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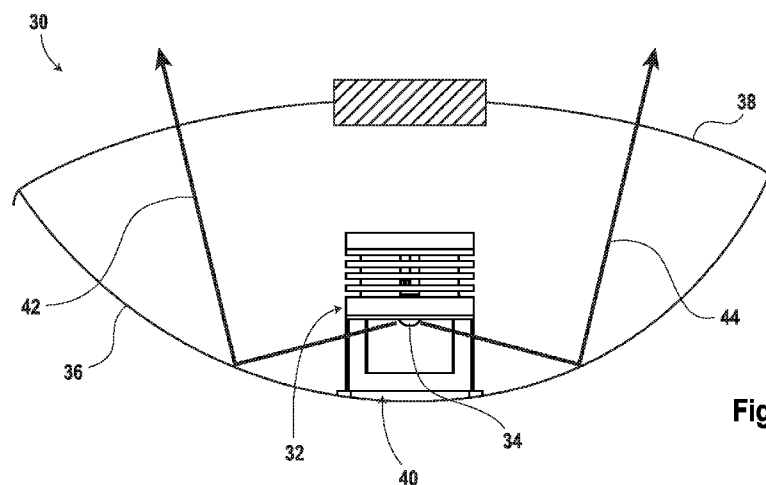
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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(54) **Title:** OPERATORY LIGHTS AND REPLACEMENT BULBS FOR OPERATORY LIGHTS



**Fig. 2**

(57) **Abstract:** An operatory light may comprise a bulb that includes a light emitting diode (LED) module positioned such that when the bulb is installed into a socket of the operatory light and powered, none of the light emitted from the LED is directed directly toward a lens of the operatory light, and only reflected light passes through the lens of the operatory light.

## **OPERATORY LIGHTS AND REPLACEMENT BULBS FOR OPERATORY LIGHTS**

### **TECHNICAL FIELD OF THE INVENTION**

**[0001]** The present invention relates to operatory lights and replacement bulbs for operatory lights. More specifically, an operatory light comprising a bulb that includes a light emitting diode (LED).

### **CROSS-REFERENCES TO RELATED APPLICATIONS**

**[0002]** This application claims the benefit of U.S. Provisional Application No. 62/120,668 filed on February 25, 2015, which is hereby incorporated by reference in its entirety.

### **SUMMARY OF THE INVENTION**

**[0003]** An operatory light may comprise a bulb that includes a light emitting diode (LED) positioned such that when the bulb is installed into a socket of the operatory light and powered, none of the light emitted from the LED is emitted directly through a lens of the operatory light; only reflected light passes through the lens of the operatory light.

**[0004]** A replacement bulb may comprise an LED positioned on a heat sink. The LED may be oriented to direct light toward a base of the replacement bulb and the base of the replacement bulb may be configured to couple with a socket of an operatory light.

**[0005]** Additional features and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by the practice of the invention. The features and advantages of the

invention may be realized and obtained by means of the instruments and combinations particularly pointed out in the appended claims. These and other features of the present invention will become more fully apparent from the following description and appended claims, or may be learned by the practice of the invention as set forth hereinafter.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0006]** In order to describe the manner in which the above-recited and other advantages and features of the invention can be obtained, a more particular description of the invention briefly described above will be rendered by reference to specific example embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are not therefore to be considered to be limiting of its scope, the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings.

**[0007]** Figure 1 shows a schematic view of an operatory light with a conventional bulb.

**[0008]** Figure 2 shows a schematic view of an operatory light with a bulb according to an embodiment of the present invention.

**[0009]** Figure 3 shows an exploded view of the bulb of Figure 2.

**[0010]** Figure 4 shows a side view of the bulb of Figure 2.

**[0011]** Figure 5 shows an exploded cross-sectional view of the bulb of Figure 2.

**[0012]** Figure 6 shows an exploded view of another bulb according to an embodiment of the present invention.

**[0013]** Figure 7 shows a side view of the bulb of Figure 6.

**[0014]** Figure 8 shows an exploded cross-sectional view of the bulb of Figure 6.

**[0015]** Figure 9 shows an exploded view of another bulb according to an embodiment of the present invention.

**[0016]** Figure 10 shows a side view of the bulb of Figure 9.

**[0017]** Figure 11 shows an exploded cross-sectional view of the bulb of Figure 9.

**[0018]** Figure 12 shows an exploded view of another bulb according to an embodiment of the present invention.

**[0019]** Figure 13 shows a side view of the bulb of Figure 12.

**[0020]** Figure 14 shows an exploded cross-sectional view of the bulb of Figure 12.

#### DETAILED DESCRIPTION

**[0021]** As shown in Fig. 1, an operatory light 10 may generally include a bulb 12, a reflector 14, and a lens 16. Traditional bulbs, such as bulb 12, may be incandescent bulbs that emit light in substantially all directions. When the bulb 12 is installed into a socket 18 of the operatory light 10 and powered, the bulb 12 may emit light directly toward the reflector 14, as illustrated by light beam 20. The bulb 12 also may emit light directly toward the lens 16, as illustrated by light beam 22.

**[0022]** In embodiments of the present invention, as shown in Fig. 2, an operatory light 30 may include a bulb 32 that includes a light emitting diode (LED) 34. The operatory light 30 (Fig. 1) may be identical to the operatory light 10 (Fig. 1), except that it includes a bulb 32 that is different than the traditional bulb 12. Referring again to Fig. 2, the operatory light 30 may include a reflector 36, a lens 38, and a socket 40. When the bulb 32 is installed into the socket 40 and powered, the LED 34 of the bulb 32 may emit light directly toward the reflector 36, as illustrated by light beams 42 and 44. None of the light from the LED 34, however, will be emitted directly toward the

lens 38, and all of the light passing through the lens 38 will be reflected light. This is because the LED 34 is positioned so that it is directed toward the socket 40 and the reflector 36 of the operatory light 30 when the bulb 32 is installed in the socket 40.

**[0023]** The bulb 32 will now be described in more detail with reference to Figs. 3-5. Fig. 3 shows an exploded view of the bulb 32. As shown, the bulb 32 may include a base 42, a cover 44, an LED module 46, a heat sink 48, control circuitry 50, and a cap 52.

**[0024]** As shown in FIG. 4, the LED module 46 may include the LED 34, which may be a single packaged LED chip or a plurality of LED chips in a package, mounted on a heat conductive material, such as a metal printed circuit board (MPCB) 54. As shown, an encapsulant that covers LED chip(s) of the LED module 46 may serve as a lens.

**[0025]** The laminate layers may build into the mouth guard the best mix of physical characteristics such as shape-memory, toughness, and abrasion/puncture resistance. In some embodiments, the mouth guard may include one or more of the following physical features to improve its effectiveness:

**[0026]** The control circuitry 50 may be located within a cavity of the heat sink 48 and the LED module may be electrically connected to the control circuitry 50 by wires (not shown) that may extend through apertures or conduits in the heat sink 48. The cap 52 may be attached to the heat sink 48 to enclose the control circuitry 50 therein.

**[0027]** Both the heat sink 48 and the cap 52 may be made from a heat conductive material, such as a metal or a thermally conductive polymer, and may serve to draw away and dissipate heat that may be generated by the LED 34 of the LED module 46. Additionally, the heat sink 48 and the cap 52 may draw away and dissipate heat that

may be generated by the control circuitry 50. Additionally, the heat sink 48 may have features, such as fins 56, that may increase the surface area of the heat sink 48 and improve heat dissipation.

**[0028]** The cover 44 may be positioned on a surface of the heat sink 48 and may cover a portion of the LED module 46. An opening in the cover 44 may be positioned such that the LED 34 of the LED module 46 so that the LED 34 is not covered and light emitted from the LED 34 may pass through the cover 44.

**[0029]** The base 42 may be coupled to the cover 44 and/or the heat sink 48 by a plurality of legs 58 at a first end. The base 42 may include pins 60 at a second end thereof for electrical connection to the socket 40 of the operatory light 30. The pins 60 may be electrically coupled to the control circuitry 50 by wires (not shown) that may pass through a passage 62 (see Fig. 5) in one or more of the legs 58, and pass through one or more apertures in the cover 44 and heat sink 48.

**[0030]** Figs. 6-8 illustrate a bulb 64, according to another embodiment of the present invention. The bulb 64 may include an LED module 76, which may be substantially identical to the LED module 46 of the bulb 32. The bulb 64 may additionally include a base 66 that is configured to attach to a socket of another operatory light. The bulb 64 may similarly include a cover 68, a heat sink 70, control circuitry 72 and a cap 74.

**[0031]** Figs. 9-11 illustrate a bulb 164, according to another embodiment of the present invention. The bulb 164 may include an LED module 176, which may be substantially identical to the LED module 46 of the bulb 32. The bulb 164 may additionally include a base 166 that is configured to attach to a socket of another operatory light. The bulb 164 may similarly include a cover 168, a heat sink 170, control circuitry 172 and a cap 174.

**[0032]** Figs. 12-14 illustrate a bulb 264, according to another embodiment of the present invention. The bulb 264 may include an LED module 276, which may be substantially identical to the LED module 46 of the bulb 32. The bulb 264 may additionally include a base 266 that is configured to attach to a socket of another operatory light. The bulb 264 may also include a heat sink 270, control circuitry 272 and a cap 274. The bulb 264 may have a cavity in the base 266, rather than the heat sink 270, that contains the control circuitry. The cover 268 may attach to the base 266 to cover a cavity in the base 266. Accordingly, the control circuitry may be coupled to the LED module 276 by wires (not shown) that extend through one or more legs 258 of the base 266.

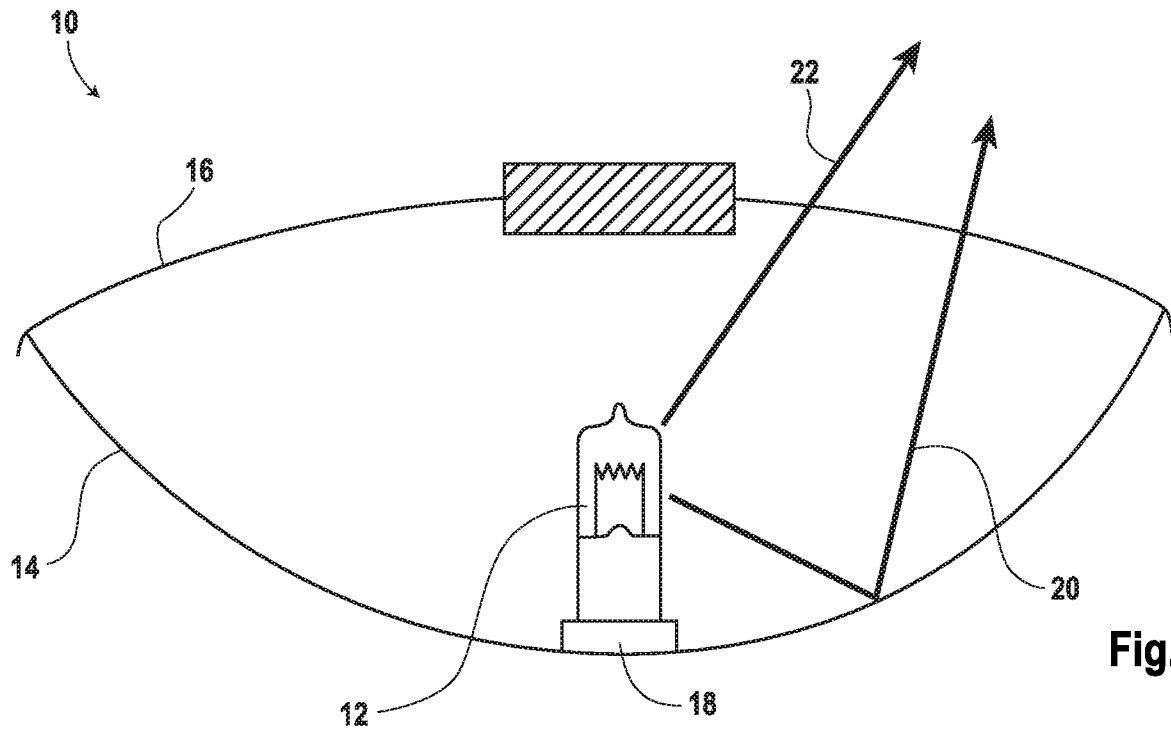
**[0033]** The present invention may be embodied in other specific forms. The described implementations are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

## CLAIMS

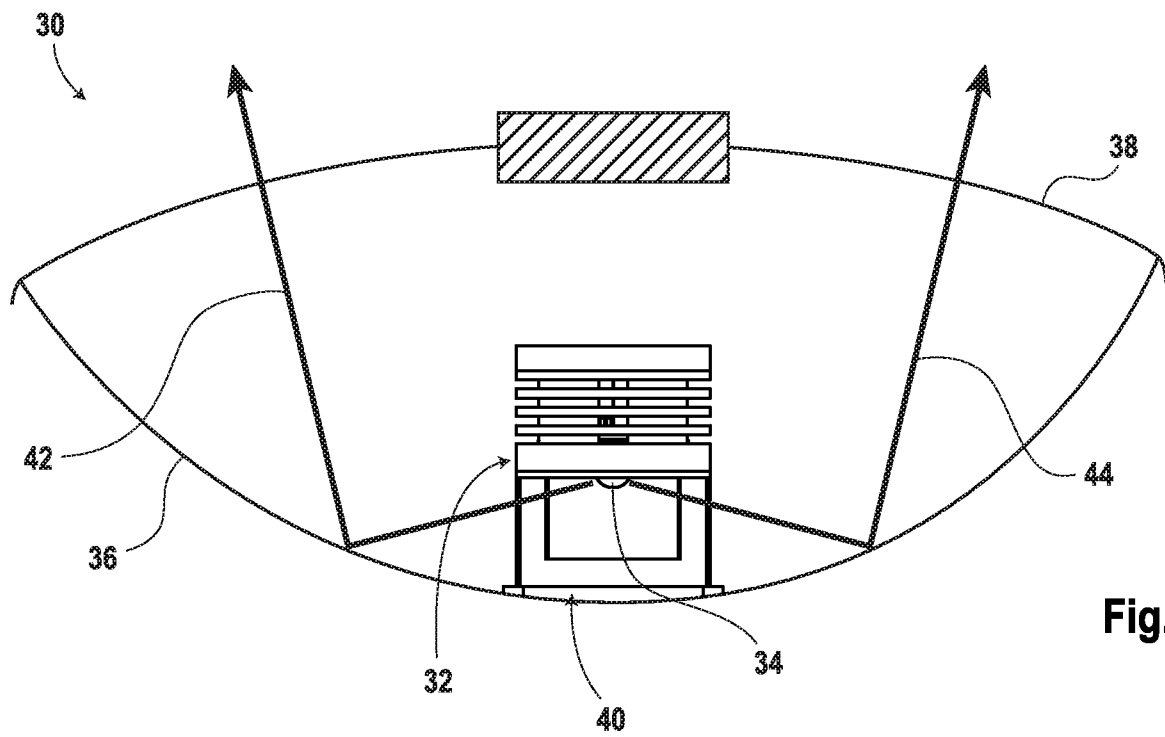
What is claimed is:

1. An operatory light comprising:  
a bulb that includes an LED module positioned such that when the bulb is installed into a socket of the operatory light and powered, none of the light emitted from the LED module is directed directly toward a lens of the operatory light, and only reflected light passes through the lens of the operatory light.
2. The operatory light of claim 1, further comprising a heat sink coupled to the LED module.
3. The operatory light of claim 2, further comprising control circuitry located within a cavity of the heat sink.
4. The operatory light of claim 2, wherein the heat sink further comprises a plurality of fins.
5. The operatory light of claim 2, wherein the bulb further comprises:  
a base coupled to the heat sink via a plurality of legs, wherein the base of the bulb is installed into the socket of the operatory light

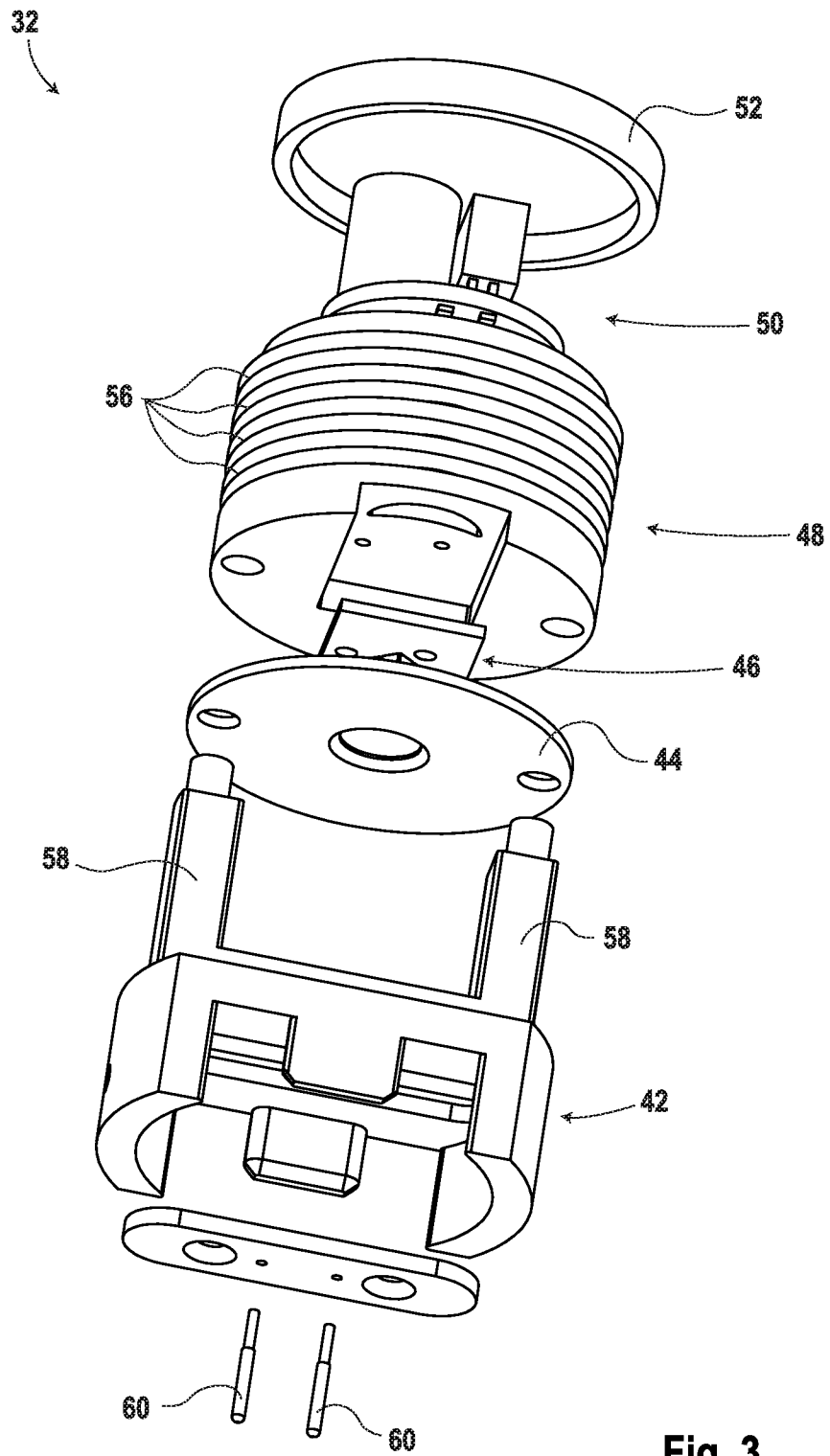
6. A bulb comprising:  
an LED module positioned on a heat sink; and  
a base connected to the heat sink and configured to couple with a socket of an  
operatory light; and  
wherein the LED module is oriented to direct light toward the base.
7. The bulb of claim 6, further comprising control circuitry located within  
a cavity of the heat sink.
8. The bulb of claim 6, wherein the heat sink further comprises a plurality  
of fins.
9. The bulb of claim 6, wherein the base is connected to the heat sink via  
a plurality of legs.



**Fig. 1**



**Fig. 2**



**Fig. 3**

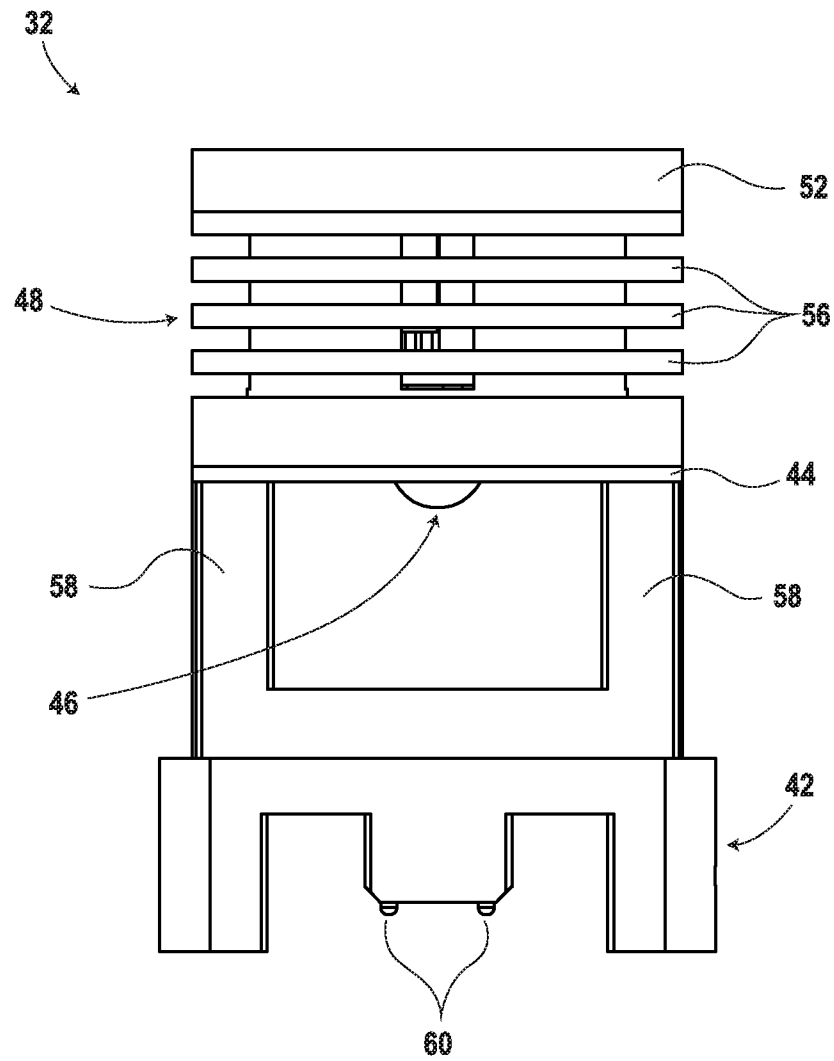
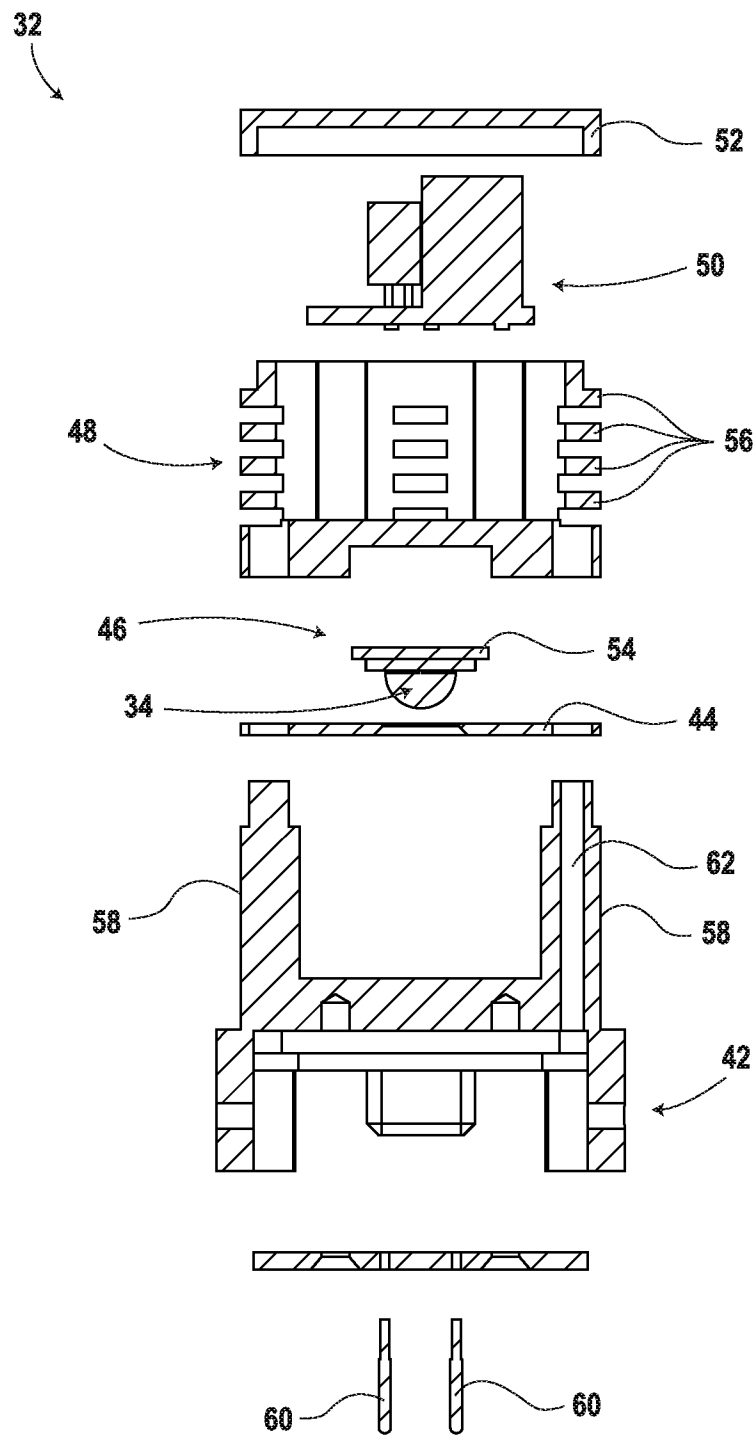
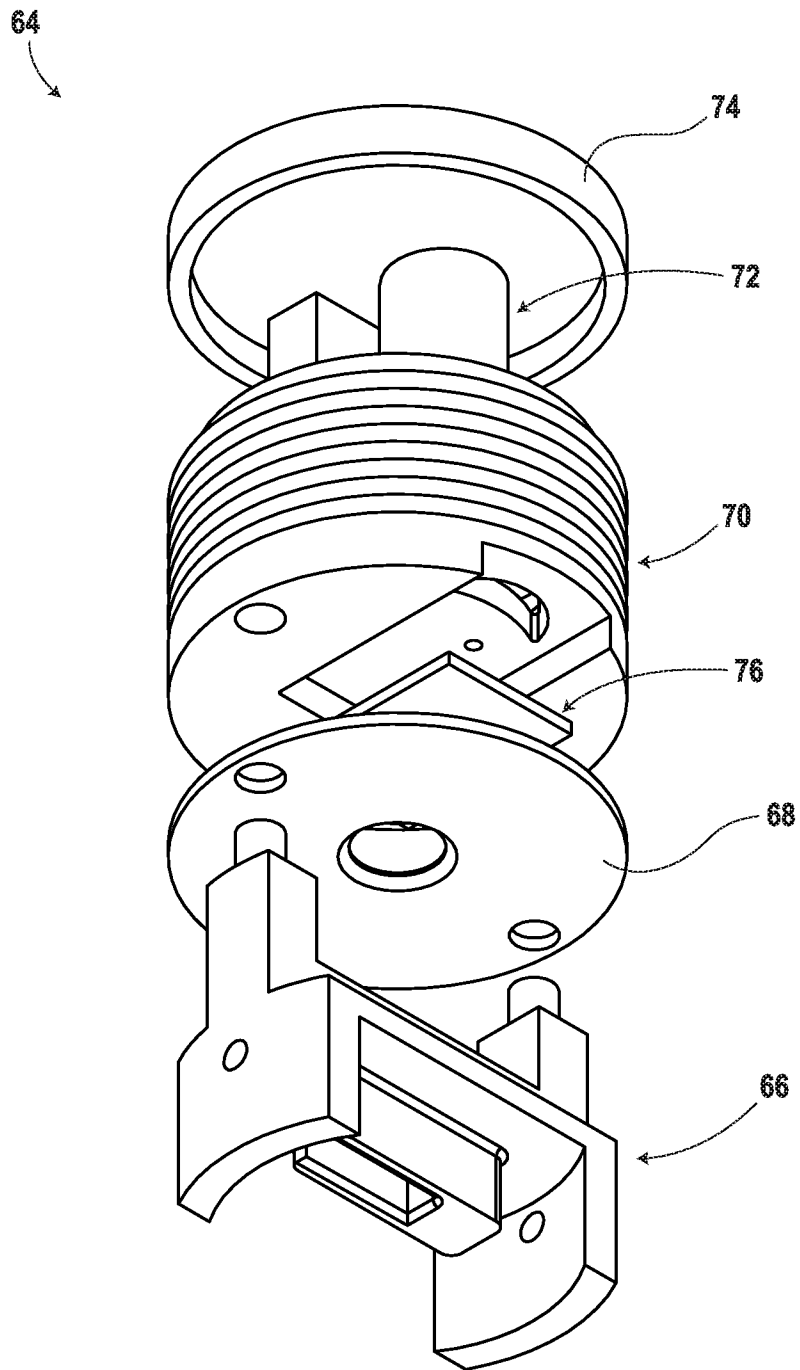


Fig. 4



**Fig. 5**



**Fig. 6**

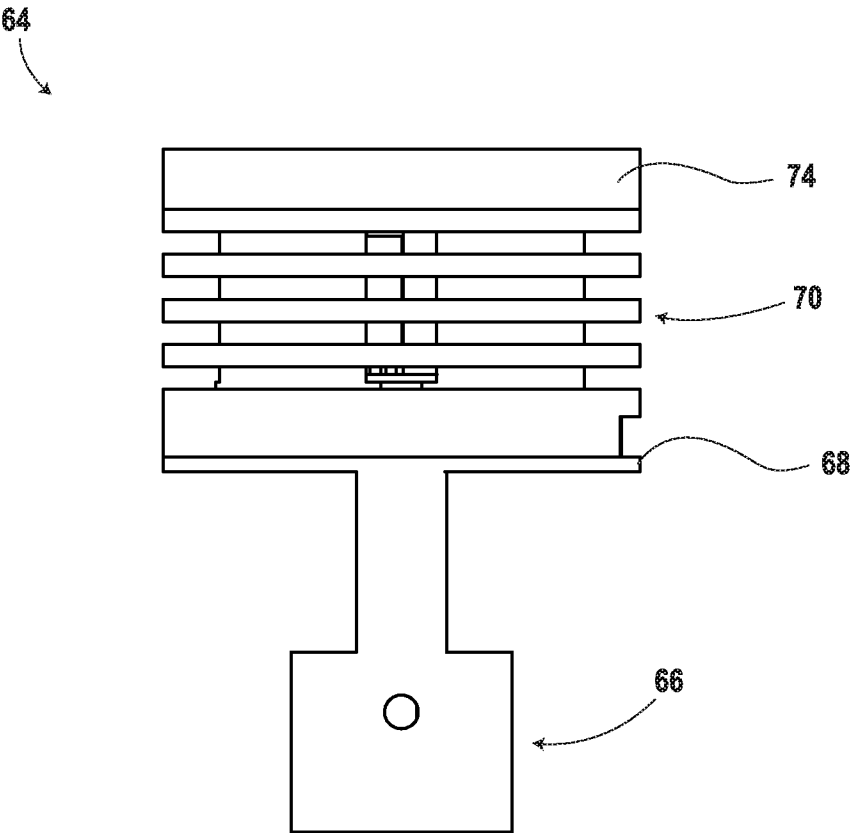
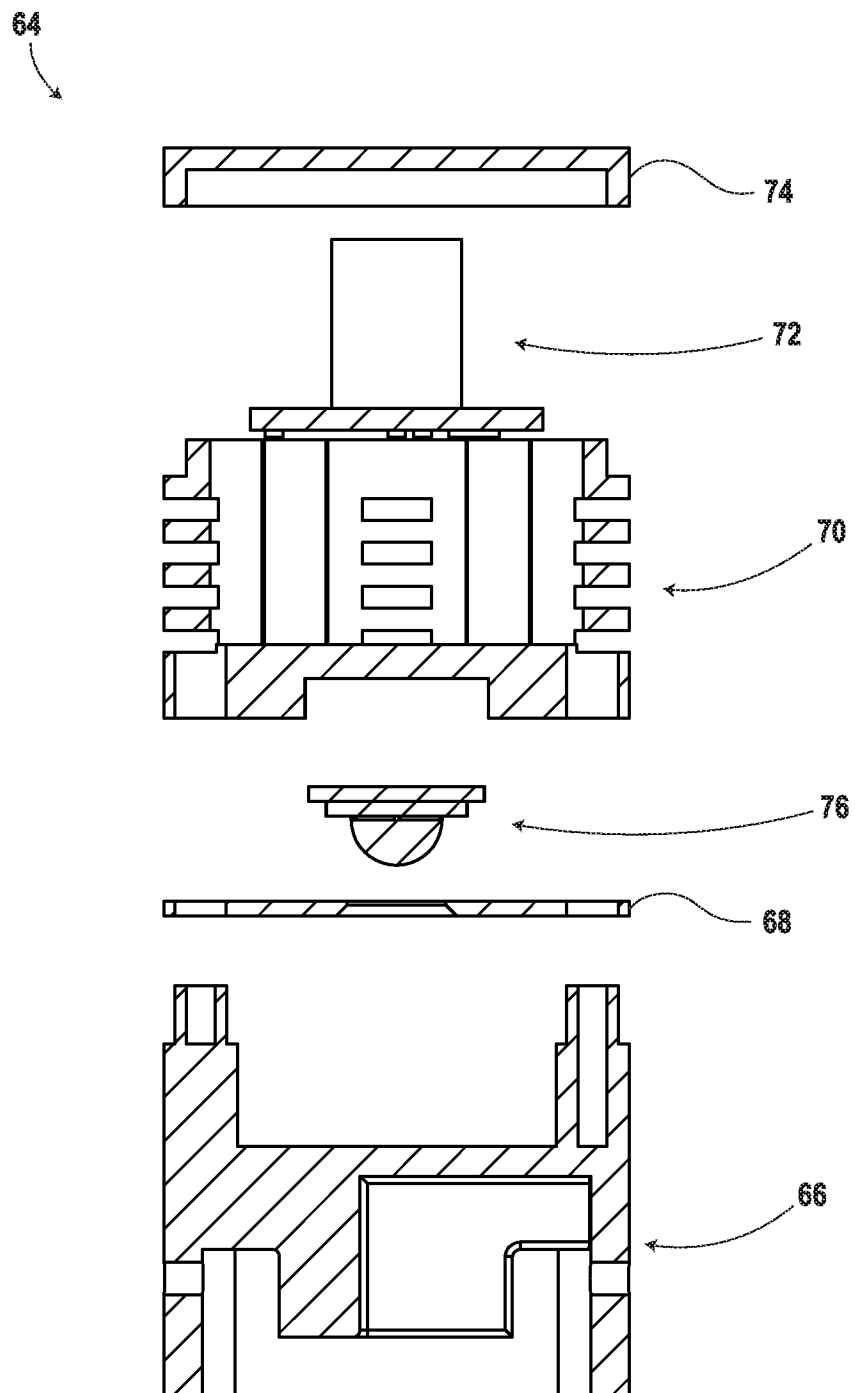


Fig. 7



**Fig. 8**

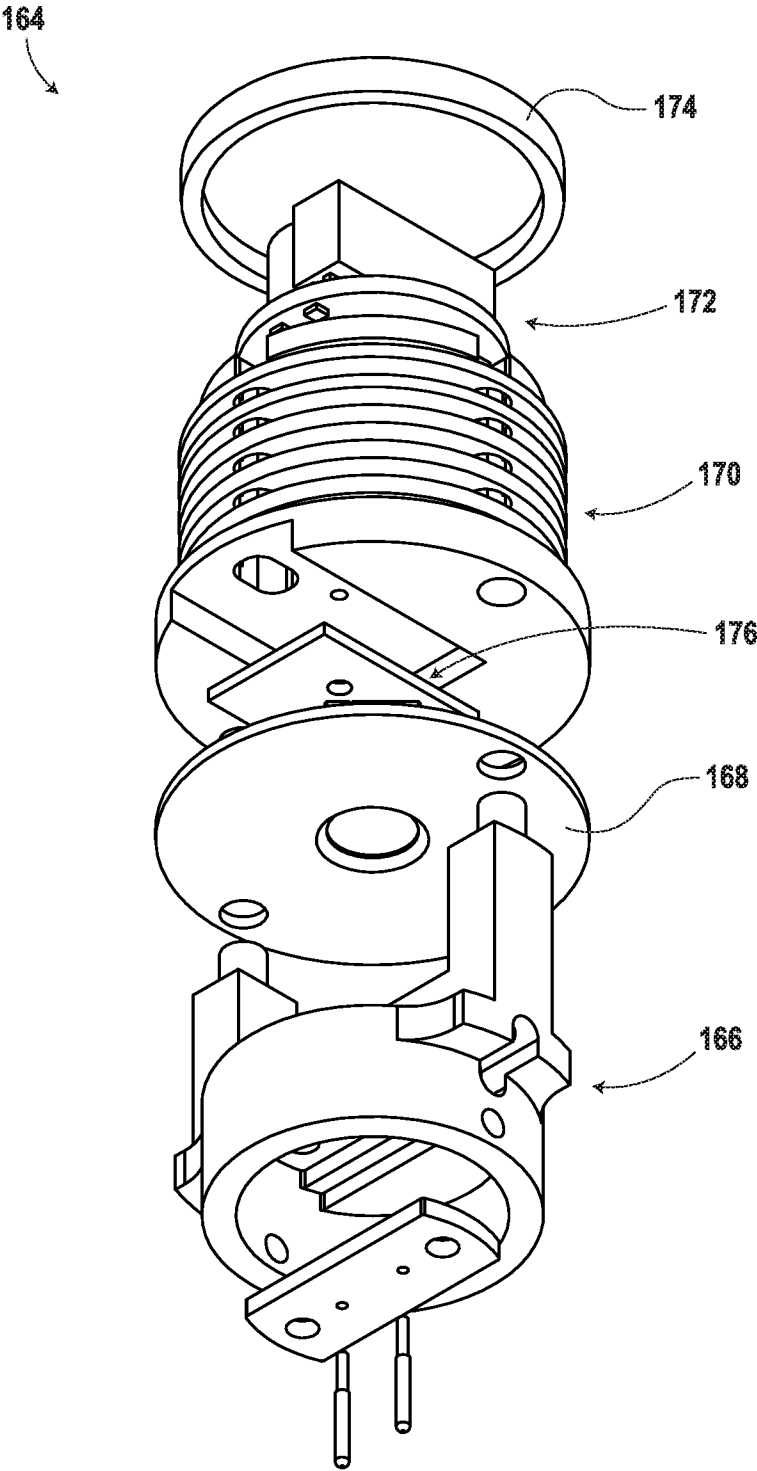


Fig. 9

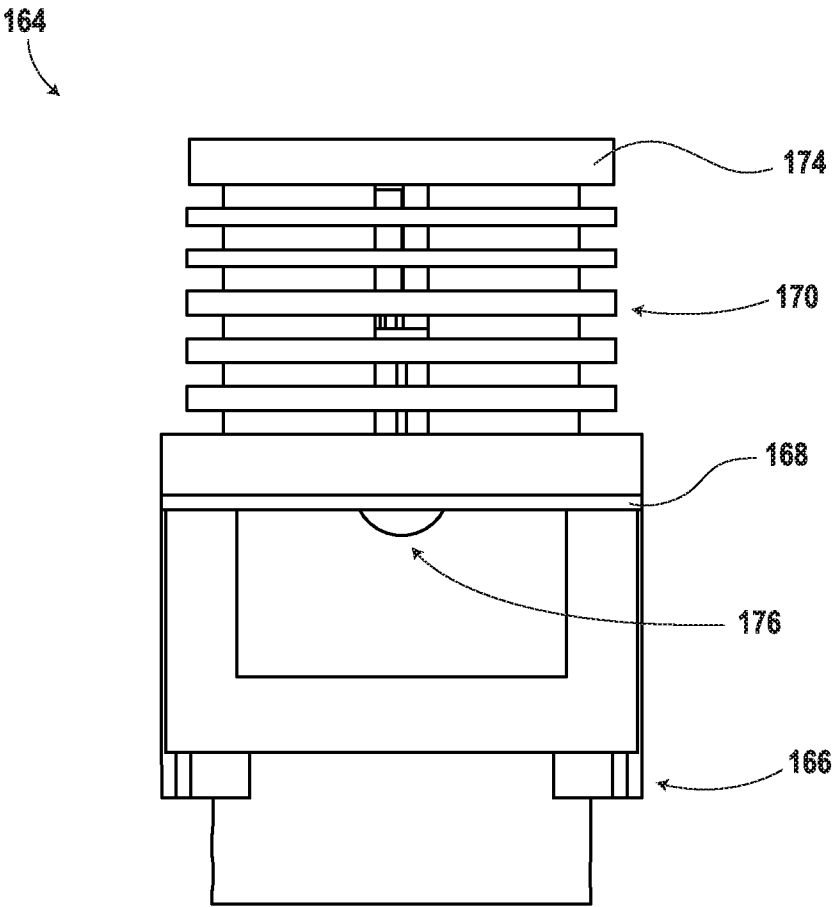


Fig. 10

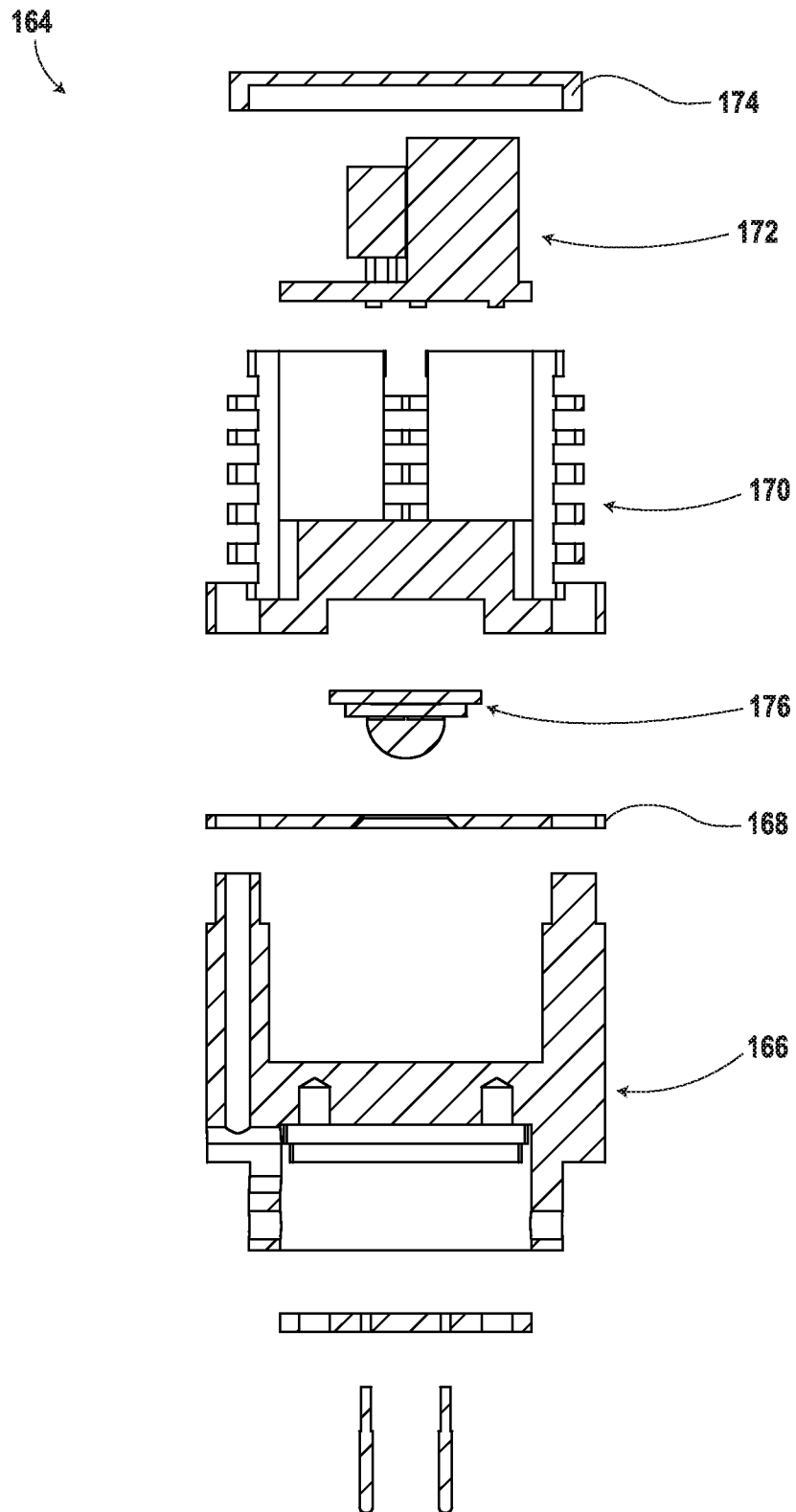


Fig. 11

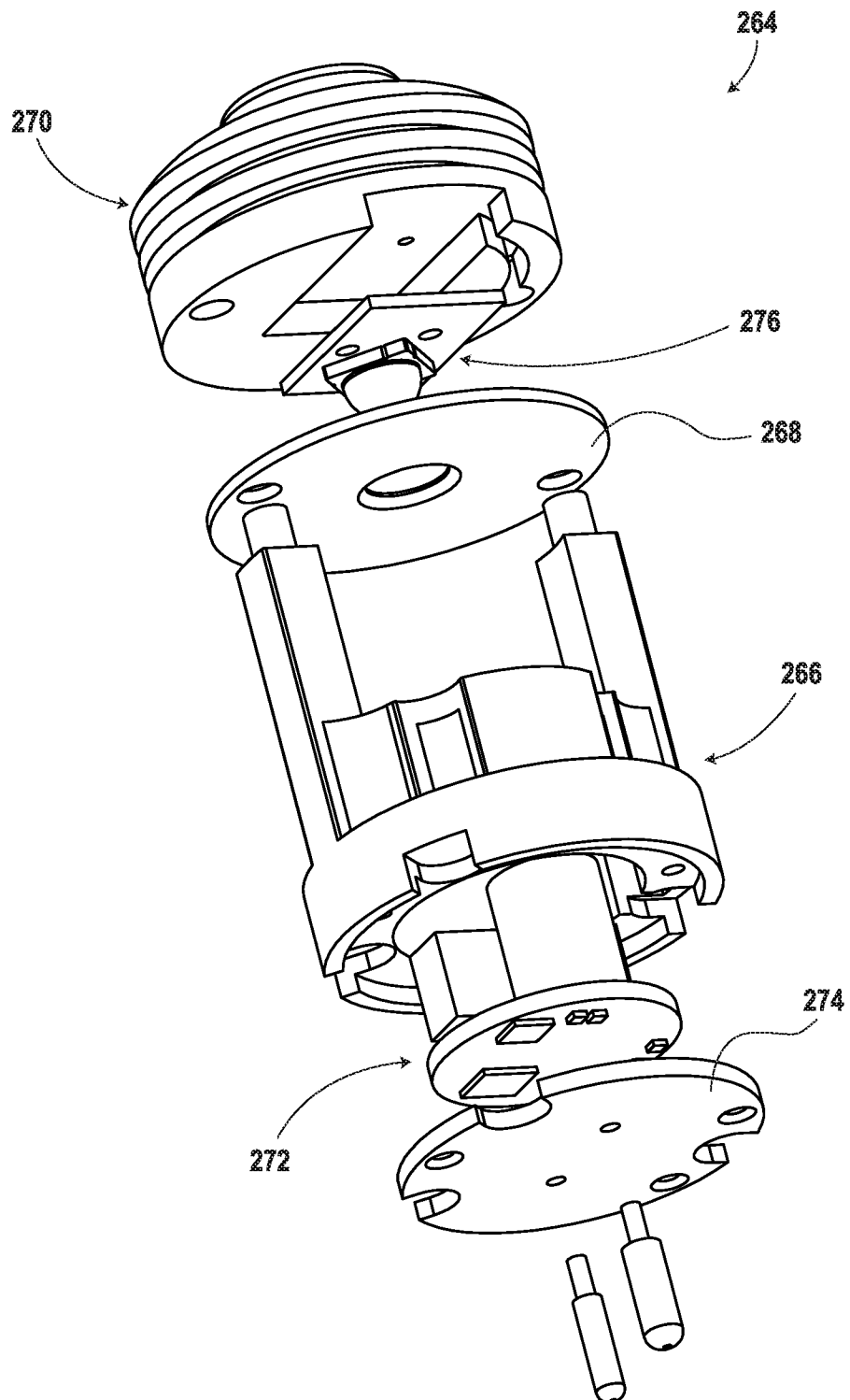


Fig. 12

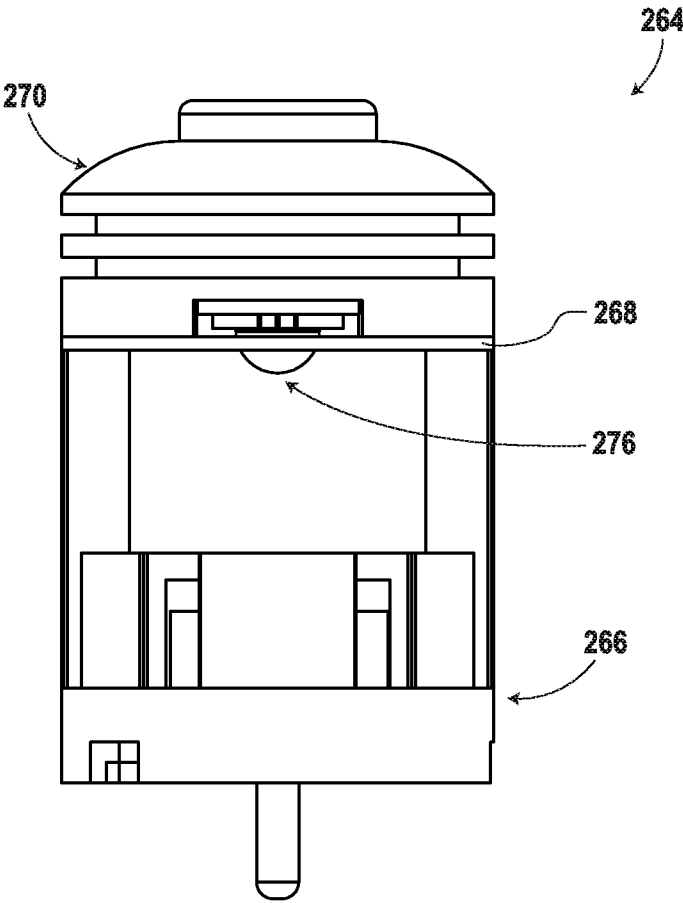


Fig. 13

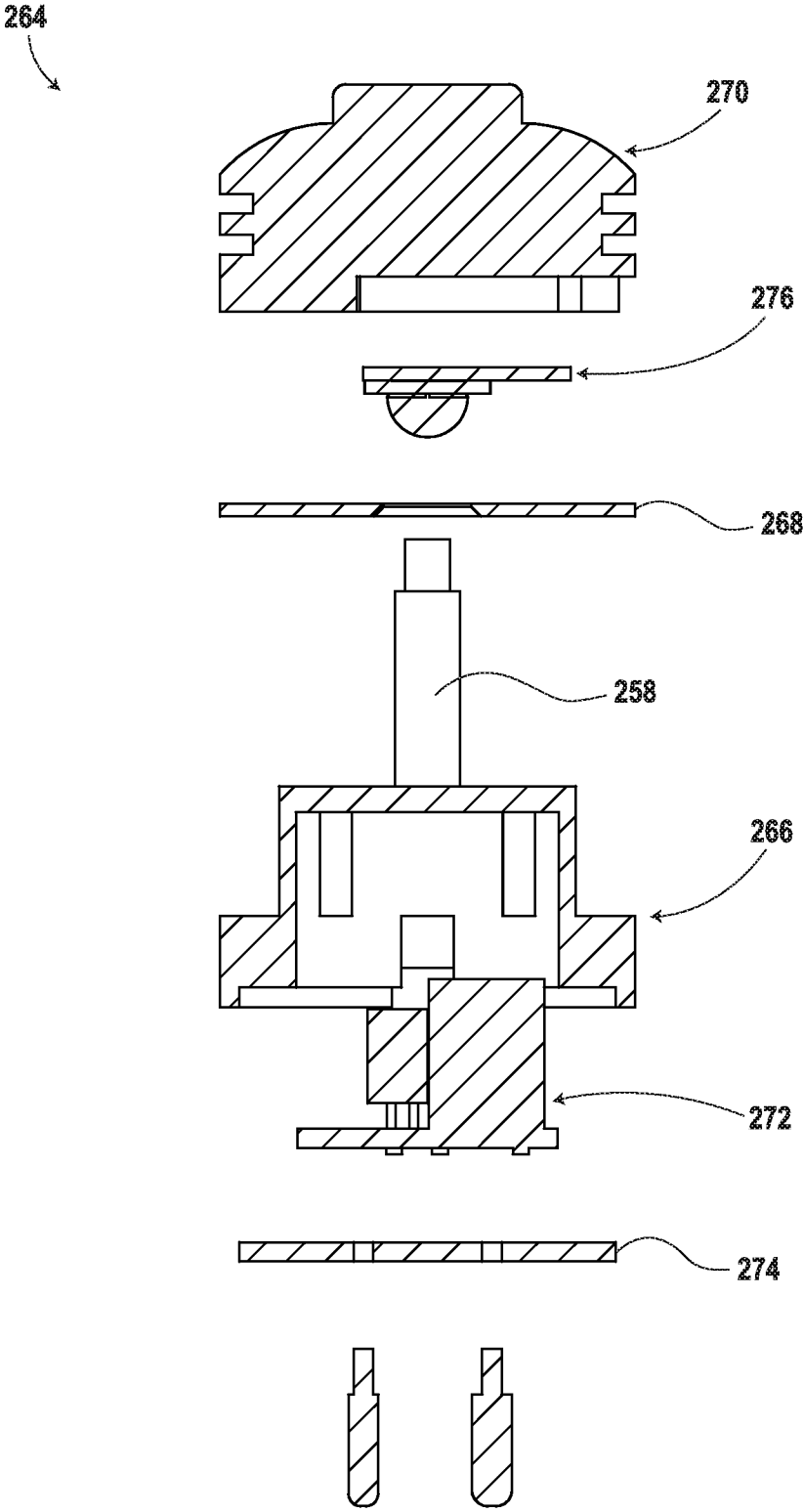


Fig. 14

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US16/19296

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - F21V 29/508, 29/74; F21K 9/65 (2016.01)

CPC - F21V 29/508, 29/74; F21K 9/58

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

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) Classifications: F21V 29/00, 29/508, 29/74; F21K 9/00, 9/65, 9/68 (2016.01)

CPC Classifications: F21K 9/00, 9/58; F21V 29/508, 29/70, 29/74

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

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

PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, Other Countries (INPADOC), RU, AT, CH, TH, BR, PH); Google Patent, Google Scholar, Total Patent, EBSCO

Keywords: LED, light emitting diode, lens, base, light, bulb, reflect, heat sink, thermal sink, fins, circuit, socket

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2007/0102033 A1 (PETROCY, R.) May 10, 2007; abstract, figures 1 & 3, paragraphs [0017], [0022], [0023]	1 & 2 --- 3-5
X --- Y	US 2009/0290349 A1 (CHU, T. et al.) November 26, 2009; figures 11, 16-18, paragraphs [0051]-[0053], [0056], [0062], [0078], [0080]	6 & 8 --- 7 & 9
Y	US 2013/0154465 A1 (ANDERSON, L.) June 20, 2013; title, abstract, figure 1, paragraphs [0016], [0017]	3, 4, & 7
Y	US 2013/0027947 A1 (VILLARD, R. et al.) January 31, 2013; figure 5, paragraphs [0039], [0058]	5 & 9

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

## \* Special categories of cited documents:

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Date of mailing of the international search report

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