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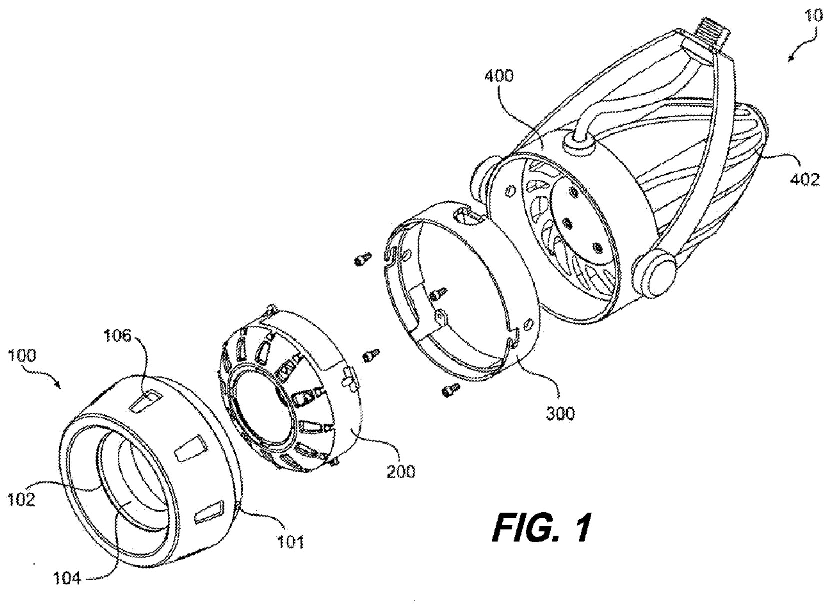

FIG. 1

(57) **Abstract**: A removable light fixture assembly is provided. The light fixture assembly includes an LED lighting element and a compression element. Operation of the compression element from a first position to a second position generates a compression force which reduces thermal impedance between the LED assembly and a thermally- conductive housing.

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LIGHT FIXTURE ASSEMBLY AND LED ASSEMBLY

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention is directed to an LED assembly that can be 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 décor 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 fixture 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.

SUMMARY OF THE INVENTION

[0007] One embodiment of a light fixture assembly may transfer heat from the LED directly into the light fixture housing though a compression-loaded member, such as a thermal pad, to allow for proper thermal conduction between the two. Additionally, certain embodiments of the light fixture assembly may allow end-users to upgrade their LED engine as LED technology advances by providing a removable LED light source with thermal coupling without using metal springs during manufacture, or without requiring use of excessive force by the LED end-user to install the LED in the light fixture housing.

[0008] Certain embodiments of a light fixture assembly may include (1) an LED assembly and (2) an LED socket. The LED assembly may contain a first engagement member, and the socket may contain a second engagement member, such as angled slots. When the LED assembly is rotated, the first engagement member may move down the angled slots such that a compression-loaded thermal pad forms an interface with a light fixture housing. This compressed interface may allow for proper thermal conduction from the LED assembly into the light fixture housing. Additionally, as the LED assembly rotates into an engagement position, it connects with the LED socket's electrical contacts for electricity transmission. Thus, the use of the compressed interface may increase the ease of operation, and at the same time allow for a significant amount of compression force without the need of conventional steel springs. Further, the LED assembly and LED socket can be used in a variety of heat dissipating fixture housings, allowing for easy removal and replacement of the LED. While in some embodiments the LED assembly and LED socket are shown as having a circular perimeter, various shapes may be used for the LED assembly and/or the LED socket.

[0009] Consistent with one embodiment of the present invention, there is provided a thermally-conductive housing; a removable LED assembly, the LED assembly comprising an LED lighting element; and a compression element, operation of the compression element from a first position to a second position generating a compression force causing the LED assembly to become thermally and electrically connected to the housing.

[0010] Consistent with another embodiment of the present invention, there is provided an LED assembly for a light fixture assembly, the light fixture assembly having a thermally-conductive housing, a socket attached to the housing, and a first engaging member, the LED assembly comprising: an LED lighting element; a resilient member; and a second engaging member adapted to engage with the first engaging member; operation of the LED assembly and the socket relative to each other from an alignment position to an engaged position causing the first engaging member to engage the second engaging member and the resilient member to create a compression force to reduce the thermal impedance between the LED assembly and the housing.

[0011] Consistent with another embodiment of the present invention, there is provided a method of manufacturing a light fixture assembly, the method comprising forming an LED assembly including an LED lighting element and a first engaging member; forming a socket attached to a thermally-conductive housing, the socket comprising a second engaging member adapted to engage with the first engaging member; and moving the LED assembly and the socket relative to each other from an alignment position to an engaged position, to cause the first engaging member to engage with the second engaging member and create a compression force establishing an electrical contact and a thermal contact between the LED assembly and a fixture housing.

[0012] Consistent with another embodiment of the present invention, there is provided a light fixture assembly comprising a thermally-conductive housing; a socket attached to the housing and comprising a first engaging member; and an LED assembly, comprising: an LED lighting element; a resilient member; and a second engaging member adapted to engage with the first engaging member; the LED assembly and the socket being movable relative to each other from an alignment position to an engaged position; the first engaging member, in the engaged position, engaging the second engaging member and fixedly positioning the LED assembly relative to the socket; and the resilient member, in the engaged position, creating a compression force forming an electrical contact and a thermal contact between the LED assembly and the housing.

[0013] Consistent with another embodiment of the present invention, a removable LED assembly for use in a light fixture assembly having a thermally-conductive housing is provided. The removable 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 assembly is coupled to a socket of the light fixture assembly. The removable LED assembly also comprises a resilient member operatively coupled to the thermal interface and configured to move from a first position to a second position to generate a compression force between the thermal interface member and the thermally-conductive housing, causing the LED assembly to become thermally connected to the housing.

[0014] Consistent with still another embodiment of the present invention, an LED assembly removably coupleable to a light fixture assembly, the light fixture assembly having a thermally-conductive housing with a socket and a first engaging member is provided. The LED assembly comprises an LED lighting element, a resilient member operatively coupled to the LED lighting element, and a second engaging member adapted to releasably engage the first engaging member to releasably couple the LED assembly to the housing. The engagement of the first and second engaging members causes the resilient member to move from an uncompressed state to a compressed state to create a compression force to form a thermal contact between the LED assembly and the housing.

[0015] Consistent with yet another embodiment of the present invention, a light fixture assembly is provided. The light fixture assembly comprises a thermally-conductive housing, and an LED assembly removably coupleable to a socket of the thermally-conductive housing, the LED assembly comprising an LED lighting element. The light fixture assembly also comprises a compression element configured to move from a first position to a second position to generate a compression force between the

LED assembly and the thermally-conductive housing, causing the LED assembly to become thermally connected to the housing.

[0016] Consistent with still another embodiment of the present invention, a light fixture assembly is provided. The light fixture assembly comprises a thermally-conductive housing, a socket attached to the housing and comprising a first engagement member and an LED assembly. The LED assembly comprises an LED lighting element, a resilient member operatively coupled to the LED lighting element, and a second engaging member adapted to engage with the first engaging member. The LED assembly and the socket are movable relative to each other from a disengaged position to an engaged position, the first engaging member, in the engaged position, engaging the second engaging member and fixedly positioning the LED assembly relative to the socket, and the resilient member, in the engaged position, creating a compression force forming a thermal contact between the LED assembly and the housing.

[0017] Consistent with yet another embodiment of the present invention, an LED assembly for a light fixture assembly is provided, the light fixture assembly having a thermally-conductive housing, a socket attached to the housing, and a first engaging member. The LED assembly comprises an LED lighting element, and a second engaging member adapted to engage with the first engaging member. Operation of the LED assembly and the socket relative to each other from an alignment position to an engaged position causing the first engaging member to engage the second engaging member, and at least one of the first and second engaging members to deform so as to create a compression force to form a thermal contact between the LED assembly and the housing.

[0018] Consistent with another embodiment of the present invention, an LED assembly for a light fixture assembly is provided, the light fixture assembly having a thermally-conductive housing, a socket attached to the housing, and a first engaging member. The LED assembly comprises an LED lighting element and a second engaging member adapted to engage with the first engaging member. Operation of the LED assembly and the socket relative to each other from an alignment position to an engaged position causing the first engaging member to engage the second engaging member, and at least one of the first and second engaging members to deform so as to create a compression force lowering the thermal impedance between the LED assembly and the housing.

[0019] Consistent with still another embodiment of the present invention, a light fixture assembly is provided, comprising a thermally-conductive housing, a socket attached to the housing and comprising a first threaded portion, and an LED assembly. The LED assembly comprises an LED lighting element and a second threaded portion, the LED assembly and the socket being movable relative to each other from a disengaged position to an engaged position where the first and second threaded portions are releasably coupled to each other to fixedly position the LED assembly relative to the socket.

[0020] Consistent with yet another embodiment of the present invention, a light fixture assembly is provided, comprising a thermally-conductive housing, a socket attached to the housing and comprising a buckle, and an LED assembly. The LED assembly comprises an LED lighting element and a buckle catch, the LED assembly and the socket being movable relative to each other from a disengaged position to an engaged position where the buckle and buckle catch are releasably coupled to each other to fixedly position the LED assembly relative to the socket.

[0021] Consistent with another embodiment of the present invention, a method for assembling a light fixture is provided. The method comprises aligning an LED assembly having an LED lighting element with a socket of a housing, and moving the LED assembly and the socket relative to each other to releasably engage a first engagement member of the socket with a second engagement member of the LED assembly to cause a resilient member of the LED assembly to move from an uncompressed state to a compressed state, which generates a compression force between the housing and LED assembly, thereby establishing a thermal contact between the LED assembly and the housing.

[0022] It is to be understood that both the foregoing general description and the following detailed description are explanatory only and are not restrictive of the invention, as claimed.

[0023] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments consistent with the invention and together with the description, serve to explain the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] Figure 1 is an exploded perspective view of a light fixture assembly consistent with the present invention;

[0025] Figure 2 is an exploded perspective view of an LED assembly of the light fixture assembly of Figure 1;

[0026] Figure 3 is a detailed perspective view of the second shell of the LED assembly of Figure 2;

[0027] Figure 4 is a perspective view of a socket of the light fixture assembly of Figure 1;

[0028] Figure 5 is a side view of the socket showing the travel of an engaging member of the LED assembly of Figure 2;

[0029] Figure 6A is a side view of the LED assembly of Figure 2 in a compressed state;

[0030] Figure 6B is a side view of the LED assembly of Figure 2 in an uncompressed state;

[0031] Figure 7 is a perspective view of the LED socket of Figure 4;

[0032] Figures 8A-8B are cross-sectional views of the light fixture assembly of Figure 1;

[0033] Figure 9 is a perspective cross-sectional view of the light fixture assembly of Figure 1;

[0034] Figure 10 is a perspective view of the light fixture assembly of Figure 1;

[0035] Figure 11 is a front view of a light fixture assembly according to a second embodiment;

[0036] Figure 12 is a front view of a light fixture assembly according to a third embodiment;

[0037] Figure 13 is a front view of a light fixture assembly according to a fourth embodiment; and

[0038] Figure 14 is a front view of a light fixture assembly according to a fifth embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0039] Reference will now be made in detail to the embodiments consistent with the present invention, an example of which is illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or similar parts. It is apparent, however, that the embodiments shown in the accompanying drawings are not limiting, and that modifications may be made without departing from the spirit and cope of the invention.

[0040] Figure 1 is an exploded perspective view of a light fixture assembly 10 consistent with the present invention. Light figure assembly 10 includes a front cover 100, a LED assembly 200, a socket 300, and a thermally-conductive housing 400.

[0041] Figure 2 is an exploded perspective view of LED assembly 200. LED assembly 200 may 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.

[0042] First shell 220 may include an opening 221 adapted to receive optic 210, which may be fixed to first shell 220 through an optic-attaching member 222. First shell 220 may also include one or more airflow apertures 225 so that air may pass through airflow apertures 225 and ventilate printed circuit board 250, LED 230, and thermally-conductive housing 400. First shell 220 may also include one more engaging members 223, such as protrusions, on its outer surface 224. While in this embodiment engaging members 223 are shown as being "T-shaped" tabs, engaging members 223 can have a variety of shapes and can be located at various positions and/or on various surfaces of LED assembly 200. Furthermore, the number of engaging members 223 is not limited to the embodiment shown in Figure 2. Additionally, the number, shape and/or location of airflow apertures 225 can also be varied. However, in certain applications, ventilation may not be required, and airflow apertures 225 may thus be omitted.

[0043] Second shell 260 may include a resilient member, such as resilient ribs 263. The thickness and width of ribs 263 can be adjusted to increase or decrease compression force, and the openings between ribs 263 can vary in size and/or shape. In one embodiment, the resilient ribs 263 can have a wishbone shape. Ribs 263 in second shell 260 are formed so as to provide proper resistance to create compression for thermal coupling of LED assembly 200 to thermally-conductive housing 400. Second shell 260 may also include one or more positioning elements 264 that engage with one or more recesses 251 in printed circuit board 250 to properly position printed circuit board 250 and to hold printed circuit board 250 captive between first shell 220 and second shell 260. Positioning elements 264 may also engage with receivers (not shown) in first shell 220. First and second shell 220 and 260 may be made of a plastic or resin material such as, for example, polybutylene terephthalate.

[0044] As shown in Figure 2, the second shell 260 may also include an opening 261 adapted to receive thermal interface member 270, which may be fixed to (1) second shell 260 through one or more attachment members 262, such as screws or other known fasteners and (2) a thermal pad 280 to create thermal interface member assembly 299. Thermal interface member 270 may include an upper portion 271, and a lower portion 272 with a circumference smaller than the circumference of upper portion 271. As shown in Figure 3, lower portion 272 may be inserted through opening 261 of second shell 260 such that upper portion 271 engages with second shell 260. Second shell 260 may be formed of, for example, nylon and/or thermally conductive plastics such as plastics made by Cool Polymers, Inc., known as CoolPoly®.

[0045] Referring now to Figure 2, thermal pad 280 may be attached to thermal interface member 270 through an adhesive or any other appropriate known fastener so as to fill microscopic gaps and/or pores between the surface of the thermal interface member 270 and thermally-conductive housing 400. Thermal pad 280 may be any of a variety of types of commercially available thermally conductive pad, such as, for example, Q-PAD 3 Adhesive Back, manufactured by The Bergquist Company. While thermal pad 280 is used in this embodiment, it can be omitted in some embodiments.

[0046] As shown in Figure 2, lower portion 272 of thermal interface member 270 may serve to position LED 230 in LED assembly 200. LED 230 may be mounted to a surface 273 of lower portion 272 using fasteners 231, which may be screws or other well-known fasteners. A thermally conductive material 240 may be positioned between LED 230 and surface 273.

[0047] 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 act to fill in these voids to reduce the thermal impedance between LED 230 and surface 273, resulting in improved thermal conduction. Moreover, consistent with the present invention, thermally conductive material 240 may be 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, manufactured by The Bergquist Company, which is designed to change from a solid to a liquid at 55°C.

[0048] While in this embodiment thermal interface member 270 may be made of aluminum and is shown as resembling a "top hat," various other shapes, sizes, and/or materials could be used for the thermal interface member to transport and/or spread heat. As one example, thermal interface member 270 could resemble a "pancake" shape and have a single circumference. Furthermore, thermal interface member 270 need not serve to position the LED 230 within LED assembly 200. Additionally, while LED 230 is shown as being mounted to a substrate 238, LED 230 need not be mounted to substrate 238 and may instead be directly mounted to thermal interface member 270. 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.

[0049] Figure 4 is a perspective view of socket 300 including one or more engaging members, such as an angled slot 310 arranged on inner surface 320 of LED socket 300. Slot 310 includes a receiving portion 311 that receives and is engageable with a respective engaging member 223 of first shell 220 at an alignment position, a lower portion 312 that extends circumferentially around a portion of the perimeter of LED socket 300 and is adapted to secure LED assembly 200 to LED socket 300, and a stopping portion 313. In some embodiments, stopping portion 313 may include a protrusion (not shown) that is also adapted to secure LED assembly 200 to LED socket 300. Slot 310 may include a slight recess 314, serving as a locking mechanism for engaging member 223. Socket 300 also includes a front cover retaining mechanism 330 adapted to engage with a front cover engaging member 101 in front cover 100 (shown in Figures 1 and 10). A front cover retaining mechanism lock 331 (Figure 5) is provided such that when front cover retaining mechanism 330 engages with and is rotated with respect to front cover engaging member 101, the front cover retaining mechanism lock holds the front cover 100 in place. Socket 300 may be fastened to thermally-conductive housing 400 through a retaining member, such as a retaining member 340 using a variety of well-known fasteners, such as screws and the like. Socket 300 could also have a threaded outer surface that engages with threads in thermally-conductive housing 400. Alternatively, socket 300 need not be a separate element attached to thermally-conductive housing 400, but could be integrally formed in thermally-conductive housing 400 itself.

Additionally, as shown in Figure 7, socket 300 may also include a tray 350 which holds a terminal block 360, such as a battery terminal connector.

[0050] Referring now to Figure 5, to mount LED assembly 200 in socket 300, LED assembly 200 is placed in an alignment position, in which engaging members 223 of LED assembly 200 are aligned with receiving portions 311 of angled slots 310 of socket 300. In one embodiment, LED assembly 200 and socket 300 may have a circular perimeter and, as such, LED assembly 200 may be rotated with respect to socket 300 in the direction of arrow A in Figure 4. As shown in Figure 5, when LED assembly 200 is rotated, engaging members 223 travel down receiving portions 311 into lower portions 312 of angled slots 310 until engaging members 223 meet stopping portion 313, which limits further rotation and/or compression of LED assembly 200, thereby placing LED assembly 200 and socket 300 in an engagement position.

[0051] Referring now to Figures 6A and 6B, second shell 260 is shown in compressed and uncompressed states, respectively. The rotation of LED assembly 200, and the pressing of engaging members 223 on upper surface 314 of angled slots 310 causes resilient ribs 263 of second shell 260 to deform axially inwardly which may decrease the height H_c of LED assembly 200 with respect to the height H_u of LED assembly 200 in an uncompressed state. Referring back to Figure 5, as engaging members 223 descend deeper down angled slot 310, the compression force generated by resilient ribs 263 increases. This compression force lowers the thermal impedance between LED assembly 200 and thermally-conductive housing 400. Engaging members 223 and angled slots 310 thus form a compression element.

[0052] Figure 9 is a perspective cross-sectional view of one embodiment of a light fixture assembly showing LED assembly 200 in a compressed state such that it is thermally and electrically connected to thermally-conductive housing 400. As shown in Figure 6B, if LED assembly 200 is removed from socket 300, resilient ribs 263 will return substantially to their initial undeformed state.

[0053] Additionally, as shown in Figures 8A and 8B, the rotation of LED assembly 200 forces printed circuit board electrical contact strips 252 on printed circuit board 250 into engagement with electrical contacts 361 of terminal block 360, thereby creating an electrical connection between LED assembly 200 and electrical contacts 361 of housing 400, so that operating power can be provided to LED 230. Alternate mechanisms may also be provided for supplying operating power to LED 230. For example, LED assembly 200 may include an electrical connector, such as a female connector for receiving a power cord from housing 400 or a spring-loaded electrical contact mounted to the LED assembly 200 or the housing 400.

[0054] As shown in Figure 7, while in this embodiment receiving portions 311 of angled slots 310 are the same size, receiving portions 311, angled slots 310, and/or engaging members 223 may be of different sizes and/or shapes. For example, receiving portions 311 may be sized to accommodate a larger engaging member 223 so that LED assembly 200 may only be inserted into socket 300 in a specific position. Additionally, the location and number of angled slots 310 are not limited to the embodiment shown in Figure 7.

[0055] Furthermore, while the above-described embodiment uses angled slots, other types of engagement mechanisms between the LED assembly 200 and the LED socket 300 may be used in other embodiments to create thermal and electrical connections between LED assembly 200 and thermally-conductive housing 400.

[0056] As shown in Figure 11, in a second embodiment of a light fixture assembly, LED assembly 230 may be mounted to a thermal interface member 270, which may include a male threaded portion 232 with a first button-type electrical contact 233 insulated from threaded portion 232. Male threaded portion 232 of thermal interface member 270 could rotatably engage with, for example, a female threaded portion 332 of socket 300, such that one or both of male and female threaded portions 232, 332 slightly deform to create compressive force such that first electrical contact 233 comes into contact with second button-type electrical contact 333 and the thermal impedance between thermal interface member 270 and housing 400 is lowered. A thermal pad 280 with a circular center cut-out may be provided at an end portion of male threaded portion 232. The thermal pad 280 can have resilient features such that resilient thermal interface pad 280 acts as a spring to create or increase a compression force to lower the thermal impedance between thermal interface member 270 and housing 400. Male and female threaded portions 232, 332 thus form a compression element.

[0057] As shown in Figure 12, in a third embodiment of a light fixture assembly, a resilient thermal interface pad 500 may be provided at an end portion of thermal interface member 270 such that resilient thermal interface pad 500 acts to create a compression force for low thermal impedance coupling. Socket 300 may include tabs 395 that engage with slots in thermal interface member 270 to form a compression element and create additional compression as well as to lock the LED assembly into place.

[0058] As shown in Figure 13, in a fourth embodiment of a light fixture assembly, thermal interface member 270 may have a buckle catch 255 that engages with a buckle 355 on thermally-conductive housing 400, thus forming a compression element. As shown in Figure 14, in a fifth embodiment of a light fixture assembly, a fastener such as screw 265 may attach to a portion 365 of heat-dissipating fixture housing 400 so as to form a compression element and create the appropriate compressive force to provide low impedance thermal coupling between thermal interface member 270 and thermally-conductive housing 400.

[0059] Referring back to Figure 1, 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 front cover 100 in place. 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 a plurality of peripheral holes 106 formed on a periphery of front cover 100. Lens 104 allows light emitted from a lighting element to pass through cover 100, while also protecting the lighting element from the environment. Lens 102 may be made from any appropriate transparent material to allow light to flow therethrough, with minimal reflection or scattering.

[0060] As shown in Figure 1, and consistent with the present invention, front cover 100, LED assembly 200, socket 300, and thermally-conductive housing 400 may be formed from materials having a thermal conductivity k of at least 12 W/m·k, and preferably at least 200 W/m·k, such as, for example, aluminum, copper, or thermally conductive plastic. Front cover 100, LED assembly 200, socket 300, and thermally-conductive housing 400 may be formed from the same material, or from different materials. 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 illustrated, embodiments consistent with the present invention may use one or more peripheral holes 106 or none at all. Consistent with an embodiment of the present invention, peripheral holes 106 are designed to allow air to flow through front cover 100, into and around LED assembly 200 and flow through air holes in thermally-conductive housing 400 to dissipate heat.

[0061] Additionally, as shown in Figure 1, 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. Thermally-conductive housing 400 may be made from an extrusion including a plurality of surface-area increasing structures, such as ridges 402 (shown in Figure 1) as described more completely in co-pending U.S. Patent Application No. 11/715,071 assigned to the assignee of the present invention, the entire disclosure of which is hereby incorporated by reference in its entirety. Ridges 402 may serve multiple purposes. For example, ridges 402 may provide heat-dissipating surfaces so as to increase the overall surface area of thermally-conductive housing 400, providing a greater surface area for heat to dissipate to an ambient atmosphere over. That is, ridges 402 may allow thermally-conductive housing 400 to act as an effective heat sink for the light fixture assembly. Moreover, 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, ridges 402 may be formed such that thermally-conductive housing 400 is shaped into an ornamental extrusion having aesthetic appeal. However, 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, but also as a heat sink for cooling LED 230.

[0062] Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples be considered as examples only, with a true scope and spirit of the invention being indicated by the following claims.

WHAT IS CLAIMED IS:

1. A removable LED assembly for use in a light fixture assembly having a thermally-conductive housing, comprising:

an LED lighting element;

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

a resilient member operatively coupled to the thermal interface and configured to move from a first position to a second position to generate a compression force between the thermal interface member and the thermally-conductive housing, causing the LED assembly to become thermally connected to the housing.

2. An LED assembly removably coupleable to a light fixture assembly, the light fixture assembly having a thermally-conductive housing with a socket and a first engaging member, the LED assembly comprising:

an LED lighting element;

a resilient member operatively coupled to the LED lighting element; and

a second engaging member adapted to releasably engage the first engaging member to releasably couple the LED assembly to the housing,

wherein the engagement of the first and second engaging members causes the resilient member to move from an uncompressed state to a compressed state to create a compression force to form a thermal contact between the LED assembly and the housing.

3. A light fixture assembly, comprising:

a thermally-conductive housing;

an LED assembly removably coupleable to a socket of the thermally-conductive housing, the LED assembly comprising

an LED lighting element; and

a compression element configured to move from a first position to a second position to generate a compression force between the LED assembly and the thermally-conductive housing, causing the LED assembly to become thermally connected to the housing.

4. A light fixture assembly, comprising:

a thermally-conductive housing;

a socket attached to the housing and comprising a first engaging member; and

an LED assembly, comprising:

an LED lighting element;

a resilient member operatively coupled to the LED lighting element; and

a second engaging member adapted to engage with the first engaging member;

the LED assembly and the socket being movable relative to each other from a disengaged position to an engaged position;

the first engaging member, in the engaged position, engaging the second engaging member and fixedly positioning the LED assembly relative to the socket; and

the resilient member, in the engaged position, creating a compression force forming a thermal contact between the LED assembly and the housing.

5. An LED assembly for a light fixture assembly, the light fixture assembly having a thermally-conductive housing, a socket attached to the housing, and a first engaging member, the LED assembly comprising:

an LED lighting element; and

a second engaging member adapted to engage with the first engaging member;

operation of the LED assembly and the socket relative to each other from an alignment position to an engaged position causing:

the first engaging member to engage the second engaging member, and

at least one of the first and second engaging members to deform so as to create a compression force to form a thermal contact between the LED assembly and the housing.

6. An LED assembly for a light fixture assembly, the light fixture assembly having a thermally-conductive housing, a socket attached to the housing, and a first engaging member, the LED assembly comprising:

an LED lighting element; and

a second engaging member adapted to engage with the first engaging member;

operation of the LED assembly and the socket relative to each other from an alignment position to an engaged position causing:

the first engaging member to engage the second engaging member; and

at least one of the first and second engaging members to deform so as to create a compression force lowering the thermal impedance between the LED assembly and the housing.

7. The assembly of claim 1, wherein the LED lighting element indirectly contacts the thermal interface member.

8. The assembly of claims 1 and 7, wherein the thermal interface member comprises a first portion having a first circumference and a second portion having a second circumference, the second circumference being smaller than the first circumference.

9. The assembly of claims 1, 7 and 8, wherein the thermal interface member comprises a phase change material.

10. The assembly of claims 1, and 7-9, wherein the thermal interface member is disposed between the LED assembly and the housing, the thermal interface member configured to provide a path for thermal energy between the LED lighting element and the housing when the LED assembly is coupled to the housing.

11. The assembly of claims 1, 2, and 4, wherein the resilient member comprises a plurality of resilient radially outwardly extending deformable ribs.

12. The assembly of claims 1, 2, 4, and 11, wherein the resilient member has a generally wishbone shape.

13. The assembly of claims 2, 4, 5 and 6, wherein the first engaging member comprises a protrusion and the second engaging member comprises a slot releasably engageable with the protrusion, wherein rotation of the LED assembly relative to the housing causes the protrusion to travel along the slot and the resilient member to deform to generate a compression force between the LED assembly and the housing.

14. The assembly of claims 1-13, comprising a connection member for removably supplying operating power to the LED lighting element.

15. The assembly of claims 1-14, comprising a resilient electrically conductive member mounted to at least one of the LED assembly and the housing, the compression force causing the LED to become electrically connected to the housing.

16. The assembly of claims 1-15, further comprising a printed circuit board electrically connected to the LED lighting element and configured to control the operation of the LED lighting element.

17. The assembly of claims 1-16, further comprising one or more electrical contact members on the LED assembly configured to contact an electrical contact on the housing when the LED assembly is coupled to the housing to provide an electrical connection between the LED assembly and the housing.

18. The assembly of claim 17, wherein the electrical contact members are electrical contact strips or pads.

19. The assembly of claims 17 and 18, wherein the electrical contact on the housing comprises an electrical contact of a socket of the housing

20. The assembly of claims 1-19, further comprising a thermally conductive substrate that supports the LED lighting element.

21. The assembly of claims 1-20, wherein the socket includes a front cover retaining mechanism adapted to engage with a front cover engaging member on a front cover of the housing.

22. A light fixture assembly, comprising:

a thermally-conductive housing;

a socket attached to the housing and comprising a first threaded portion; and

an LED assembly, comprising:

an LED lighting element; and

a second threaded portion;

the LED assembly and the socket being movable relative to each other from a disengaged position to an engaged position where the first and second threaded portions are releasably coupled to each other to fixedly position the LED assembly relative to the socket.

23. The light fixture assembly of claim 22, wherein the threaded coupling of the first and second threaded portions generates a compression force between the LED assembly and the housing.

24. A light fixture assembly, comprising:

a thermally-conductive housing;

a socket attached to the housing and comprising a buckle; and

an LED assembly, comprising:

an LED lighting element; and

a buckle catch;

the LED assembly and the socket being movable relative to each other from a disengaged position to an engaged position where the buckle and buckle catch are releasably coupled to each other to fixedly position the LED assembly relative to the socket.

25. The light fixture assembly of claim 24, wherein the coupling of the buckle and buckle catch generates a compression force between the LED assembly and the housing.

26. A method for assembling a light fixture, comprising:

aligning an LED assembly having an LED lighting element with a socket of a housing; and

moving the LED assembly and the socket relative to each other to releasably engage a first engagement member of the socket with a second engagement member of the LED assembly to cause a resilient member of the LED assembly to move from an uncompressed state to a compressed state to generate a compression force between the housing and LED assembly, to thereby establish a thermal contact between the LED assembly and the housing.

27. The method of claim 26, wherein moving includes rotating the LED assembly relative to the socket.

28. The method of claims 26 and 27, wherein moving the LED assembly and the socket relative to each other further comprises releasably engaging one or more electrical contact strips of the LED assembly to an electrical contact member on the socket to establish an electrical connection between the LED assembly and the housing.

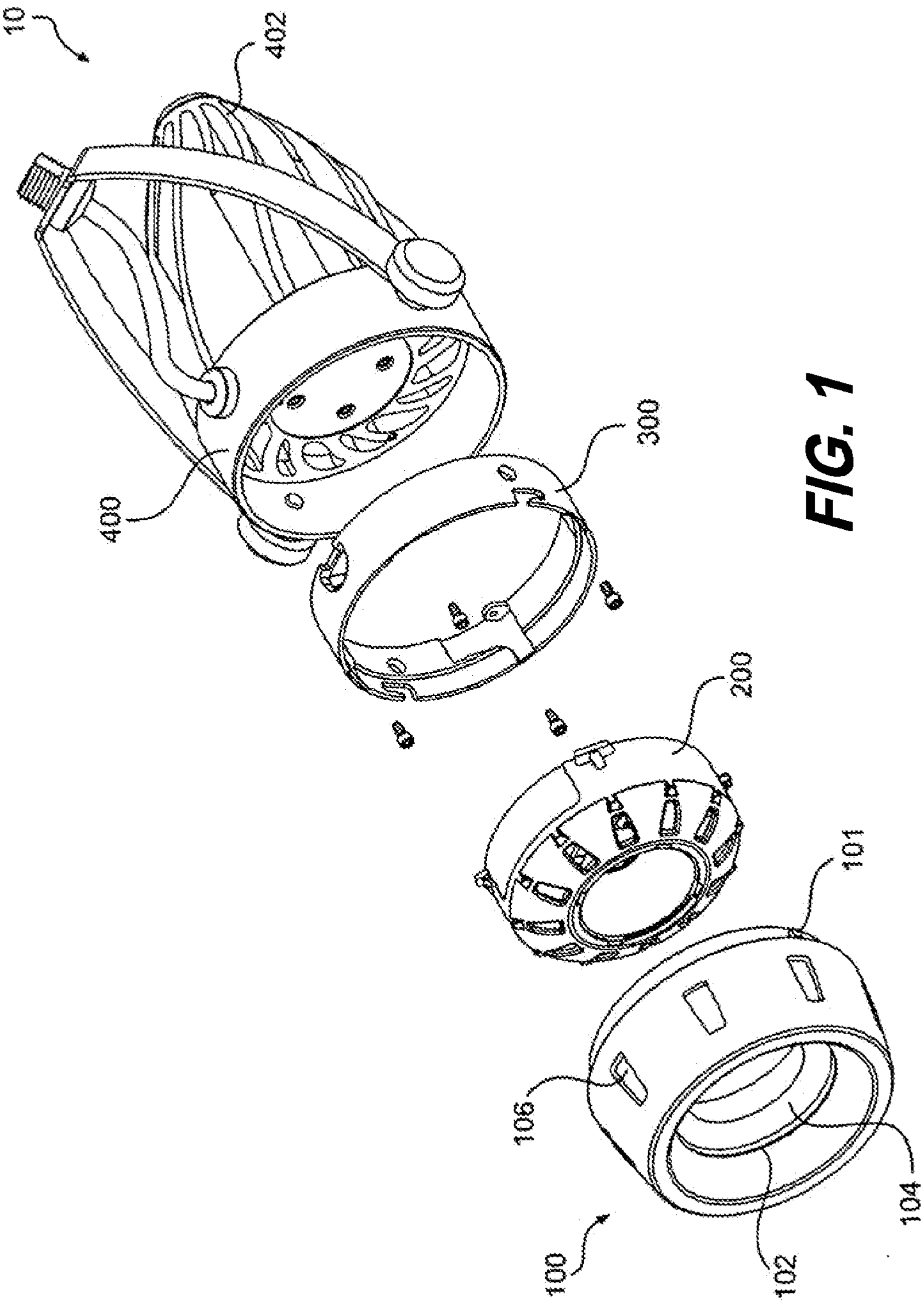

FIG. 1

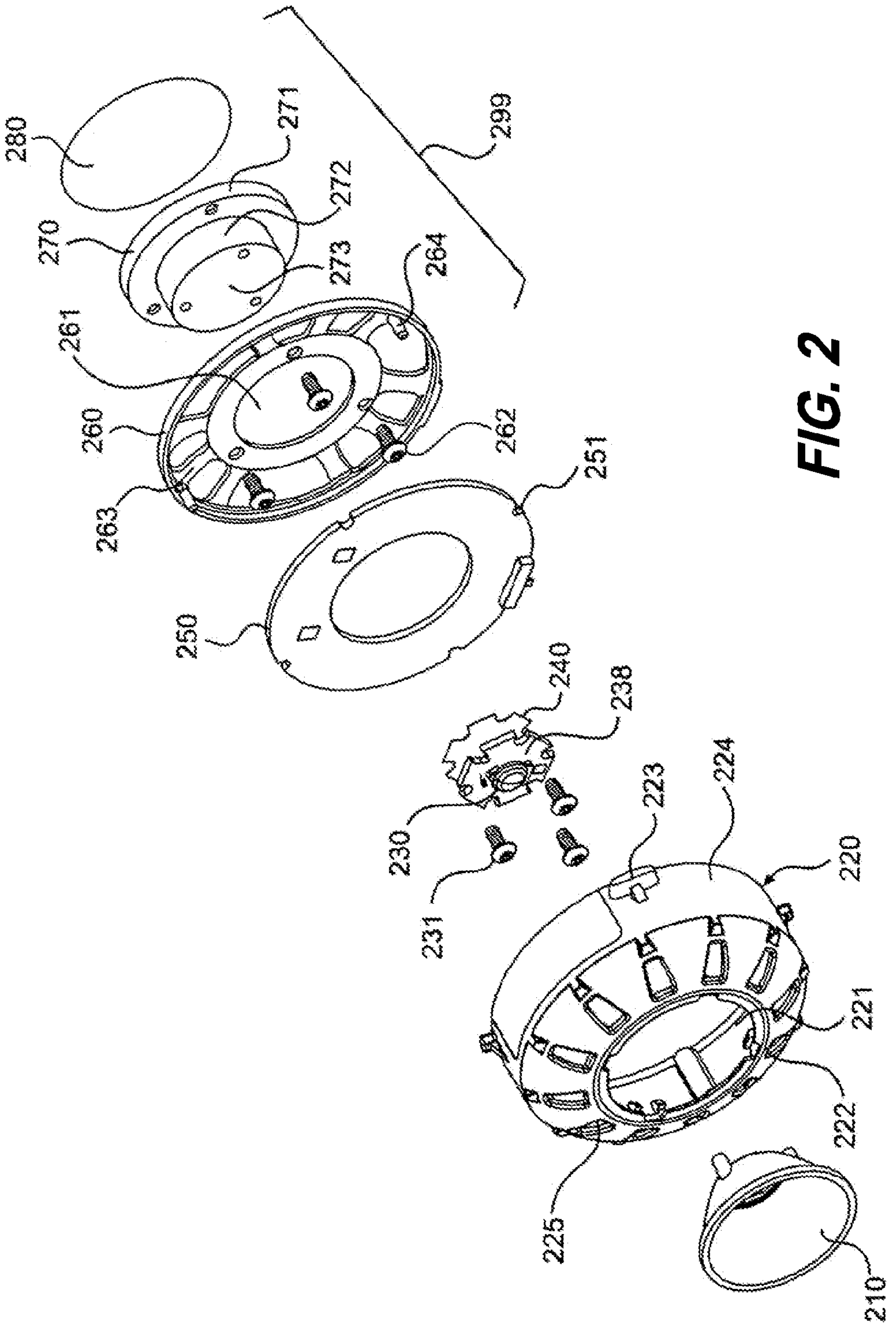
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FIG. 2

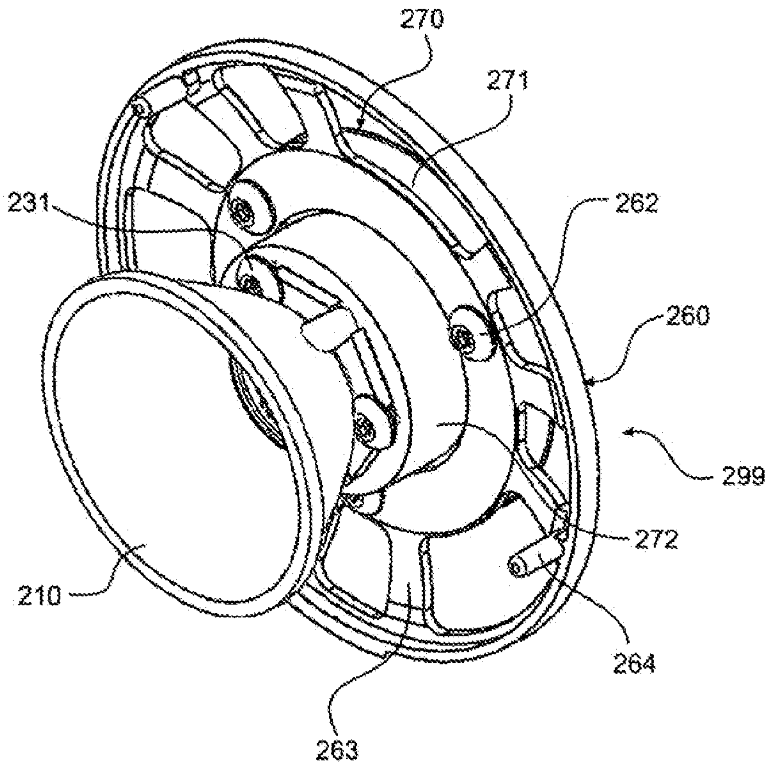

FIG. 3

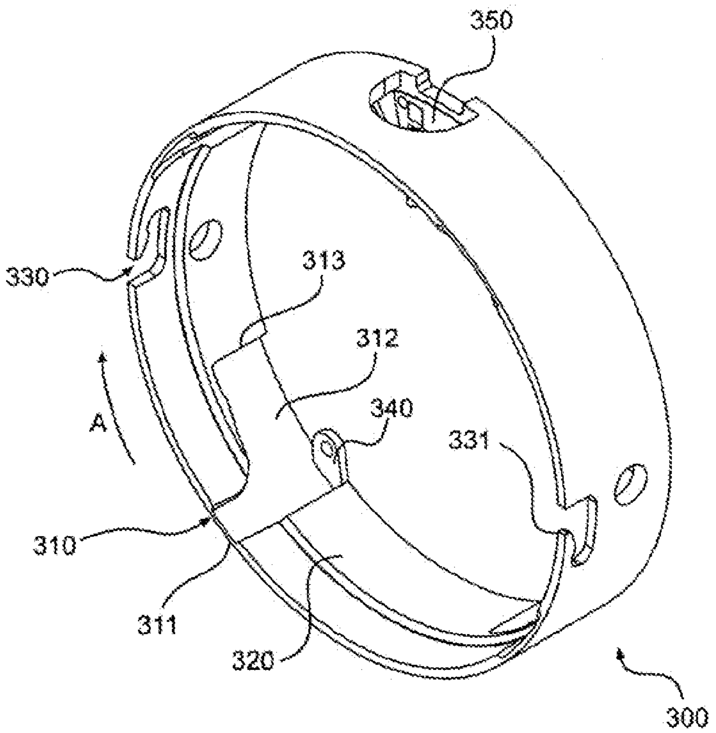

FIG. 4

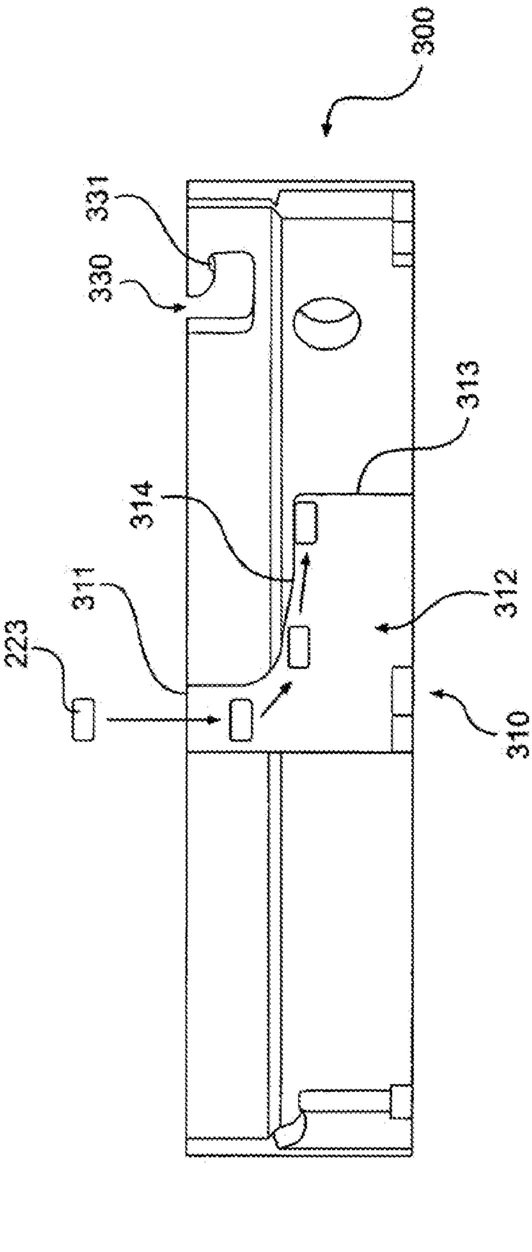

FIG. 5

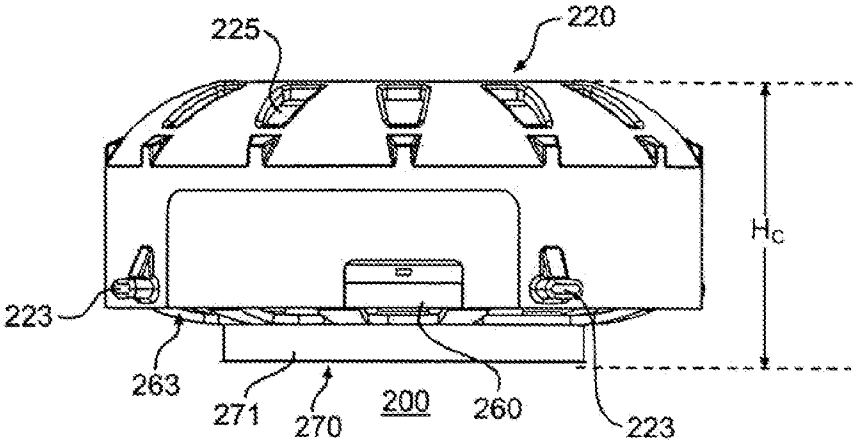
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FIG. 6A

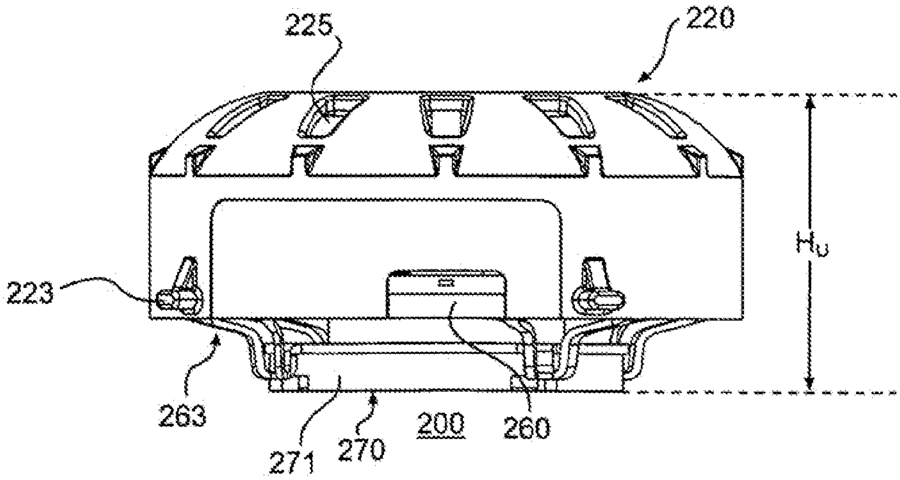
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FIG. 6B

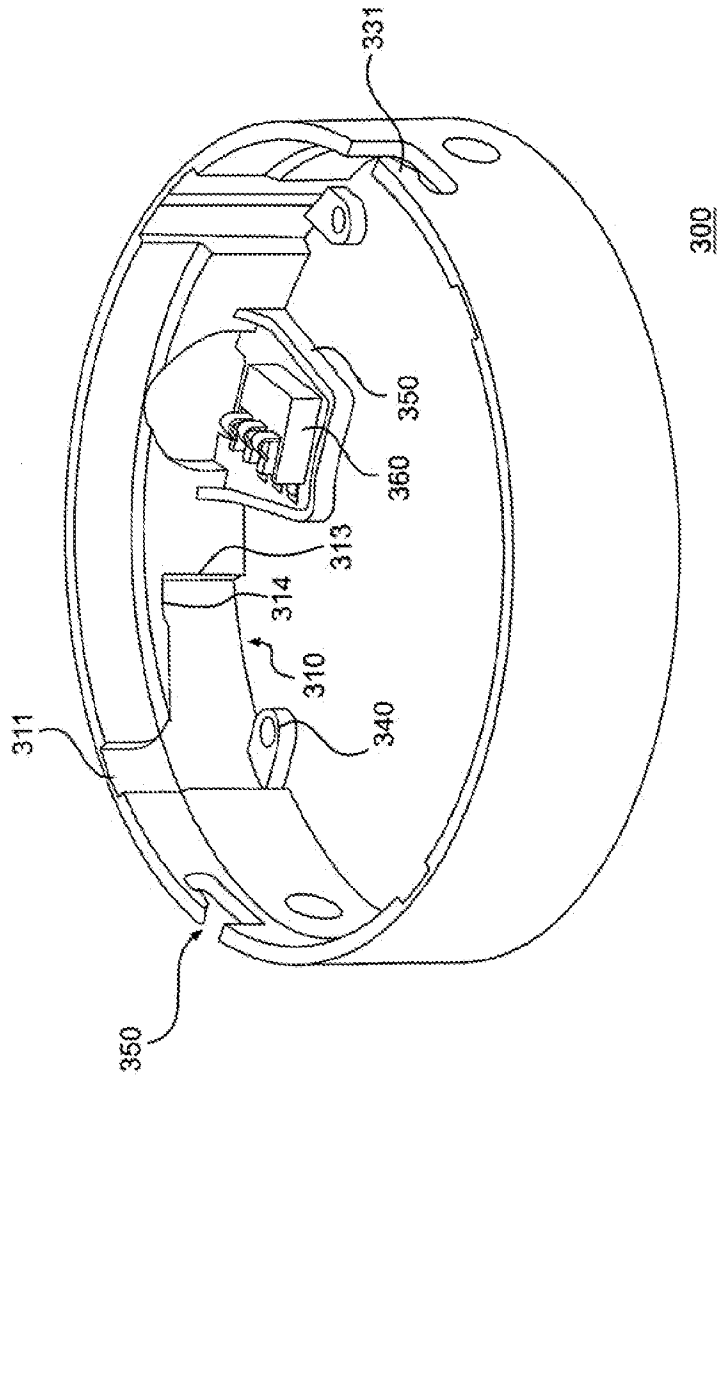

FIG. 7

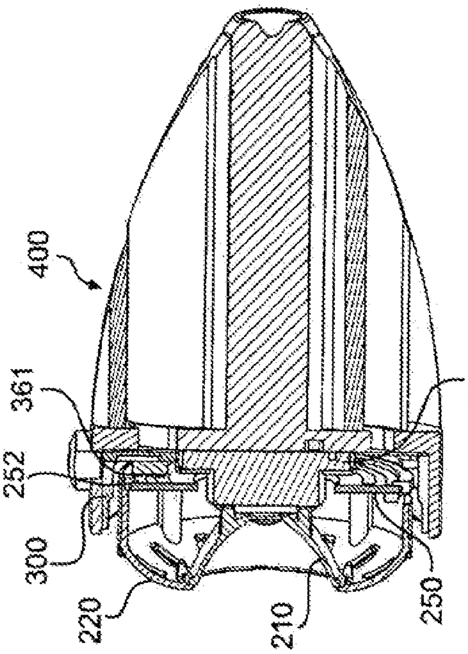

FIG. 8B

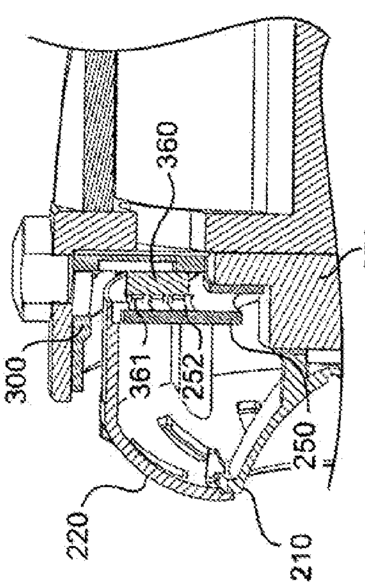

FIG. 8A

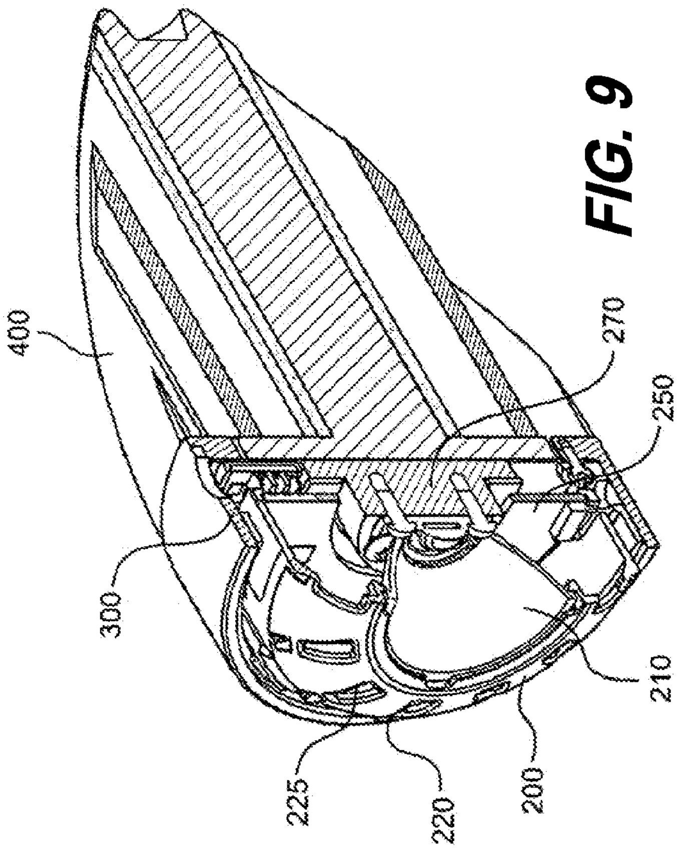

FIG. 9

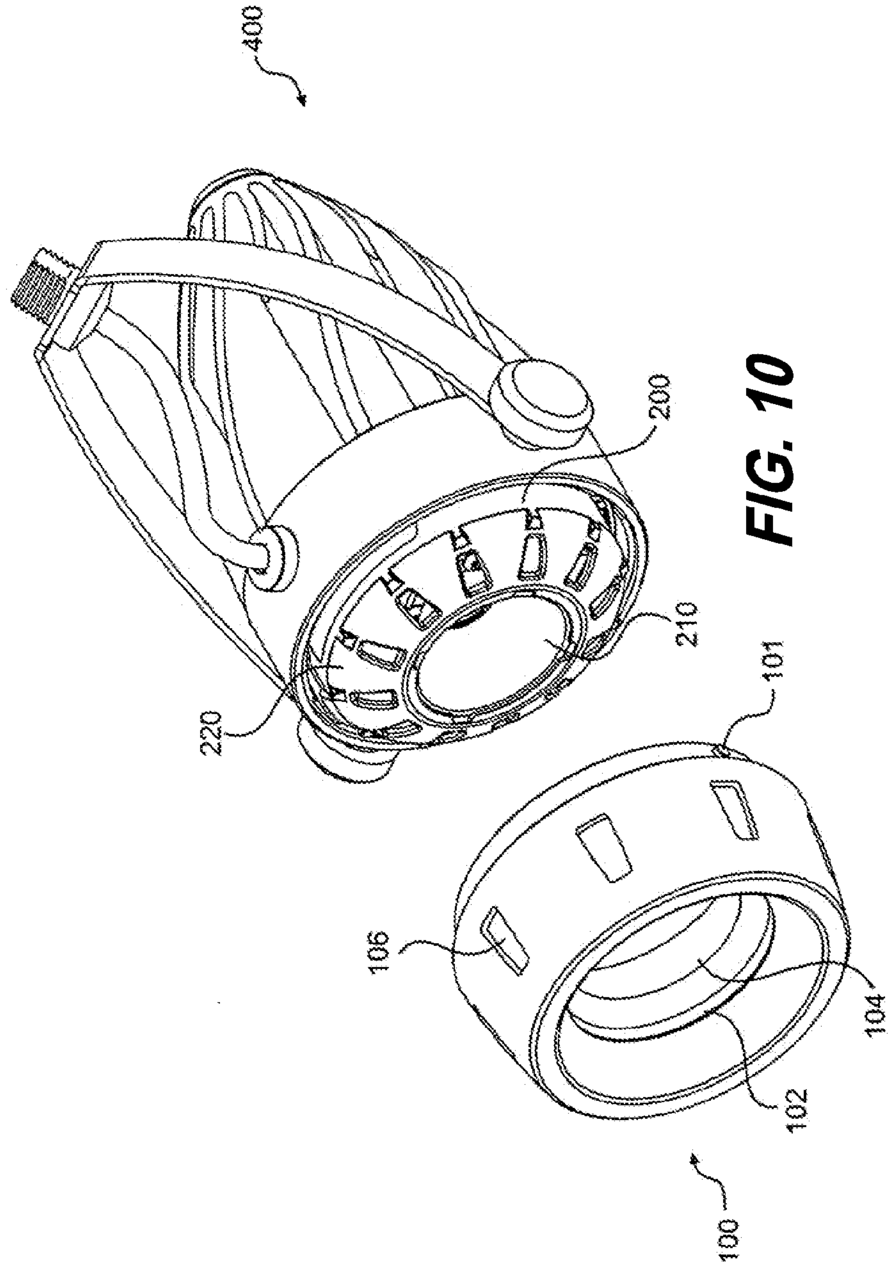

FIG. 10

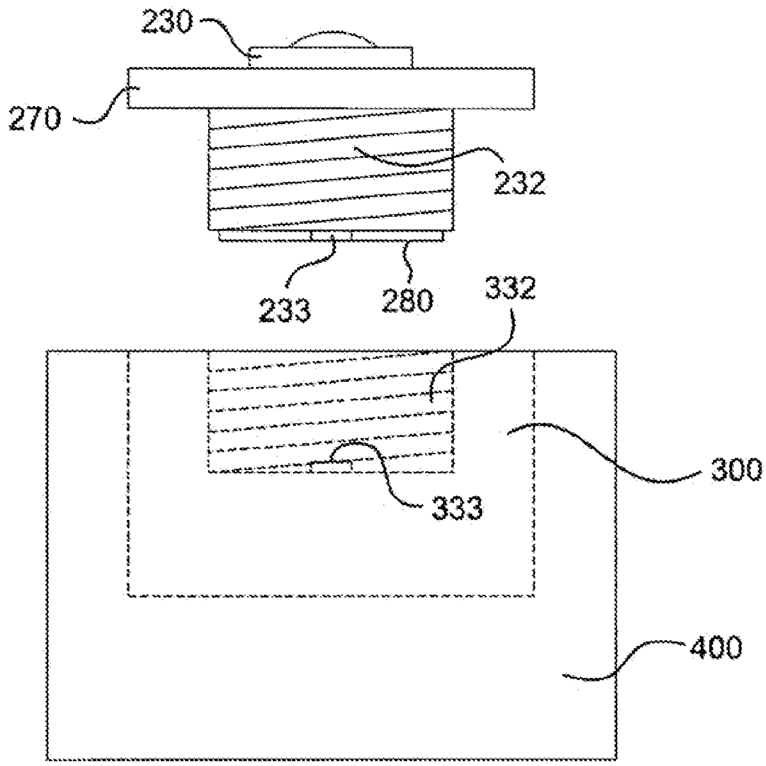

FIG. 11

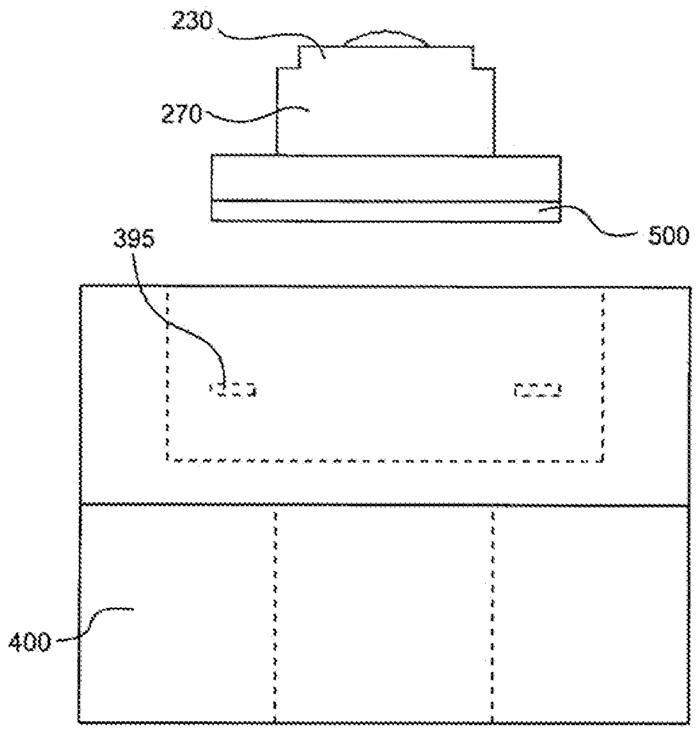

FIG. 12

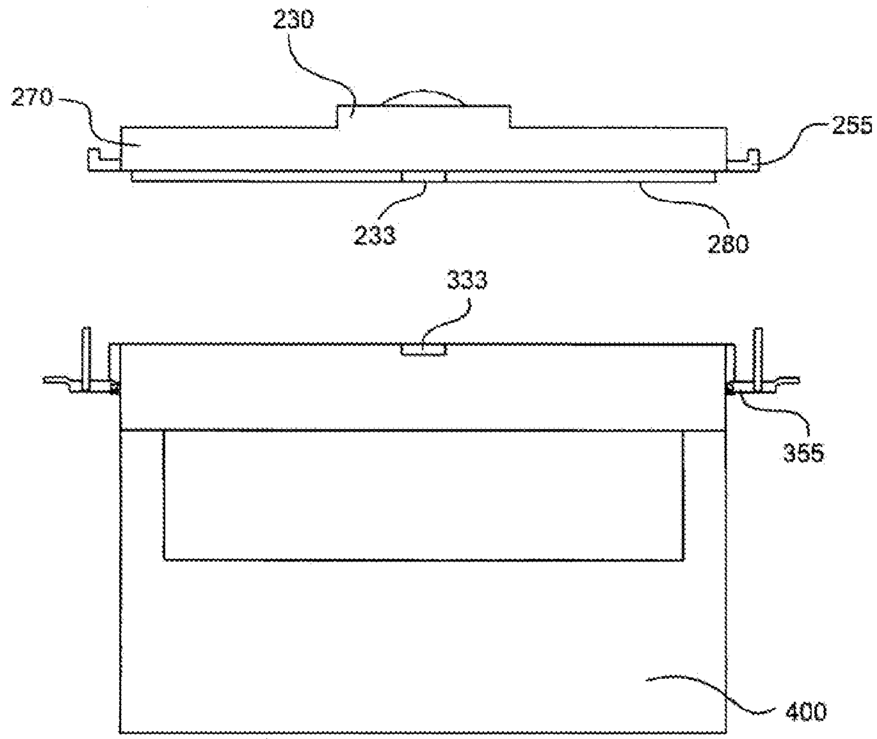

FIG. 13

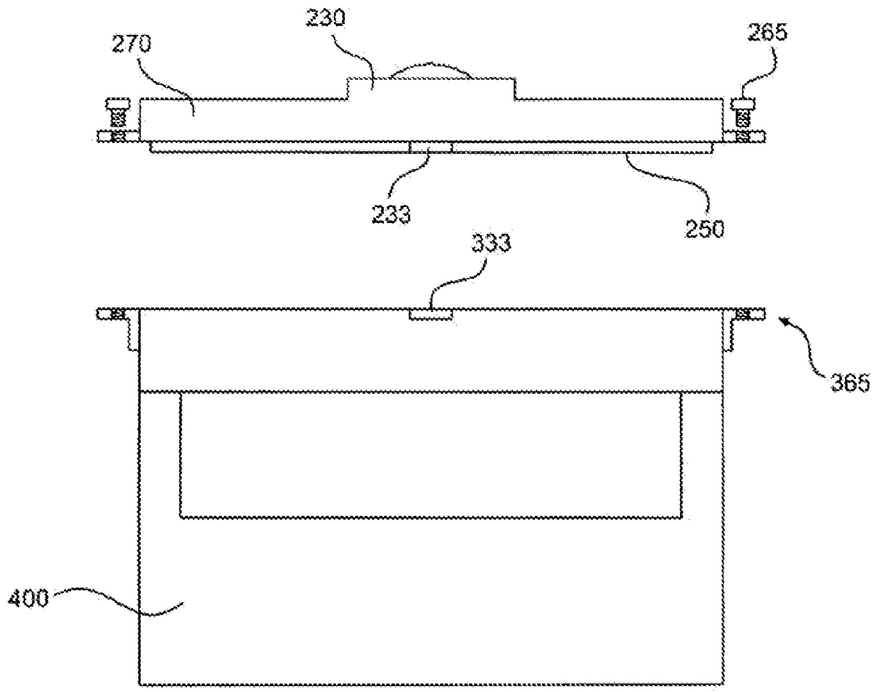

FIG. 14

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/035321

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21V19/00 F21V29/00
ADD. F21Y101/02

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)
F21V

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 practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/128070 A1 (ELECTRICS PTY LTD SPA [AU]; RICHARDS LARRY JOHN [AU]) 15 November 2007 (2007-11-15) the whole document	1-28
X	US 2005/146884 A1 (SCHEITHAUER ULRICH [DE]) 7 July 2005 (2005-07-07) paragraphs [0021], [0035] - [0037]; figures	1-28
X	JP 2004 265626 A (MATSUSHITA ELECTRIC IND CO LTD) 24 September 2004 (2004-09-24) abstract; figures	1-28
A	JP 2007 273209 A (MITSUBISHI ELECTRIC CORP; MITSUBISHI ELEC LIGHTING CORP) 18 October 2007 (2007-10-18) abstract; figures	1-28

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"E" earlier document 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
17 June 2009	25/06/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Berthommé, Emmanuel

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/035321

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2006/076672 A1 (PETROSKI JAMES [US]) 13 April 2006 (2006-04-13) paragraph [0001] - paragraph [0004] paragraph [0020] - paragraph [0021]; figures	1-28

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2009/035321

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
WO 2007128070	A1	15-11-2007	NONE			
US 2005146884	A1	07-07-2005	NONE			
JP 2004265626	A	24-09-2004	JP	4095463	B2	04-06-2008
JP 2007273209	A	18-10-2007	NONE			
US 2006076672	A1	13-04-2006	CN	101040378	A	19-09-2007
			EP	1805797	A2	11-07-2007
			WO	2006044027	A2	27-04-2006