodiments. In one embodiment, the resilient member 263 can be made of the same material as the rest of the second shell 260. In another embodiment, the resilient member 263 can be made of a different material than the rest of the second shell 260. In one embodiment, the resilient member 263 can be made of metal, such as stamped stainless steel. However, the resilient member 263 can be made of other suitable materials, such as a plastic material, including a shape memory plastic material.

[0029] The thickness and width of the resilient member 263 can be adjusted in different embodiments to increase or decrease the spring force provided by the resilient member 263. The resilient member 263 can include an opening between the ribs 263a that can have any suitable size or shape to, for example, adjust the flexibility of the resilient member 263. The resilient members 263 in second shell 260 preferably provide the desired spring force to generate a compression force between the LED light assembly 200 and the housing 400 of the light assembly 10 (see FIG. 6) to effect a resilient thermal coupling between the LED light assembly 200 and the thermally-conductive housing 400 so that heat can be effectively dissipated from the LED light assembly 200 to the housing 400. In another embodiment, a gasket (e.g., annular gasket) of resilient material can be disposed adjacent an attachment ring 262 of the second shell 260 so that the gasket provides an interface between the ring 262 and a portion of the circuit board 250. Said gasket can also provide a compression force, in addition to the compression force provided by the resilient members 263, to achieve the desired thermal coupling between the LED light assembly 200 and the housing 400. In another embodiment (not shown), the compression force between the LED light assembly 200 and the housing 400 can be provided solely by a gasket between the ring 262 and the circuit board 250.

[0030] In the illustrated embodiment, the ring 262 of the second shell 260 can have one or more compression limiter tabs 266. In the illustrated embodiment, the ring 262 has twelve compression limiter tabs 266. However, in other embodiments, the ring 262 can have more or fewer compression limiter tabs 266. The compression limiter tabs 266 preferably limit the deflection of the resilient members 263 when the attachment ring 262 is moved toward the printed circuit board 250 (e.g., via the movement of the thermal interface member 270 when the LED light assembly 200 is coupled to the housing 400) to thereby maintain the resiliency and elasticity of the resilient members 263 and inhibit the over-flexing (e.g., plastic deformation) of the resilient members 263. In another embodiment, where the LED light assembly 200 includes an optic 210, the optic 210 can engage the LED 230 to limit the travel of the attachment ring 262 relative to the printed circuit board 250 to inhibit damage to the resilient members 263.

[0031] The second shell 260 can also include one or more positioning elements 264 that can engage corresponding recesses 251 in the printed circuit board 250 to ensure the desired orientation and position of the printed circuit board 250 and to hold printed circuit board 250 in a desired orientation (e.g., inhibit rotation of the circuit board 250) between first shell 220 and second shell 260. Each positioning element 264 may also engage a receiver 220c in the first shell 220 to secure the second shell 260 to the first shell 220. First and second shells 220, 260 may be made of any plastic or resin material such as, for example, polybutylene terephthalate. However, the shells 220, 260 can be made of other suitable materials, such as a metal (e.g., a die cast metal).

[0032] The printed circuit board 250 can have one or more electrical contact portions 252 on a rear side of the printed circuit board 250, so that the contact portions 252 face toward the resilient members 263 of the second shell 260. The electrical contact portion 252 can preferably engage a corresponding electrical contact 361 (see FIG. 7) in the housing 400, which can be electrically connected to a power source. Accordingly, placing the electrical contact portion 252 in contact with the electrical contact of the housing 400 allows for power to be provided to the LED light assembly 200 to provide light. The printed circuit board 250 is preferably electrically coupled to the LED 230 and controls the operation of the LED 230. In the illustrated embodiment, the LED light assembly 200 can include a wattage adjust control 253 (e.g., a switch) that can be accessed by a user. In one embodiment, the wattage adjust control 253 can be accessed through an opening 224a in the first shell 220 of the LED light assembly 200. Advantageously, the wattage adjust control 253 can be operatively connected to the LED 230 so that a user can manually adjust the wattage of the LED light assembly 200 by adjusting the wattage adjust control 253. In one embodiment, the wattage adjust control 253 can be actuated to vary the wattage of the LED light assembly 200 between a variety of predetermined wattage set points (e.g., between 6 W, 8W and 10W). In one embodiment, the wattage adjust control 253 can be electrically connected to the printed circuit board 250.

[0033] In the illustrated embodiment, the circuit board 250 has four electrical contact portions 252, each positioned between two resilient members 263, which advantageously allows a user to bring the LED light assembly 200 into electrical contact with the electrical contact 361 (see FIG. 7) of the housing 400 irrespective of the orientation of the LED light assembly 200 when coupled to the housing 400, which facilitates the installation of the LED light assembly 200. This is particularly useful where the light fixture assemblies 10 are attached to high ceilings that require a user to reach up to the light fixture 10 to install the LED light assembly 200. The multiple electrical contact portions 252 ensure that the user will correctly install the LED light assembly 200 on the first try, as opposed to a LED light assembly 200 with only one electrical contact portion 252, where the user may need more than one try to effectively bring the electrical contact portion 252 of the LED light assembly 250 into contact with the corresponding electrical contact 361 of the housing 400. In other embodiments, the circuit board 250 can have fewer or more contact portions 252.

[0034] In one embodiment, the electrical contact portions 252 can be gold plated to provide effective electrical contact between the LED light assembly 250 and the housing 400. However, in other embodiments, the electrical contact portions 252 can include other suitable electrically conductive materials, such as tin (e.g., via solder tinning). In some embodiments, the electrical contact portions 252 can be in the form of strips or pads. In another embodiment, the electrical contact portions 252 can have a curved or arc shape, as shown in FIG. 4. However, the electrical contact portions 252 can have other suitable shapes.

[0035] With continued reference to FIG. 5, the second shell 260 may also include an opening 261 sized to receive therethrough at least a portion of the thermal interface member 270. The thermal interface member 270 can be fixed to the second shell 260 through one or more attachment members (not shown), such as screws or other known fasteners, that can be inserted through openings 275 in the thermal interface member 270 and engage corresponding bosses 265 in the second shell 260. However, the interface member 270 can be fixed to the second shell 260 in other suitable manners, such as, for example, via a press-fit connection. The thermal interface member 270 can also be fixed to a thermal pad 280, via which the LED light assembly 200 can be in thermal contact, for example, with the housing 400, as discussed further below.

[0036] The thermal interface member 270 may include an upper portion 271 with a top surface 271a and a bottom surface 271b with recessed portions 271c aligned with the openings 275, and a lower portion 272 with a circumference smaller than the circumference of upper portion 271. With continued reference to FIG. 5, the lower portion 272 of the thermal interface member 270 can be inserted through opening 261 of second shell 260 such that upper portion 271 engages the second shell 260 (e.g., via the bosses 265 and openings 275, as discussed above). The second shell 260 may be formed of any plastic or resin material such as, for example, polybutylene terephthalate. In another embodiment, the second shell 260 can be formed of, for example, nylon and/or thermally conductive plastics such as plastics made by Cool Polymers, Inc., known as CoolPoly®. However, other suitable materials, including metallic materials, can be used.

[0037] Referring now to FIGS. 4 and 5, the thermal pad 280 may be attached to thermal interface member 270 via an adhesive or any other suitable fastener so as to substantially fill microscopic gaps and/or pores between the surface of the thermal interface member 270 and thermally-conductive housing 400 to thereby minimize the thermal impedance between the thermal interface member 270 and the housing 400 when the LED light assembly 200 is coupled to the housing 400. The thermal pad 280 may be any suitable commercially available thermally conductive pad, such as, for example, Q-PAD 3 Adhesive Back, manufactured by The Bergquist Company. However, in other embodiments, the thermal pad 280 can be omitted from the LED light assembly 200.

[0038] With continued reference to FIG. 5, the lower portion 272 of thermal interface member 270 can facilitate the positioning of the LED 230 in LED assembly 200. In the illustrated embodiment, the LED 230 can be mounted to a surface 273 of lower portion 272 using fasteners 231, which may be screws, bolts, rivets, or other suitable fasteners. In the illustrated embodiment, the fasteners 231 are screws that can be inserted through recesses 234 in a substrate 238 on which the LED 230 is mounted, so that the screws extend into openings 277 on the surface 273 of the lower portion 272. The fasteners 231 advantageously fasten the LED 230 to the thermal interface member 270 as well as inhibit the rotation of the LED 230 once fixed to the thermal interface member 270 via the interaction of the fasteners 231 and the recesses 234. A thermally conductive material 240 can in one embodiment be positioned between LED 230 and surface 273. In another embodiment, the LED 230 is fastened to the surface 273 without the use of a thermally conductive material 240.

[0039] The machining of both the bottom surface of LED 230 and surface 273 during the manufacturing process may leave minor imperfections in these surfaces, forming voids. These voids may be microscopic in size, but may act as an impedance to thermal conduction between the bottom surface of LED 230 and surface 273 of thermal interface 270. Thermally conductive material 240 may facilitate the conduction of heat between the LED 230 and the surface 273 of the thermal interface member 270 by substantially filling these voids to reduce the thermal impedance between LED 230 and surface 273, resulting in improved thermal conduction and heat transfer. In one embodiment, the thermally conductive material 240 may be a phase-change material which changes from a solid to a liquid at a predetermined temperature, thereby improving the gap-filling characteristics of the thermally conductive material 240. For example, thermally conductive material 240 may include a phase-change material such as, for example, Hi-Flow 225UT 003-01, which is designed to change from a solid to a liquid at 55°C and is manufactured by The Bergquist Company.

[0040] In one embodiment, the thermal interface member 270 may be made of aluminum and is shown as resembling a "top hat," various other shapes, sizes, and/or materials with suitable thermal conductivity could be used for the thermal interface member to transport and/or spread heat. In another embodiment, thermal interface member could have a planar or "pancake" shape with a single diameter. Additionally, while the LED 230 is shown as being mounted to the substrate 238, the LED 230 need not be mounted to the substrate 238 and may in other embodiments be directly mounted to thermal interface member 270 (see FIG. 9). The LED 230 may be any appropriate commercially available single- or multiple-LED chip, such as, for example, an OSTAR 6-LED chip manufactured by OSRAM GmbH, having an output of 400-650 lumens.

[0041] In the embodiments disclosed above, the LED light assembly 200 advantageously requires few fasteners to assemble the LED light assembly 200, which reduces manufacturing cost and time. For example, in the illustrate embodiment, the LED light assembly can be assembled simply with the use of fasteners 231 to fasten the LED 230 to the thermal interface member 270, and fasteners (not shown), such as screws to fasten the top portion 271 of the thermal interface member 270 to the bosses 265 of the second shell 260. In another embodiment (not shown), the thermal interface member 270 and second shell 260 can be fastened without using screws or similar fasteners. For example, in some embodiments, a press-fit, quick disconnect or clip-on manner can be used to fasten the thermal interface member 270 to the second shell 260. Similarly, in certain embodiments, the substrate 238 to which the LED 230 is mounted can be fastened to the surface 273 of the thermal interface member 270 with an adhesive or other mechanism that does not include the use of elongate fasteners 231, such as screws and bolts.

[0042] FIG. 6 is an exploded perspective view of one embodiment of a light fixture assembly 10 with which the LED light assembly 200 embodiments disclosed herein can be used. The light fixture assembly 10 can include a front cover 100, the LED light assembly 200, a socket 300 and a thermally-conductive housing 400 to which the socket 300, in one embodiment, can be coupled.

[0043] In one embodiment, the socket 300 can be ring shaped. In another embodiment, the socket 300 can have a back plate and a circumferential wall that define a cavity or recess therebetween. In another embodiment, the back plate and circumferential wall are one piece. In still another embodiment the back plate and circumferential wall can be separate pieces removably attachable to each other. The socket 300 can be of a die cast metal or plastic. For example, the socket 300 can in one embodiment be made of aluminum.

[0044] With reference to FIGS. 6 and 7, the socket 300 can releasably lock the LED light assembly 200 in place within the light fixture assembly 10. In the illustrated embodiment, the socket 300 includes one or more recesses or slots 310 in the wall 320 of the socket 300, where the recesses 310 can define a path (e.g., J-shaped, L-shaped, etc.) from an opening 311 at a rim of the socket 300 through a horizontal recess 314 to a stop portion 313. The engaging members 223 of the LED light assembly 200 can be inserted into the slots 310 of the socket 300 to releasably couple the LED light assembly 200 to the socket 300. For example, the LED light assembly 200 can be inserted into the socket 300 and then rotated so that the engaging members 223 follow the path defined by the opening 311, horizontal recess 314 and stop portion 313 to engage an edge defined by the recess 310 of the socket 300 to lock the LED light assembly 200 in place in the socket 300. In the illustrated embodiment, the LED light assembly 200 can be rotated in the opposite direction to allow the engaging members 223 to disengage the edge of the recess 310 and the LED light assembly 200 to be removed from the socket 300. However, in other embodiments, the LED light assembly 200 and the housing 400 can be releasably coupled via other suitable mechanisms (e.g., via a threaded connection, a clamped connection, etc.).

[0045] With continued reference to FIG. 7, the socket 300 can be fastened to the housing 400 via one or more fastening members 340. In the illustrated embodiment, the fastening member 340 is a tab through which a fastener (e.g., bolt, screw, rivet) can be inserted to fasten the socket 300 to the housing 400. In another embodiment, the socket 300 and the thermally-conductive housing 400 can be one piece.

[0046] As shown in the embodiment of FIG. 7, the socket 300 can have a tray 350 that supports a terminal block 360 with at least one electrical contact 361. The recesses 310 in the socket 300 are preferably dimensioned to allow at least one of the electrical contact portions 252 of the printed circuit board 250 to contact the electrical contact 361 when the LED light assembly 200 is coupled to the thermally-conductive housing 400 via the socket 300 to thereby establish an electrical connection between the LED light assembly 200 and the housing 400. The terminal block 360 can be connected to a power source (e.g., a battery, a residential power supply via an electrical cord), so as to supply electricity to the LED light assembly 200 when the LED light assembly 200 is coupled to the housing 400. Additionally, in one embodiment, the recesses 310 are preferably dimensioned to cause the flexible members 263 to compress as the engaging members 223 are moved along the paths defined by the recesses 310, thereby generating a compression force between the thermal interface member 270 and the thermally-conductive housing 400 to thereby establish a thermal connection between the LED light assembly 200 and the thermally-conductive housing 400.

[0047] In one embodiment, when the LED light assembly 200 is installed in the housing 400, the compression force generated by the resilient member 263 causes a subassembly of the LED light assembly 200 to travel relative to the first shell 220. In one embodiment, the subassembly includes the thermal interface member 270 and LED 230, which move toward the opening 221 of the first shell 220 when the LED light assembly is installed in the housing 400. In one embodiment, when the LED light assembly 200 is removed from engagement with the housing 400, the subassembly can travel in the opposite direction (e.g., the thermal interface member 270 and LED 230 can move away from the opening 221 of the first shell 220. In one embodiment, the LED 230 is positioned out of the focal point of the reflector or optic 210 when the LED light assembly 200 is decoupled from the housing 400, but the spring force of the resilient member 263 causes the LED 230 to move into the focal point of the optic 210 as the LED light assembly 200 is coupled to the housing 400. In one embodiment, the subassembly can also include the circuit board 250, which can be fixed to the thermal interface member 270, so that the circuit board 250 can also travel as the LED light assembly 200 is installed in the housing, or disengaged from the housing. In another embodiment, the subassembly can include the optic 210, which can be coupled to the thermal interface member 270, so that the optic 210 can also travel as the LED light assembly 200 is installed in the housing or removed from the housing. In still another embodiment, both the circuit board 250 and optic 210 can be coupled to the thermal interface member 270 and travel relative to the first shell 220 when the LED light assembly 200 is installed with, or disengaged from, the housing 400. However, the subassembly can include other components.

[0048] With continued reference to FIG. 6, after LED assembly 200 is installed in thermally-conductive housing 400, a front cover 100 may be attached to socket 300 by engaging front cover engaging member 101 on the front cover 100 with front cover retaining mechanism 330, and rotating front cover 100 with respect to socket 300 to secure the front cover engaging member 101 with a front cover retaining mechanism lock 331 (e.g., slot) to lock the front cover 100 in place. The front cover 100 may include a main aperture 102 formed in a center portion of cover 100, a transparent member, such as a lens 104 formed in aperture 102, and one or more peripheral holes 106 formed on a periphery of front cover 100. The lens 104 allows light emitted from a lighting element (e.g., LED 230) to pass through the cover 100, while also protecting the lighting element from the environment. The lens 102 may be made from any appropriate transparent material to allow light to flow therethrough, with minimal reflection or scattering.

[0049] As shown in Fig. 6, the front cover 100, LED light assembly 200, socket 300, and thermally-conductive housing 400 may be formed from materials having a thermal conductivity k of at least 12 W/mK, and preferably at least 200 W/mK, such as, for example, aluminum, copper, or thermally conductive plastic. However, other suitable materials can be used. The front cover 100, LED assembly 200, socket 300, and thermally-conductive housing 400 may be formed from the same material, or from different materials. The one or more peripheral holes 106 may be formed on the periphery of front cover 100 such that they are equally spaced and expose portions along an entire periphery of the front cover 100. Although a plurality of peripheral holes 106 are shown in the illustrated embodiment, one or more peripheral holes 106 or none at all can be used in other embodiments. The peripheral holes 106 can advantageously allow air to flow through front cover 100, into and around the LED assembly 200 and flow through air holes in the thermally-conductive housing 400 to dissipate heat generated by the LED 230.

[0050] Additionally, as shown in FIG. 6, the one or more peripheral holes 106 may be used to allow light emitted from LED 230 to pass through peripheral holes 106 to provide a corona lighting effect on front cover 100. In one embodiment, the thermally-conductive housing 400 may be made from an extrusion process, including a plurality of surface-area increasing structures, such as ridges 402. Further details on the thermally conductive housing 400 and light fixture assemblies 10 with which the LED light assembly 200 can be used are provided in U.S. Patent Application Nos. 11/715,071 and 12/149,900, the entire contents of both of which are hereby incorporated by reference in their entirety and should be considered a part of this specification.

[0051] The ridges 402 may serve multiple purposes. For example, ridges 402 may provide heat-dissipating surfaces so as to increase the overall surface area of the thermally-conductive housing 400, thereby providing a greater surface area for heat to dissipate to an ambient atmosphere over. That is, the ridges 402 may allow the thermally-conductive housing 400 to act as an effective heat sink for the light fixture assembly 10. Moreover, the ridges 402 may also be formed into any of a variety of shapes and formations such that thermally-conductive housing 400 takes on an aesthetic quality. That is, the ridges 402 may be formed such that thermally-conductive housing 400 is shaped into an ornamental extrusion having aesthetic appeal. However, the thermally-conductive housing 400 may be formed into a plurality of other shapes, and thus function not only as a ornamental feature of the light fixture assembly 10, but also as a heat sink to dissipate heat from the LED 230.

[0052] FIGS. 8A and 8B show another embodiment of a socket 300′ that can be used to releasably lock the LED light assembly 200. The socket 300′ is similar to the socket 300, except as noted below. Thus, the reference numerals used to designate the various features of the socket 300′ are identical to those used for identifying the corresponding features of the socket 300 in FIG. 7, except that a "′" has been added to the reference. The socket 300′ differs from the socket 300 in that it does not have the front cover retaining mechanism 330 or front cover retaining mechanism lock 331 to lock the front cover 100 to the thermally-conductive housing 400. Rather, other suitable mechanisms can be used to lock the front cover 100 to the thermally-conductive housing 400, such as a press-fit connection.

[0053] FIGS. 9 and 10 illustrate another embodiment of an LED light assembly 200′, which can be used with the light fixture assembly 10 and the socket 300, 300′ disclosed herein. The LED light assembly 200′ is similar to the LED light assembly 200, except as noted below. Thus, the reference numerals used to designate the various components of the LED light assembly 200′ are identical to those used for identifying the corresponding components of the LED light assembly 200 in FIGS. 1-5, except that a "′" has been added to the reference numerals of the LED light assembly 200′.

[0054] As shown in FIG. 9, the LED light assembly 200′ includes a second shell assembly 260′ that includes a locking assembly 260a′, a resilient assembly 260b′ and a compression limiting assembly 260c′ as separate components. In the illustrated embodiment, the resilient assembly 260b′ is made of metal and the locking assembly 260a′ and compression limiting assembly 260c′ are made of a plastic material. However, in other embodiments, the locking assembly 260a′, resilient assembly 260b′ and compression limiting assembly 260c′ can all be made of metal, or all be made of a plastic material, or at least one of the three components 260a′, 260b′, 260c′ can be made of a different material than the remaining components 260a′, 260b′, 260c′.

[0055] In the illustrated embodiment, the locking assembly 260a′ is ring-shaped with positioning elements 264, as described above, that can engage corresponding recesses 251 in the printed circuit board 250 and receiving members 220c in the first shell 220. The locking assembly 260a′ can also have an orientation marker 264a′ that can engage a corresponding recess 251a in the printed circuit board to ensure a desired orientation of the locking assembly 260a′ relative to the printed circuit board 250.

[0056] The locking assembly 260a′ can be fastened to the resilient assembly 260b′ by aligning a rim 263b′ of the resilient assembly 260b′ with a rim 264b′ of the locking assembly 260a′. In one embodiment, the rim 263b′ of the resilient assembly 260b′ can be held between a lip 264c′ of the rim 264b′ and the positioning elements 264.

[0057] The compression limiting assembly 260c′ can be fastened to the resilient assembly 260b′ by inserting the bosses or members 265 through openings in tabs 263c′ of the resilient assembly 260b′. The bosses 265 can further be inserted through openings 275 in the thermal interface member 270 so that the bosses 265 extend into the recesses or slots 271c on the back surface 271b of the thermal interface member 270, and so that the tabs 263c′ contact with the top surface 271a of the thermal interface member 270. The ends of the bosses 265 that extend into the recesses 271c can then be melted or heat staked to fasten the second shell assembly 260′ to the thermal interface member 270. However, other suitable mechanisms can be used to fasten the second shell assembly 260′ to the thermal interface member 270. In another embodiment, fasteners (e.g., bolts, screws, rivets) can be inserted through the openings 275 and coupled to the bosses 265 (e.g., threadably coupled to the bosses 265 where the bosses 265). In another embodiment, the bosses 265 can be press-fitted into the openings 275.

[0058] Advantageously, the second shell assembly 260′ can be assembled, as described above and illustrated in FIG. 9, without the use of separate fasteners, such as screws, bolts or rivets, which results in a reduction in manufacturing cost and time. Moreover, the second shell assembly 260′ can also be fastened to the first shell 220 without the use of separate fasteners.

[0059] With reference to the embodiment of FIG. 10, the LED 230 is directly mounted to, or populated onto, the thermal interface member 270. In the illustrated embodiment, a dielectric layer 240′ that is thermally conductive and electrically insulating is applied to the surface 273′ of the thermal interface member 270. In one embodiment, the dielectric layer 240′ is screen printed onto the surface 273′ of the thermal interface member 270. A trace pattern 242′ can then be screen printed on top of the dielectric layer 240′. In one embodiment, a solder mast 274 is applied to cover the dielectric layer 240′ and trace pattern 242′, leaving only the portions of the trace pattern 242′ exposed to which soldering is desired. Solder masts or terminations 274 are attached to the dielectric layer 240′ and are electrically connected to the trace pattern 242′, where the solder masts 274 can be electrically coupled to the circuit board 250. The LED 230 is populated onto the dielectric layer 240′ so that the terminations (e.g., pins, leads) of the LED 230 are electrically connected to the trace pattern 242′. The LED 230 can be populated onto the dielectric layer 240′ using an automation process, such as an SMT (surface mount technology) method. In another embodiment, the LED 230 can be attached directly to the surface 273′ of the thermal interface member 270 without a dielectric layer positioned therebetween.

[0060] FIGS 11A-B show another embodiment of a light fixture assembly 500 with which the LED light assembly 200, 200′ embodiments disclosed herein can be used. The light fixture assembly 500 can include a mounting plate 510 and a thermally-conductive housing 520 with a recessed opening 522 that can receive the socket 300, 300′ therein. In another embodiment, the socket 300, 300′ can be integrally formed with the thermally conductive housing 520. The LED assembly 200, 200′ can thus be coupled to the housing 520 via the socket 300, 300′ and the housing 400 can serve as a heat sink to conduct heat away from the LED assembly 200, 200′. Additionally, the housing 400 can have one or more fins 524 for dissipating to the environment via convection heat transfer. The light fixture assembly 500 can also have a transformer 530, which can be an off-the-shelf transformer (e.g., 110V AC to 24V AC transformer), electrically connected to the socket 300, 300′.

[0061] The light fixture assembly 500 can also have a front cover 540 (e.g., trim ring) with an opening 542 that allow light generated by the LED 230 to pass therethrough. The front cover 540 can also have one or more locking members 542 that can couple to the corresponding front cover retaining mechanism 330 of the socket 300. In the illustrated embodiment, the locking members 542 can be protrusions that can releasably engage the slot 331 of the front cover retaining mechanism to attach the front cover 540 to the socket 300. In another embodiment, the front cover 540 can couple to the light fixture assembly 500 in other suitable ways (e.g., press-fit connection, threaded connection).

[0062] The light fixture assembly 500 can be used to provide a recessed lighting arrangement in a home or business, where the socket 300 can be on one side of the mounting surface (e.g., wall) and the mounting plate 510, housing 520 and transformer 530 can be out of sight on an opposite side of the mounting surface. Accordingly, a user can readily install and replace the LED light assembly 200, 200′ and cover the socket 300, 300′ with the front cover 540. In a preferred embodiment, the front cover 540 couples to the socket 300 so that no portion of the LED assembly 200, 200′ is exposed, which provides an aesthetically pleasing arrangement.

[0063] Of course, the foregoing description is that of certain features, aspects and advantages of the present invention, to which various changes and modifications can be made without departing from the spirit and scope of the present invention. Moreover, the LED assembly need not feature all of the objects, advantages, features and aspects discussed above. Thus, for example, those of skill in the art will recognize that the invention can be embodied or carried out in a manner that achieves or optimizes one advantage or a group of advantages as taught herein without necessarily achieving other objects or advantages as may be taught or suggested herein. In addition, while a number of variations of the invention have been shown and described in detail, other modifications and methods of use, which are within the scope of this invention, will be readily apparent to those of skill in the art based upon this disclosure. It is contemplated that various combinations or subcombinations of these specific features and aspects of embodiments may be made and still fall within the scope of the invention. Accordingly, it should be understood that various features and aspects of the disclosed embodiments can be combined with or substituted for one another in order to form varying modes of the discussed reciprocating mechanism for a reel assembly.

WHAT IS CLAIMED IS:

1. An LED light module removably coupleable to a light fixture, comprising:

an LED lighting element;

a thermal interface member coupled to the LED lighting element and configured to resiliently contact the light fixture when the LED light module is releasably coupled to the light fixture, the thermal interface member configured to thermally couple the LED lighting element and the light fixture;

one or more resilient members operatively coupled to the thermal interface member, the resilient members configured to generate a compression force when the LED light module is coupled to the light fixture to maintain a compressive force configured to drive the thermal interface member into resilient contact with the light fixture; and

a plurality of electrical contact members electrically connected to the LED lighting element, one of the electrical contact members configured to releasably contact an electrical contact on the light fixture when the LED light module is coupled to the light fixture irrespective of the orientation of the LED light module during installation.

2. The removable LED light module of claim 1, wherein the electrical contact members are electrical contact strips or pads spaced apart from a bottom of the thermal interface member.

3. The removable LED light module of claim 1, wherein the electrical contact members comprise gold plated electrical contact members.

4. The removable LED light module of claim 1, wherein the resilient member has a generally wishbone shape, each of the electrical contact members accessible through an opening between adjacent resilient members.

5. The removable LED light module of claim 1, wherein the compression force causes a subassembly of the LED light module to travel relative to a first shell.

6. The removable LED light module of claim 5, wherein the subassembly comprises an optic coupled to the thermal interface member and movable toward an opening in a first shell of the LED light module when the LED light module is coupled to the light

fixture, the opening in the first shell allowing light from the LED lighting element to pass therethrough.

7. The removable LED light module of claim 6, wherein the LED lighting element is configured to move into a focal point of the optic aligned with the opening in the first shell when the LED light module is coupled to the light fixture and to move out of the focal point when the LED light module is disengaged from the light fixture.

8. The removable LED light module of claim 7, further comprising a second shell removably coupleable to the first shell without the use of threaded fasteners, the second shell coupleable to the thermal interface member.

9. The removable LED light module of claim 1, further comprising a wattage adjust control switch actuatable to adjust a wattage of the LED light module.

10. The removable LED light module of claim 1, wherein the one or more resilient members are made of metal.

11. The removable LED light module of claim 1, wherein the LED lighting element is directly coupled to the thermal interface member.

12. An LED light module removably coupleable to a light fixture, comprising:

an LED lighting element;

a thermal interface member coupled to the LED lighting element and configured to resiliently contact a thermally conductive housing of the light fixture assembly when the LED light module is coupled to the thermally conductive housing, the thermal interface member configured to thermally couple the LED lighting element and the thermally conductive housing;

a plurality of resilient members operatively coupled to the thermal interface member, the resilient members movable to a compressed state when the LED light module is coupled to the thermally conductive housing to generate a compression force configured to drive the thermal interface member into resilient contact with the thermally conductive housing to establish a thermal connection between the LED light module and the housing; and

a plurality of electrical contact members electrically connected to the LED lighting element and spaced apart from the thermal interface member, one of the electrical contact members configured to releasably contact an electrical contact on the light fixture when the light module is coupled to the thermally conductive housing to establish an electrical connection between the LED lighting element and the light fixture irrespective of the orientation of the LED light module during installation.

13. The removable LED light module of claim 12, wherein the electrical contact members comprise gold plated electrical contact members.

14. The removable LED light module of claim 12, further comprising a wattage adjust control switch actuatable to adjust wattage of the LED light module.

15. The removable LED light module of claim 12, wherein the resilient members are made of metal.

16. The removable LED light module of claim 12, wherein the LED lighting element is directly coupled to the thermal interface member.

17. The removable LED light module of claim 12, further comprising a first shell of the LED light module having an opening that allows light from the LED lighting element to pass therethrough, the first shell housing the LED lighting element therein.

18. The removable LED light module of claim 17, further comprising a second shell removably coupleable to the first shell without the use of threaded fasteners, the second shell coupleable to the thermal interface member.

19. A light fixture assembly, comprising:

a light fixture;

an LED light module removably coupleable to the light fixture, comprising:

an LED lighting element;

a thermal interface member coupled to the LED lighting element and configured to resiliently contact the light fixture when the LED light module is coupled to the light fixture to establish a thermal contact between the LED lighting element and the light fixture;

one or more resilient members operatively coupled to the thermal interface member, the resilient members movable to a compressed state when the LED light module is coupled to the light fixture to generate a compression force to drive the thermal interface member into resilient contact with the light fixture; and

one of the LED light module and light fixture comprising a plurality of electrical contact members, one of the electrical contact members configured to releasably contact an electrical contact on the other of the LED light module and light fixture when the LED light module is coupled to the light fixture irrespective of the orientation of the LED light module during installation.

20. The light fixture assembly of claim 19, wherein the light fixture comprises a socket configured to releasably couple to the LED light module, said socket comprising the electrical contact configured to electrically connect to one of the electrical contact members of the LED light module, the socket dimensioned to cause the resilient members to move to the compressed state when the LED light module is coupled to the socket.

21. The light fixture assembly of claim 20, wherein the socket is removably coupled to a thermally-conductive housing of the light fixture.

22. The light fixture assembly of claim 19, wherein the resilient members are made of metal.

23. The light fixture assembly of claim 20, wherein the electrical contact members of the LED light module comprise gold plated electrical contact members.

24. The light fixture assembly of claim 19, wherein the LED light module is releasably coupled to a thermally conductive housing of the light fixture via the interaction of protrusions on the LED light module and slots in a socket of the light fixture.

25. The light fixture assembly of claim 19, further comprising a wattage adjust control switch actuatable to adjust a wattage of the LED light module.

26. A method of using a light fixture assembly, comprising:

axially moving at least a portion of an LED light module into contact with a light fixture, the LED light module comprising:

an LED lighting element;

a thermal interface member coupled to the LED lighting element; and

one or more resilient members operatively coupled to the thermal interface member rotating the LED light module relative to the light fixture, causing the LED light module to move further axially relative to the light fixture so that the resilient members move to a compressed state to generate a compression force that drives the thermal interface member into resilient contact with the light fixture, thereby establishing a thermal contact between the LED light module and the light fixture,

wherein one of the LED light module and light fixture comprises a plurality of electrical contact members, and one of the plurality of electrical contact members contacts an electrical contact on the other of the LED light module and light fixture during said rotation of the LED light module relative to the light fixture.

27. The method of claim 30, wherein said rotation of the LED light module releasably locks the LED light module to the light fixture.

28. The method of claim 26, wherein rotation the LED light module relative to the light fixture comprises moving protrusions on the LED light module along slots of the light fixture, said movement causing the LED light module to move further axially relative to the light fixture.

29. The method of claim 26, wherein axially moving the LED light module comprises inserting at least a portion of the LED light module into a socket of the light fixture.

30. The method of claim 28, wherein said slots are formed in a socket of the light fixture.

31. The method of claim 26, wherein rotating the LED light module comprises rotating the LED lighting element, the LED lighting element being fixed relative to a housing of the LED light module.

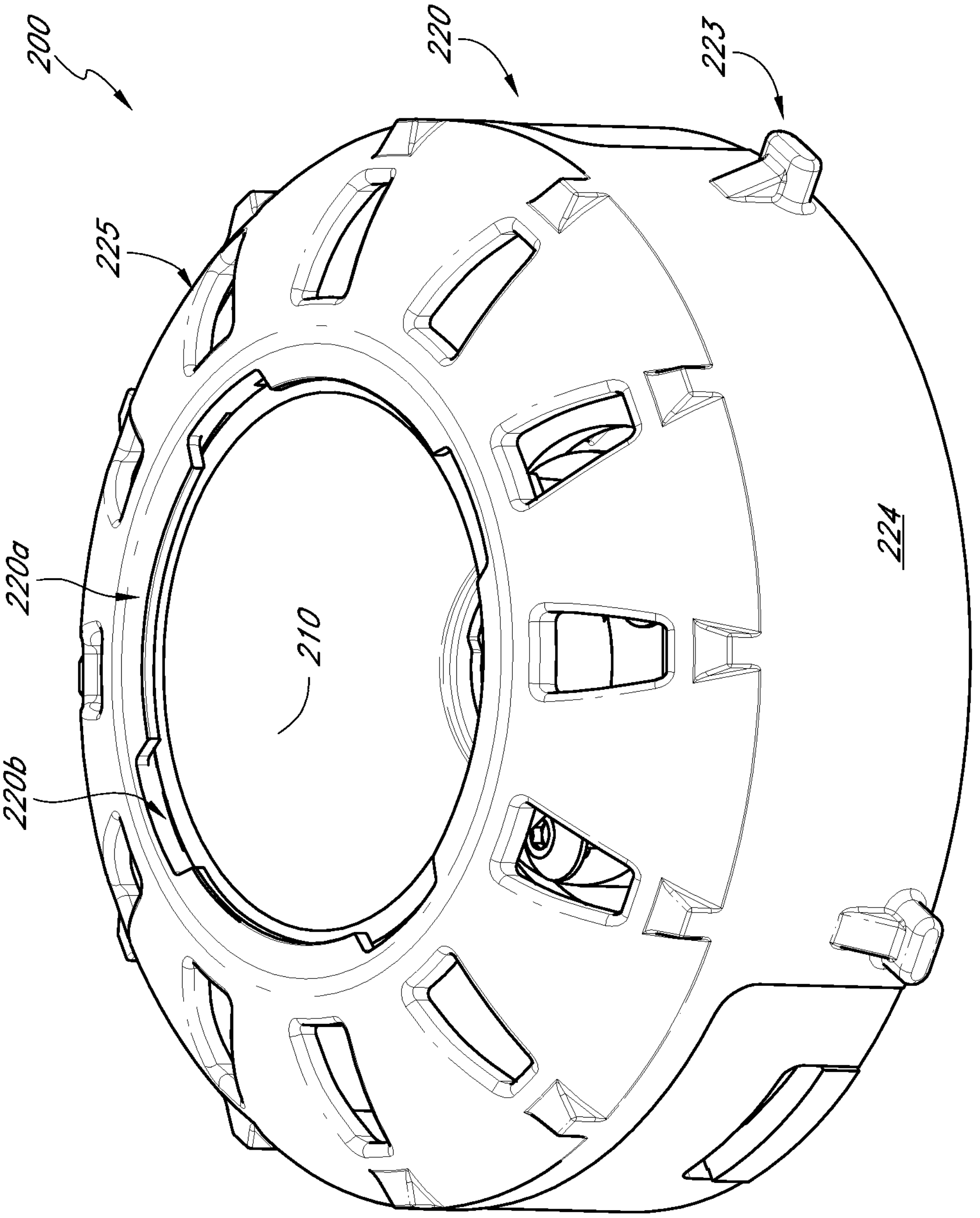


FIG. 1

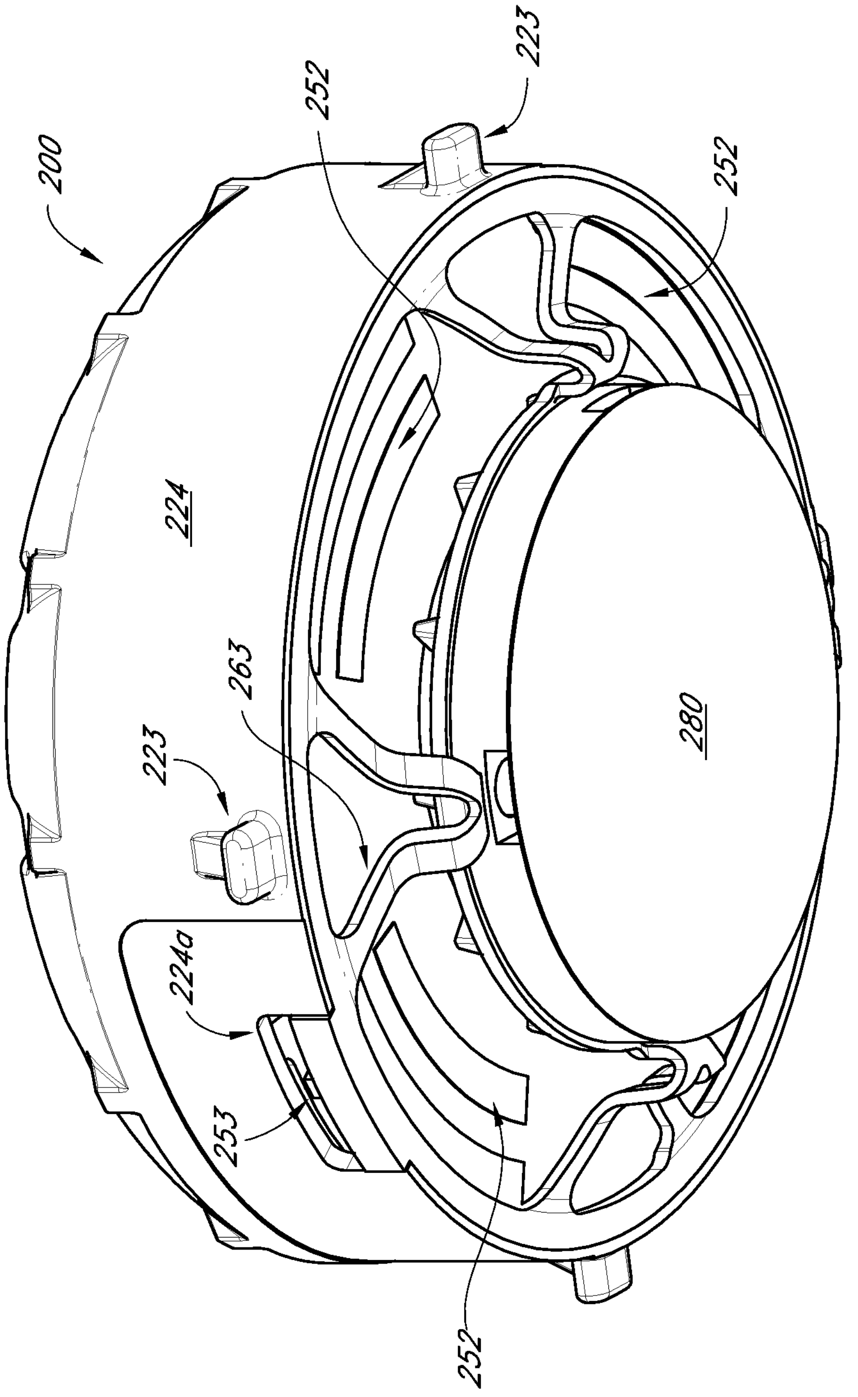


FIG. 2

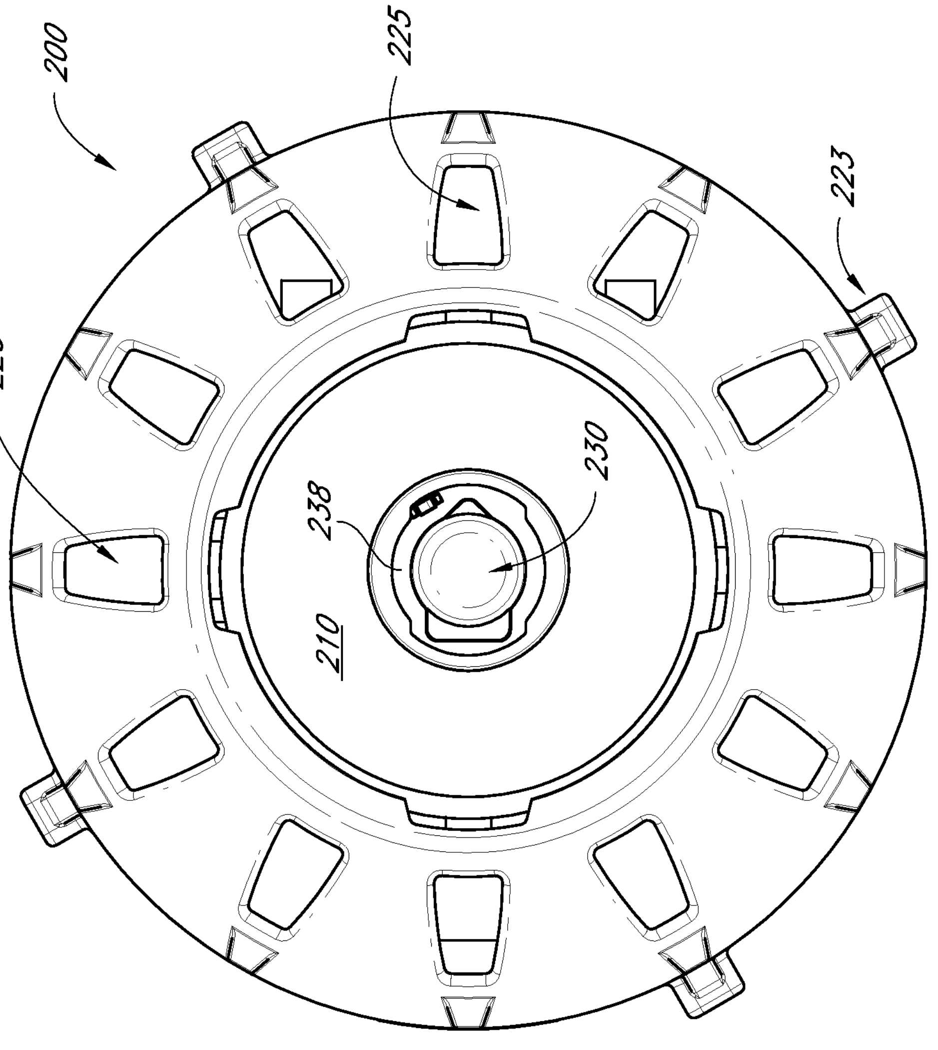


FIG. 3

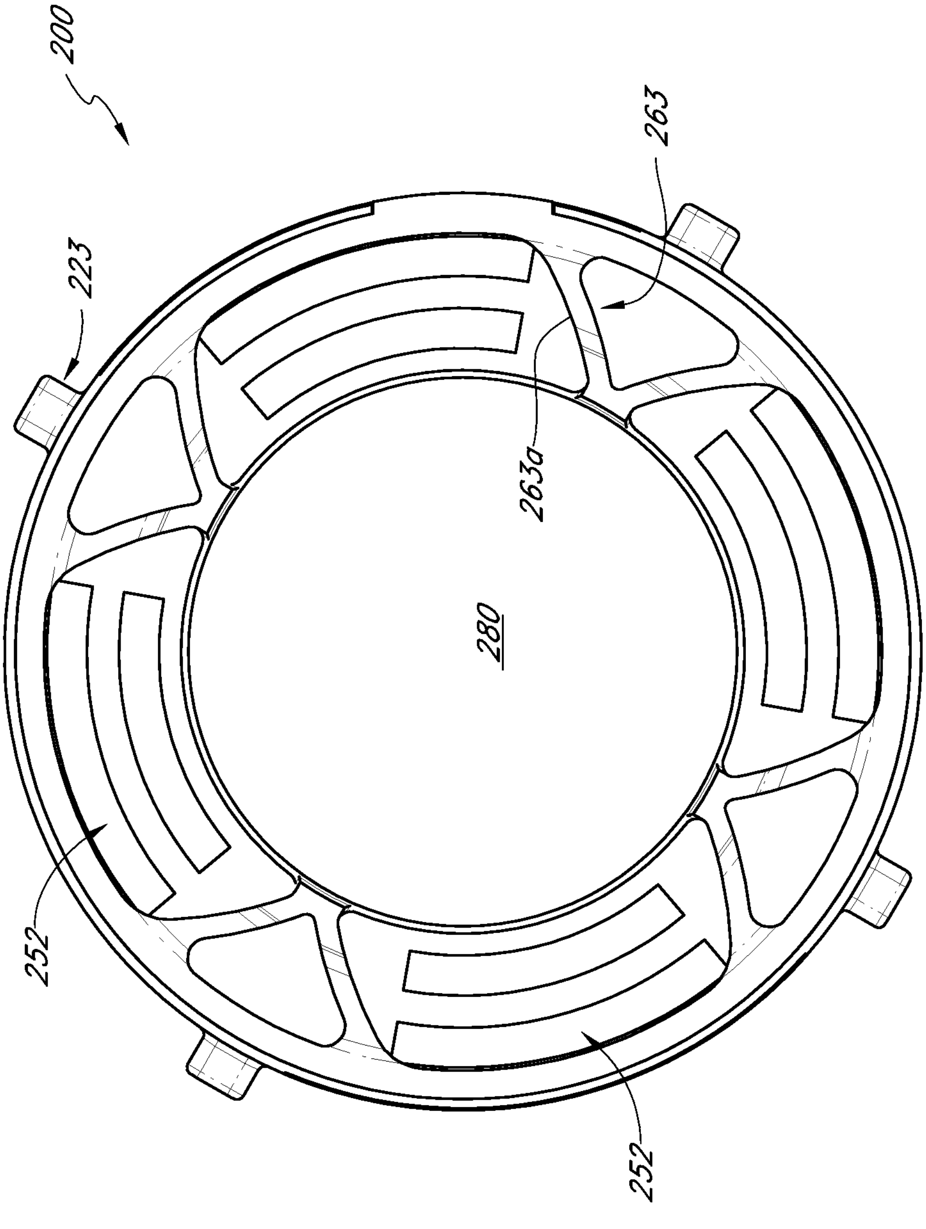
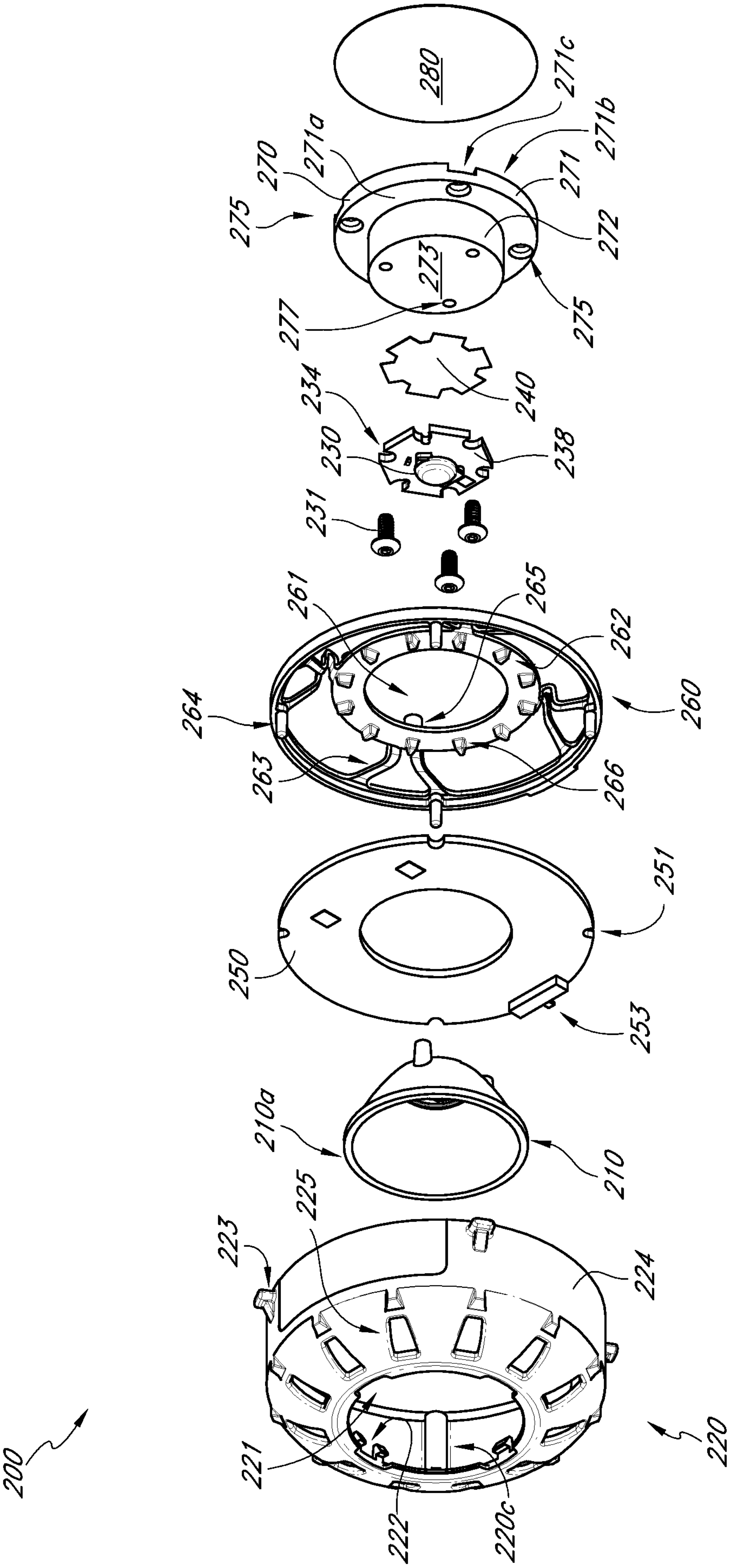


FIG. 4


280
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271a
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271
272
275
273
277
240
234
230
238
231
261
265
262
264
260
263
266
251
250
253
210a
210
225
223
224
221
222
220c
220
200

FIG. 5

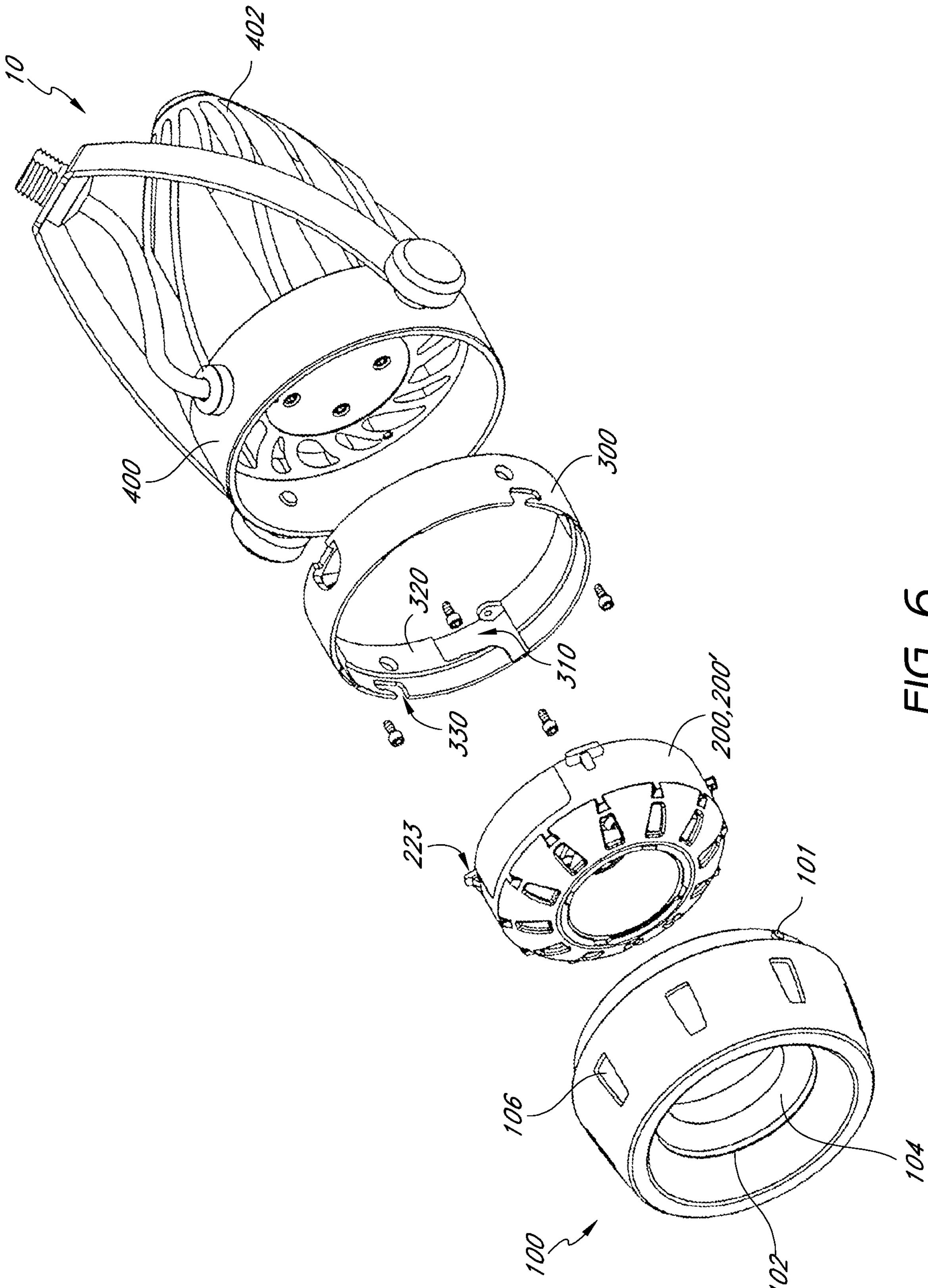

FIG. 6

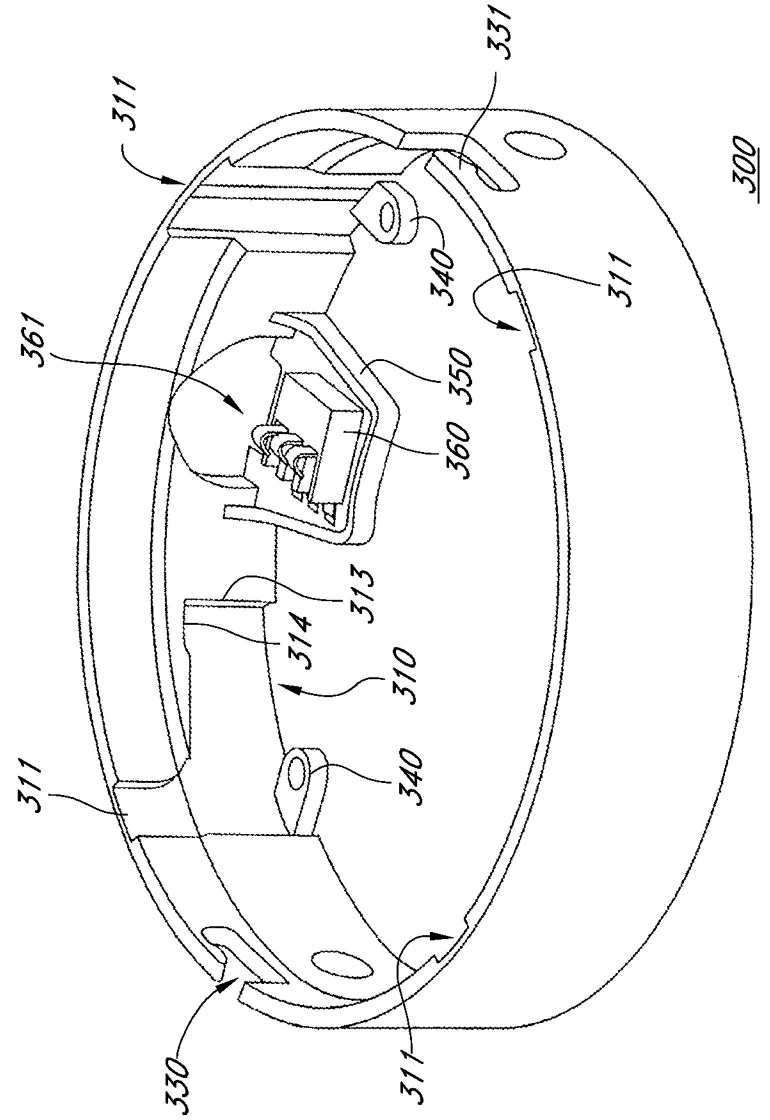

FIG. 7

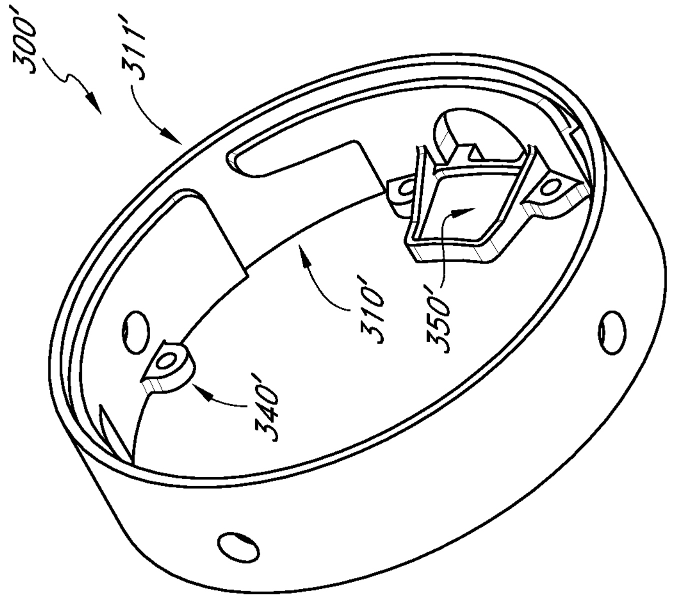

FIG. 8B

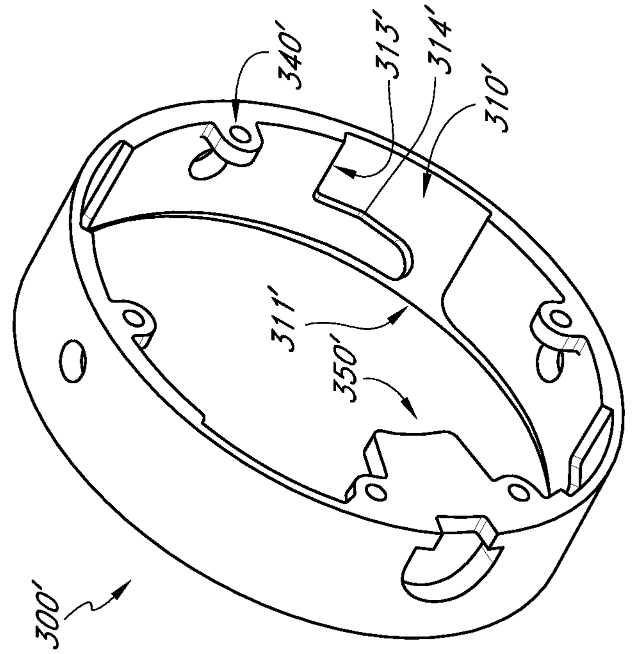

FIG. 8A

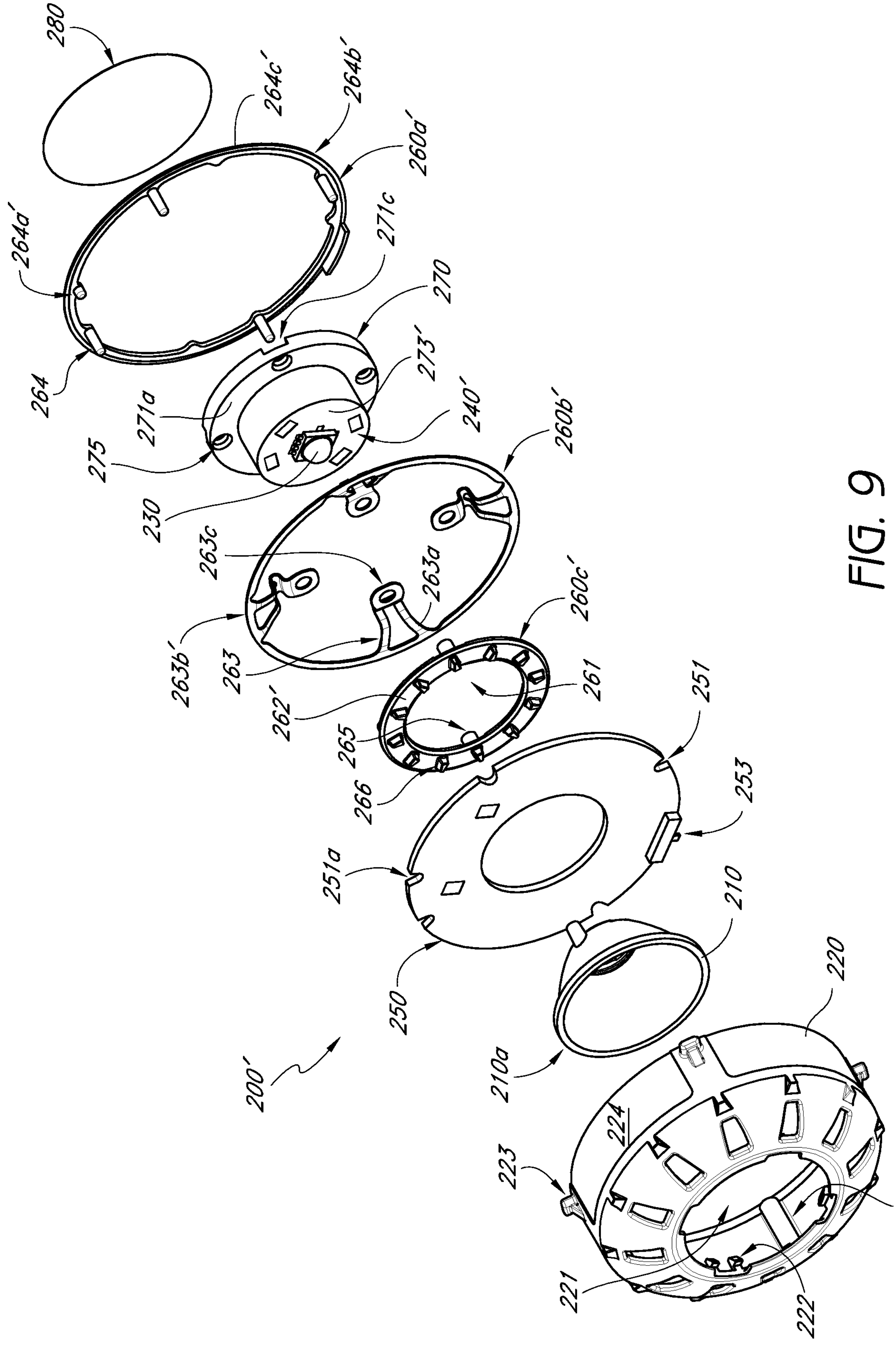
280
264c'
264b'
260a'
264a'
271c
270
264
271a
273'
275
240'
260b'
230
263c
263a
260c'
263b'
263
261
262'
251
265
266
253
251a
210
250
220
200'
210a
224
223
220c
221
222

FIG. 9

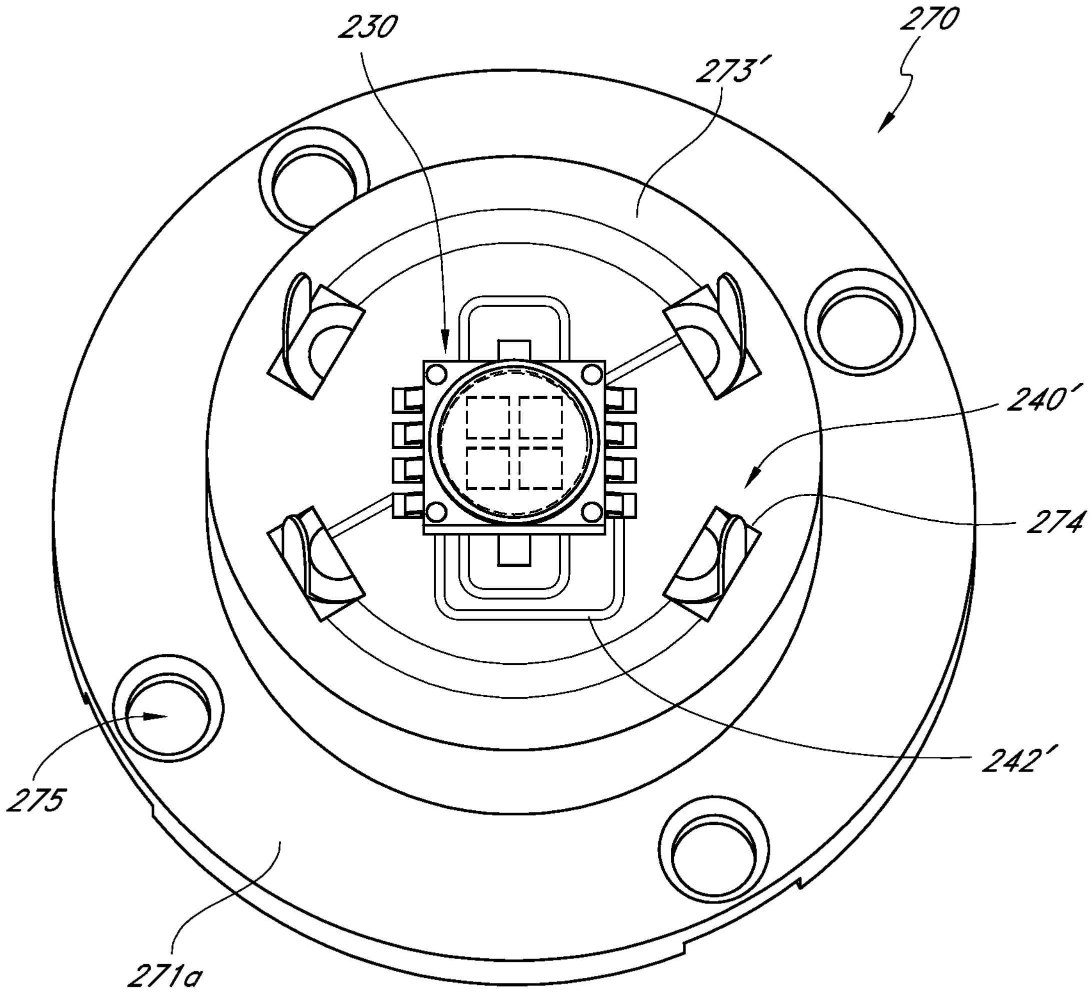

FIG. 10

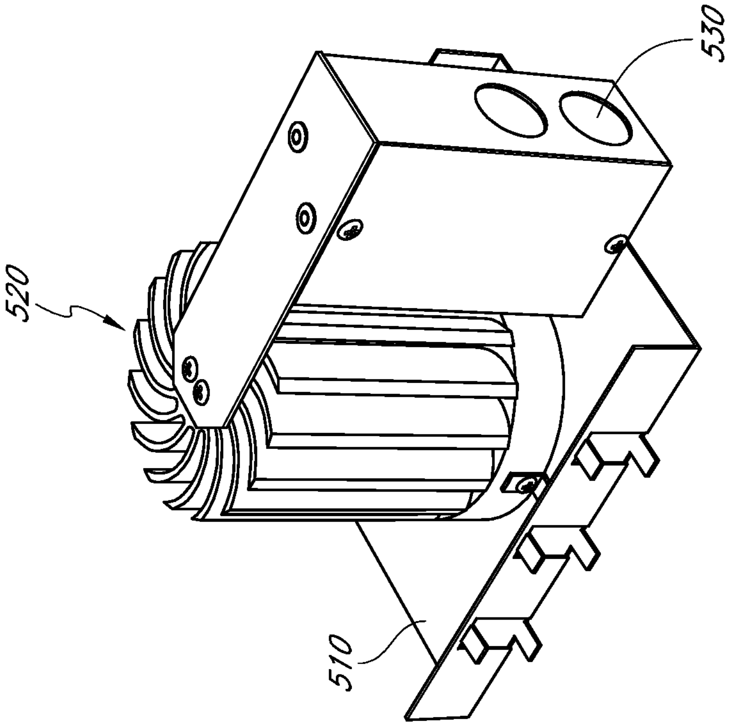

FIG. 11B

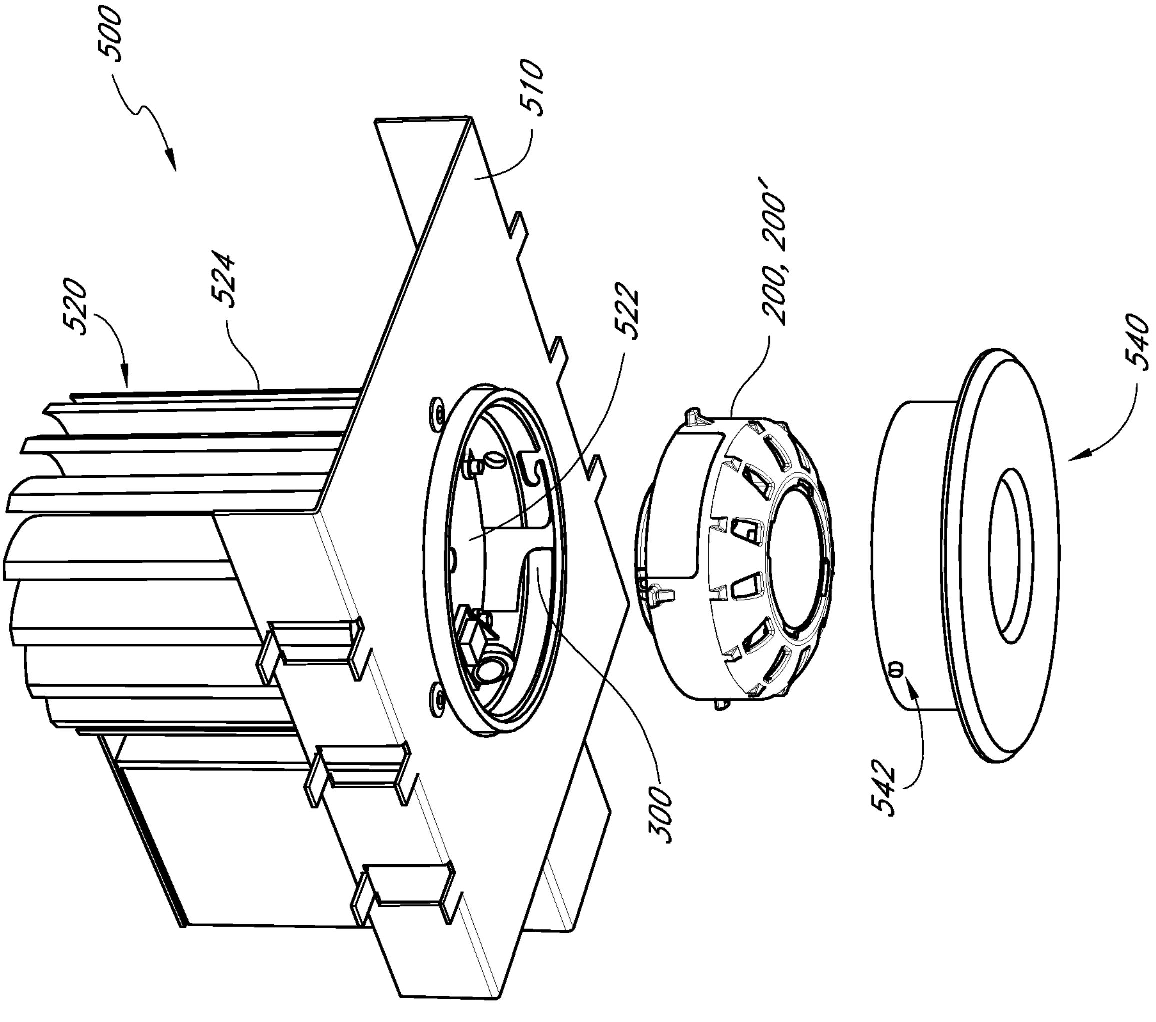

FIG. 11A

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 09/64858

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H01R 33/00 (2009.01)
USPC - 362/645
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)
USPC - 362/227,640,645,647-649,652,655,656,658,800

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 362/227,640,645,647-649,652,655,656,658,800

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST(USPT,PGPB,EPAB,JPAB); Google, Google Patents.
Search Terms Used: LED, thermal, contact, resilient, removable, releasable, remove, release, gold, focal, point, wishbone, V shape, Y shape.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,682,211 B2 (ENGLISH et al.) 27 January 2004 (27.01.2004), abstract, col 2 ln 25-45, col 3 ln 52, 53, 60-64, col 5 ln 20-24, col 7 ln 66,67, col 8 ln 1, Fig. 11.	1 - 31
Y	US 7,207,696 B1 (LIN) 24 April 2007 (24.04.2007), abstract, col 2 60-65, col 4 ln 3-40, Fig. 1, 3, 4.	1 - 31
Y	US 5,303,124 A (WROBEL) 12 April 1994 (12.04.1994), abstract; col 4 ln 65-68; col 5 ln 1, 15-68; Fig. 5.	4, 28, 30
Y	US 5,634,822 A (GUNELL) 03 June 1997 (03.06.1997), abstract, col 3 ln 52,53, col 5 ln 65,66, Fig. 3, 3a.	3, 13, 17, 18, 23
	US 6,902,291 B2 (RIZKIN et al.) 07 June 2005 (07.06.2005), abstract, col 5 ln 1-4, col 4 ln 9-15.	7 - 9, 14, 25

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"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	Date of mailing of the international search report
23 December 2009 (23.12.2009)	19 JAN 2010

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PCT OSP: 571-272-7774