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(54) Title: CONNECTOR ASSEMBLY FOR TERMINATION OF MINIATURE ELECTRONICS

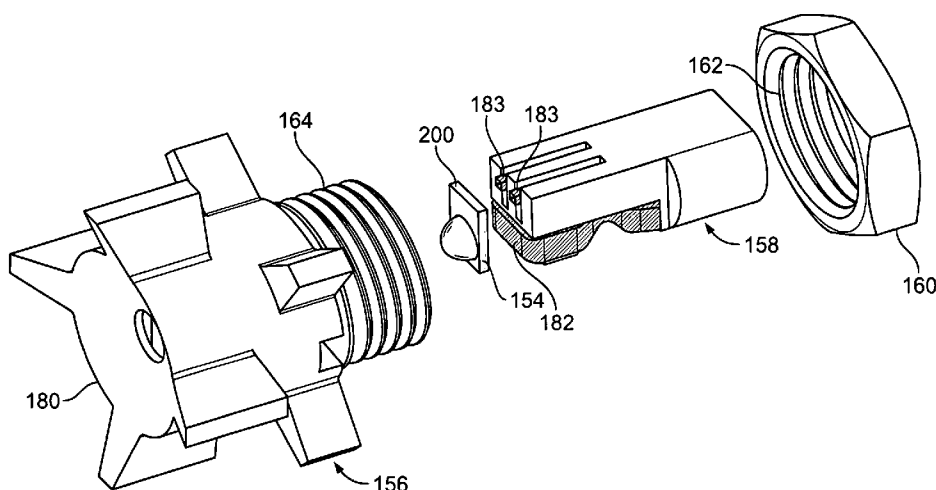


FIG. 15A

(57) Abstract: Connector and connector assemblies for use with miniature high power electrical components, and specifically with miniature LEDs (154). Although the connectors and connector assemblies are designed for use with miniature LEDs (154), these devices are not so limited and can also be used with other miniature electronic devices. These connectors and connector assemblies provide a mechanical connection between the miniature electronic component and electrical contacts instead of a soldered connection, providing a reliable electrical contact between the component, whether used in a PCB-type drop-in connection or some other connection. The connector also includes a heat sink to remove heat from the connector assembly generated by the LED (154) and provides for a reliable mechanical connection between the LED (154) and heat sink.

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- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

## CONNECTOR ASSEMBLY FOR TERMINATION OF MINIATURE ELECTRONICS

[0001] The present invention is directed to connector assemblies for miniature electronics, and specifically, to connector assemblies for use with miniature LEDs that include heat sinks.

[0002] Light emitting diodes (LEDs) are used in a variety of applications and one class of these LEDs has been shrunk so that they can be used in miniature electronics, such as in surface mount applications. These miniature high power LEDs are assembled onto connectors or printed circuit boards (PCBs) as drop-ins, which are then soldered using reflow techniques to provide electrical contact. Difficulties can be encountered with soldering, as reflow can result in poor connections. But soldering also adds processing costs and complexity.

[0003] These assemblies are also limited with respect to the amount of heat that can be generated, as these assemblies do not incorporate heat sinks and heat dissipation capabilities are limited. The design operating temperature is an important factor in extending the life of an LED-based system, so either minimizing the heat generated, or moving the heat away for the LED can extend the life of the LED. Thus, electrical as well as thermal concerns are important to an effective design.

[0004] The problem to be solved is a need for connectors or connector assemblies for use with miniature LEDs so that the LED or LEDs can be assembled thereto without the need for soldering. In addition, these connectors or connector assemblies should include means to remove heat when such capability is required.

[0005] The solution is provided by the present invention wherein connector and connector assemblies for use with miniature electrical components, and specifically with miniature LEDs. Although the connectors and connector

assemblies are designed for use with miniature LEDs, these devices are not so limited and can also be used with other miniature electronic devices. These connectors and connector assemblies provide a mechanical connection with the miniature electronic component that provides a reliable electrical contact between the component whether used in a PCB-type drop-in connection or some other connection. The mechanical connection eliminates the troublesome solder connections that have been used with miniature electronic devices. In addition, the heat sinks reliably remove heat, thereby providing these devices with higher current ratings and longer mean life ratings and usage.

[0006] Other features and advantages of the present invention will be apparent from the following more detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of the invention.

[0007] Figure 1 is a perspective of an embodiment of a connector assembly of the present invention.

[0008] Figure 2A is an exploded view of the connector assembly of Figure 1.

[0009] Figure 2B is an exploded view of the connector assembly of Figure 1 from a second view, omitting some parts for clarity.

[0010] Figure 2C is a cross-sectional view of the connector assembly of Figure 1 through the latch structure.

[0011] Figure 2D is a cross-sectional view of the connector assembly of Figure 1 through the power contacts.

[0012] Figure 3 is a back view of the connector assembly of Figure 1 depicting the power contact connections.

[0013] Figure 4 is a perspective view of a second embodiment of a stamped connector assembly of the present invention.

[0014] Figure 5 is an exploded view of the connector assembly of Figure 4.

[0015] Figures 6-9 are perspective views of the connector assembly of Figures 4 and 5 at various stages of assembly.

[0016] Figure 10 depicts compliant contacts between the LED and a Mini-CT connector, without a stamped heat sink.

[0017] Figure 11 is a cross sectional view of the connector assembly of Figure 6.

[0018] Figure 12 depicts a 2X2 array of the connector assembly of Figure 4 assembled onto a light fixture heat sink.

[0019] Figures 13 and 14 depict a perspective front view and back view of a third embodiment of the present invention.

[0020] Figure 15A is an exploded view of the embodiment of Figure 13.

[0021] Figure 15B is an exploded view of the embodiment of Figure 13 from a second angle or perspective.

[0022] Figure 16 depicts a reverse detail view of the contact cartridge assembly of Figure 15A.

[0023] Figure 17 is an exploded view of the contact cartridge assembly of Figure 16.

[0024] Figure 18 is a cross-sectional view of the connector assembly of Figure 13.

[0025] The present invention can be modularized, so that a heat sink of suitable size can be included with the connector to transfer heat away from

the miniature electrical component. The heat sink component can be included integrally in the connector, or can be added as needed to form an assembly.

[0026] An advantage of the present invention is that it provides a connector that can be integrated into miniature electronics to form reliable connections without the complications and added costs of soldering.

[0027] Another advantage of the present invention is that it conveniently incorporates a heat sink into the connector design to move heat away from the miniature electronics, thereby preventing heat build-up as a result of heat generation from applied electrical current. This permits the miniature electronics device to operate either at a lower temperature or with higher power requirements (i.e. higher current ratings), or both.

[0028] Yet another advantage of the present invention is that high power LED assemblies with heat sinks can be mounted remotely from the driver electronics, allowing the light output to be directed where it is needed.

[0029] Still another advantage of the present invention is that assembly is simplified, as the connection between the connector and the miniature electronic device is a simple mechanical connection. This permits existing miniature electronic devices to be assembled with a mechanical connection to provide a reliable electrical contact, and eliminates the necessity of soldering the miniature electronic device to establish an electrical contact.

[0030] Figure 1 is an embodiment of the present invention that depicts a connector assembly 10 that includes a heat sink assembly. Figure 2A is an exploded view of assembly 10 that comprises a lens/LED nest 12 assembled over a miniature LED 14 (miniature LEDs include small surface mountable LEDs such as the LUXEON® Rebel available from Philips Lumileds Lighting Company of the Netherlands and with facilities in San Jose, CA), holding LED 14 against heat sink/optical reflector 16 comprising a thermally conductive material. Lens 12 is an optically clear thermoplastic. While shown in Figure 1 as having a hexagonal shape, the reflector 16 and lens 12 be any convenient

preselected geometry for a particular application, so that it can be round, octagonal, etc. Reflector 16 includes a plurality of arms 40 between apertures 20 that link a center raised pad 41 to the periphery of reflector 43. Reflector 16 also includes a plurality of tabs 42 located between each pair of arms 40 extending slightly into apertures 20. Lens 12 includes a plurality of latches 24, each latch including a first tooth 35 near its end, and a second tooth 36 nearer to the base of the latch on the opposite side of the latch 24 from the first tooth 35. The latches 24 are inserted through apertures 20, with each latch flexing inward as its second tooth 36 encounters the adjacent reflector tab 42. As the heat pad 50 of the LED 14 engages the center pad 41 of the reflector 16, the arms 40 flex and center pad 41 exerts a force on the LED heat pad 50. When fully inserted, each latch 24 springs back toward its free state and the second tooth 36 engages tab 42, thus retaining lens 12 with pressure between center pad 41 and LED heat pad 50 as shown in Figure 2C. Arms 40 provide multiple thermally conductive paths between center raised pad 41 and periphery 43 of reflector 16 to guide heat away from LED 14. Referring to Figures 2A, 2B, 2C and 2D, power contacts are inserted through a plurality or second set of apertures 28 of connector back 18, the ends of power contacts 26 extending from either side of connector back 18, as evident from Figure 3 on the power connection side, and toward LED side as evident in Figure 2D. The second set of apertures 28 include walls 51 that prevent power contacts 26 from being pressed completely through connector back 18. Assembly continues as lens latches 24 are inserted through apertures 22, with each latch 24 flexing outward as its first tooth encounters the side of aperture 22. As latches 24 are inserted, power contacts 26, supported by walls 51, engage LED power pads 52 and provide an electrical path between LED 14 and power connection portion 54 of connector back 18. When latches 24 are fully inserted, each latch 24 springs back toward its free state as it engages a relieved mating ledge 52 in connector back 18, thus retaining the assembly against the force of the mated power pins 26. The first tooth 35 and second tooth 36 are on opposite sides of latch 24 so that engagement of second tooth 36 to tab 42 is not loosened as latch 24 flexes to engage first tooth 35. The

ends 30 of power contacts extending from the connector back 18, see Figures 2D and Figure 3, can be attached to power wiring. The connector back 18 can be compatible with the commercially available Tyco Electronics Mini-CT connector, available from Tyco Electronics, Middletown, PA.

[0031] Heat sink/optical reflector 16 is comprised of a thermally conductive material, preferably stamped or formed from aluminum or stainless steel, although it can be comprised of a thermally conductive polymer. It conducts heat away from the LED to its outer surfaces, where the heat can then be removed by the natural convective flow of air over the heat sink optical reflector. It also reduces heat build up from the assembly as a reflector, which reflects radiant energy in the form of light away from the assembly, rather than absorbing it.

[0032] A second embodiment of the present invention is depicted in Figures 4-11. This embodiment is the LED stamped connector assembly 100 comprising a Carclo lens 110 assembled to a thermoplastic lens carrier 112, which is assembled over a heat sink assembly 120. An exploded view of LED stamped connector assembly 100 is depicted in Figure 5. Heat sink assembly 120, shown in Figure 6 is comprised of stamped heat sink 126 through which is mounted a plastic contact carrier 128 into which is assembled compliant power contacts 130, more clearly visible in Figures 8 and 10. A contact carrier assembly 129 comprising the compliant power contacts 130 assembled into the plastic contact carrier 128 is shown in Figure 7. The contact carrier assembly 129 snaps into the aperture pattern on the top face of stamped heat sink 126 as shown in Figure 8. An LED 124 is positioned into a locator pocket molded into plastic contact carrier 128, as depicted in Figure 9. Referring back to Figures 5 and 6, a retention clip 122, preferably of stainless steel is assembled over LED and snapped into position around the plastic contact carrier. The retention clip 122 includes a pair of apertures 134 (only one of which is visible) that engages protrusion or bump 136 on plastic contact carrier, Figures 5 and 7. Once engaged, LED is visible through the cut out 138 in top surface of retention clip 122. Retention clip 122 provides a

downward force on LED 124, which urges LED into mechanical contact with compliant contacts 130 and heat sink 126.

[0033] The compliant contacts 130, urged into contact with the LED 124, are in communication with a power source. The compliant contacts can be mated to a PCB, which can power them. Alternatively, the compliant contacts 130 can be hard-wired to a power source. As shown in Figures 5 and 11, contact carrier assembly 129 is mated to a Mini-CT connector 132, which is connected to a power source. Figure 10 shows the detail of the connection of the compliant contacts 130 between LED 124 and Mini-CT connector 132, the plastic contact carrier 128 having been removed from this view for clarity. Figure 11 is a cross sectional view of the contact carrier assembly 129 assembled to heat sink 126 and to Mini-CT connector 132.

[0034] In the design depicted in Figures 4-11, light generated by miniature LED 124 is directed by lens 110. To reduce heat buildup, heat is conducted away from LED 124 by stamped heat sink 126, which dissipates the heat. Retention clip 122 is a metal, which imparts a normal force on LED 124 to urge it into contact with compliant power contacts 130, while pad 200, integral with LED 124, is urged into contact with heat sink 126. It is preferably a metal that has a high mechanical strength such as a stainless steel alloy, although in certain applications, other metals may be used. Stamped heat sink 126 preferably is a metal that has high thermal conductivity and can be formed by stamping, such as a stainless steel alloy, an aluminum or aluminum alloy or a copper and copper alloy. However, it may also be a conductive polymer. Stamped heat sink 126 includes feet that allow heat sink assembly 120 to be securely but removably mounted to a surface, such as a PCB surface or a light fixture heat sink 142, such as depicted in Figure 12 that is provided with features to capture heat sink 126. Figure 11 is a cross-sectional view of the assembly of Figure 6. This view shows the interface between the retention clip 122, LED 124 and contact carrier 128. Retention clip applies the force to enable a reliable mechanical contact between LED 124 and compliant contacts, as well as between LED 124 and stamped heat sink 126.

[0035] The stamped connector assembly 100 can be arranged into an array formed from a plurality of connector assemblies 100. A simple 2x2 array 140 is depicted in Figure 12, but this array can be expanded to any desired size. The array can be assembled onto a light fixture heat sink 142 to enhance heat dissipation, to allow the LEDs to be operated at even higher currents.

[0036] Figures 13 and 14 depict a third embodiment of the present invention. An LED connector heat sink assembly 150 is depicted in Figure 13. The back end of the LED connector heat sink assembly 150 is shown in Figure 14. The back end 152 is a Mini-CT connector-compatible, permitting a Mini-CT connector to be inserted into the back end 152.

[0037] An exploded view of the LED connector heat sink assembly 150 is depicted in Figures 15A and 15B. Connector heat sink assembly 150 comprises a miniaturized LED 154, such as the Rebel LED discussed previously. The miniaturized LED 154 is inserted into and positioned in heat sink body 156 and is held in place by contact cartridge assembly 158. An optional mounting nut 160 having threads 162 may be threaded over optional mating threads 164 on the exterior of heat sink body 156, to mount the connectorized heat sink to a panel.

[0038] Contact cartridge assembly 158 is depicted in Figure 16, and in exploded view in Figure 17. Contact cartridge assembly 158 includes a plastic cartridge body 166 that includes a pair of slots 168 extending through the body and tabs 170 extending away from the body opposite the slots. Slots 168 accept compliant power contacts 172 that are positioned therein and which extend from either end of cartridge body 166. Compliant thermal contact/retention clip 174, comprising a thermally conductive spring like material, is inserted over tabs 170 of cartridge body 166.

[0039] Referring to Figure 18, which is a cross-sectional view of LED connector heat sink assembly 150, LED 154 is inserted into heat sink body

156, where LED 154 is visible through an aperture. Contact cartridge assembly 158 is inserted into heat sink body 156, capturing LED 154 within heat sink body 156 so that LED 154 is positioned in a central aperture of heat sink body 156. The compliant thermal retention clip 174 is driven against LED 154 as contact cartridge assembly 158 is inserted. Arms 178 of compliant thermal retention clip 174 spring outwardly, engaging retention features 181 in a counterbore in heat sink body 156, the counterbore configured to accept an end of cartridge assembly 158 that includes retention clip 174. Thus, a force is exerted that keeps thermal contact region 182 of thermal retention clip 174 in contact with LED heat pad 184, and keeps power contact tips 183 in contact with power pads 185, as shown in Figures 15A and 15B. It further maintains sides 186 of compliant thermal retention clip 174 in contact with the inside surface of heat sink body 156, thus providing the thermal conduction path from the LED 154 to the heat sink body 156. Power contacts 172 may be wired to a power source or may plug into a PCB from which it derives power.

[0040] Heat sink body 156 has a central aperture extending longitudinally through the body from a first end to a second end and may be comprised of any thermally conductive material such as a conductive metal, including but not limited to stainless steels, aluminum and its alloys, and copper and its alloys, or of a thermally conductive resin. When the heat sink body comprises a conductive metal, some minor modifications within the skill of the art are required to electrically isolate the heat sink body 156 from the power contacts 172 of contact cartridge assembly. The heat sink body 156 has a predetermined fin pattern extending axially from the body for axial and cross-flow of air to facilitate removal of heat from the heat sink body 156. Preferably, the heat sink body has a concave conical face to maximize fin area without encroaching on the light path from the LED 154. This conical face can be coated with a reflective material to further maximize the light output of assembly 150. Heat from power losses in LED 154 is transferred to heat sink body 156 through the compliant thermal retention clip 174, which

moves heat away from LED 154 and transfers the heat to air passing over the outer surfaces of heat sink body 156. A more effective transfer of heat away from the LED 154 and heat sink body 156 results in a higher current rating for LED connector heat sink assembly 150.

[0041] The present invention can be used with small LEDs, including small surface mountable LEDs such as the LUXEON® Rebel available from Philips Lumileds Lighting Company of the Netherlands and with facilities in San Jose, CA. The present invention also can be used with the Tyco Electronics Mini CT connectors available from Tyco Electronics, Middletown, PA.

## CLAIMS

## WHAT IS CLAIMED IS:

1. An assembly (150) for use with miniature electronic components, comprising:

- a contact carrier assembly (129), wherein the contact carrier assembly (129) includes a contact carrier (128) having a pocket on a top surface, and power contacts (130) having one end in communication with a power source, the power contacts (130) extending through the contact carrier with an opposite end extending through its top surface;

- a miniature LED (154), the miniature LED (154) including a heat pad (184) and power pads (185), the LED (154) housed in the pocket of the contact carrier (128);

- a heat sink body (156) having a top face that includes an aperture pattern, wherein the contact carrier assembly (129) extends through the aperture pattern on the top face of the heat sink assembly (156);

- a retention clip (122) having an aperture (134) assembled over the LED (154), the retention clip (122) captured by the contact carrier (128), wherein the captured retention clip (122) exerts a force on the LED (154) urging it into contact with the power contacts (130) and heat sink body (156);

- a thermoplastic lens carrier (112) assembled to the heat sink body (156); and

- a lens (110) fitted into the lens carrier (112) and over the LED (154).

2. The assembly (150) of claim 1 wherein the power contacts (130) having one end in communication with a power source further includes a connector that provides a connection between the power contacts (130)

and the power source, the connector having an interface compatible with the contact carrier assembly (129).

3. The assembly (150) of claim 1 wherein the heat sink body (156) comprises a thermally conductive material.
4. The assembly (150) of claim 3 wherein the heat sink body (156) comprises aluminum and alloys thereof.
5. The assembly (150) of claim 1 wherein the retention clip (122) comprises a material having high mechanical strength.
6. The assembly (150) of claim 5 wherein the retention clip (122) comprises stainless steel.
7. The assembly (150) of claim 1 further comprising a plurality of the miniature LEDs (154) arranged in an array.
8. The assembly (150) of claim 1 wherein the heat sink body (156) has a concave conical face at an end opposite a counterbore.
9. The assembly (150) of claim 8 wherein the conical face is coated with a reflective material.

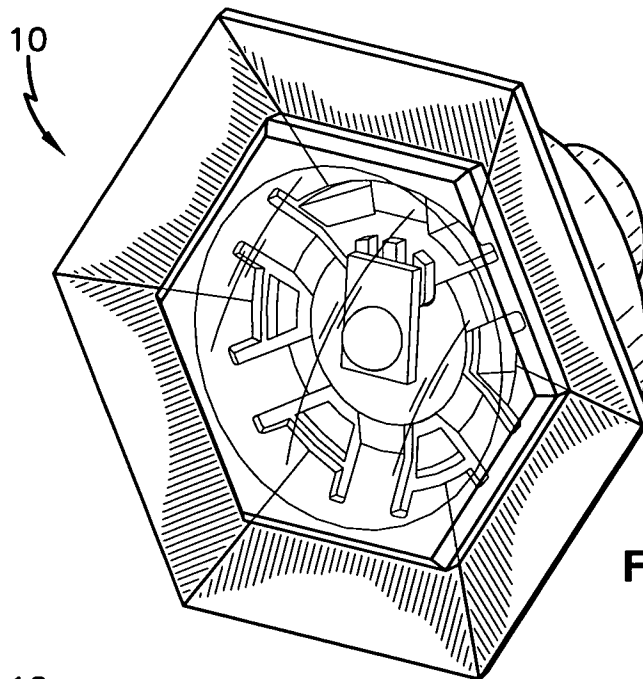


FIG. 1

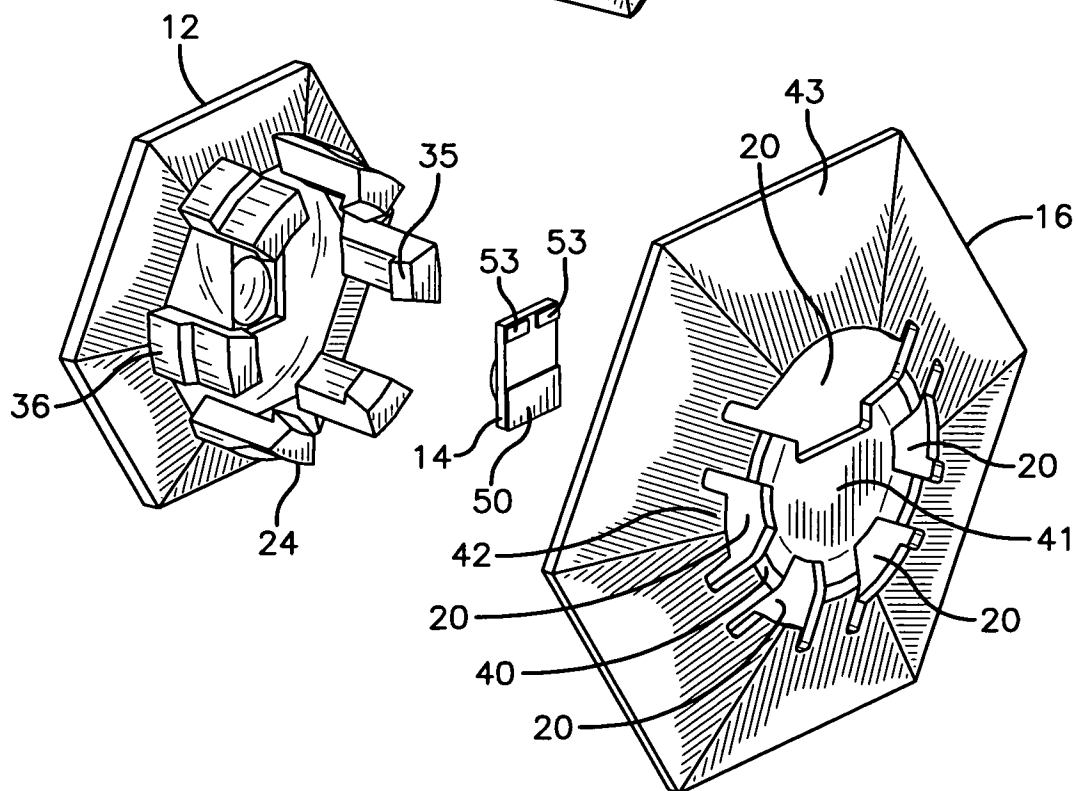


FIG. 2B

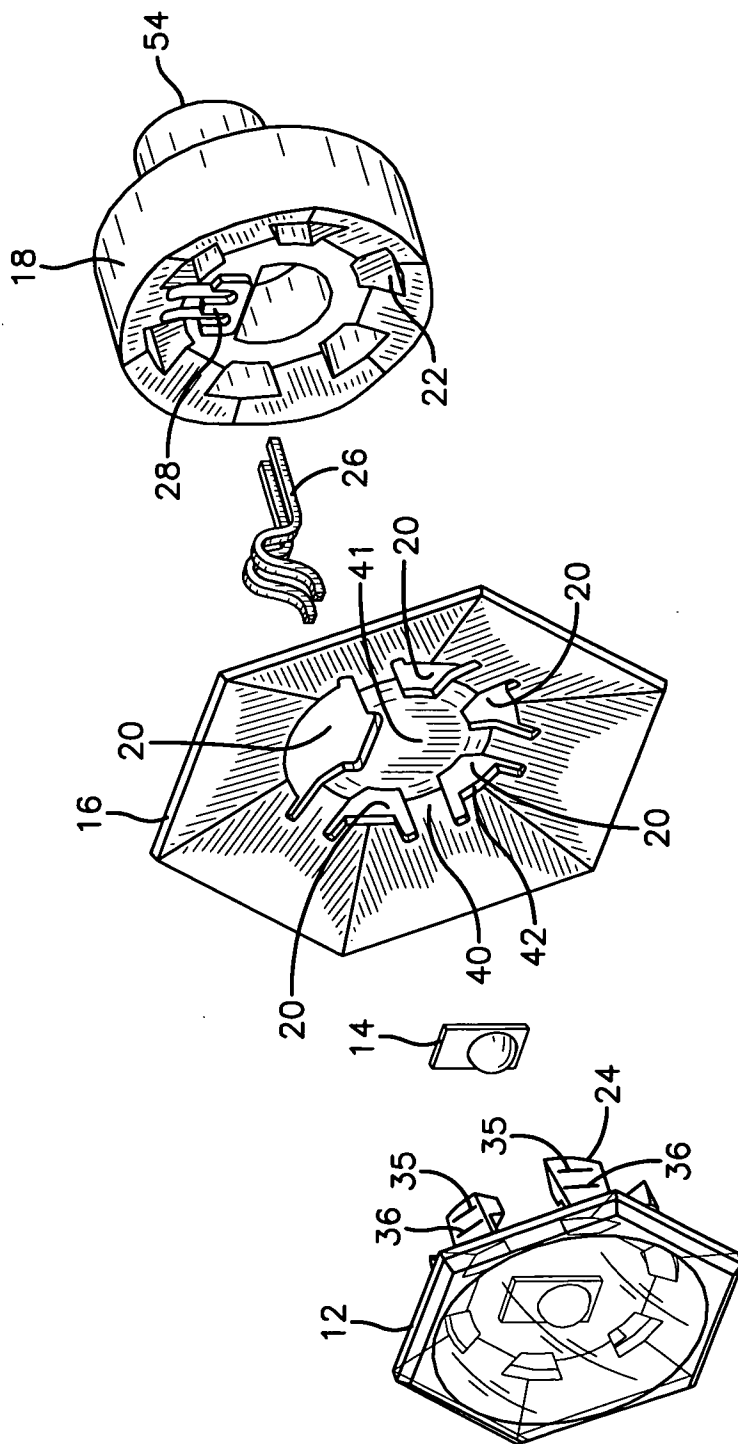


FIG. 2A

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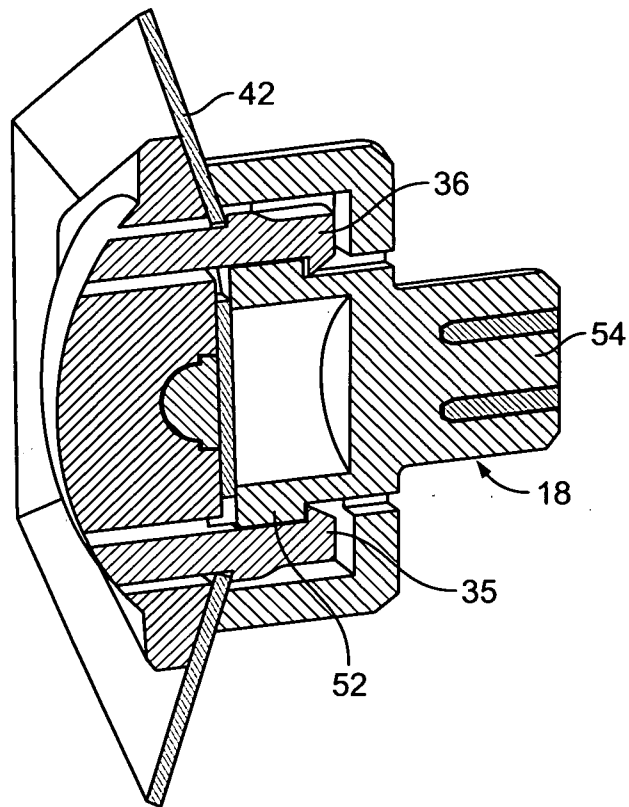


FIG. 2C

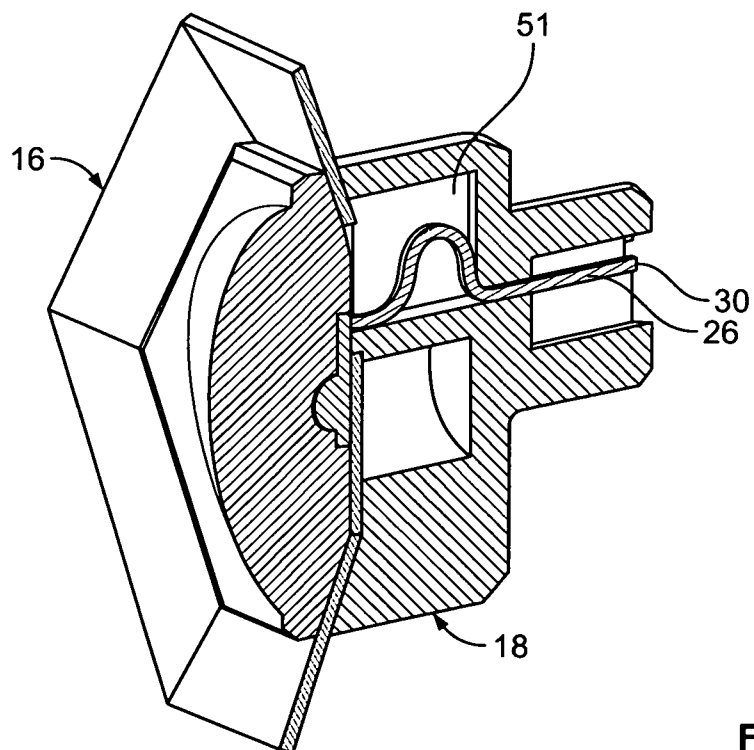


FIG. 2D

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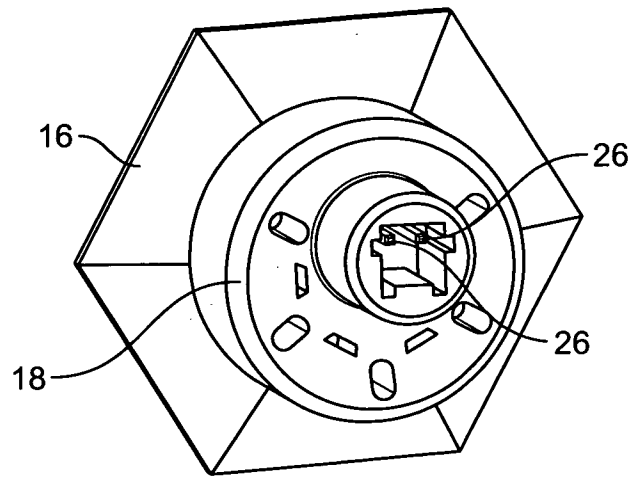


FIG. 3

100 →

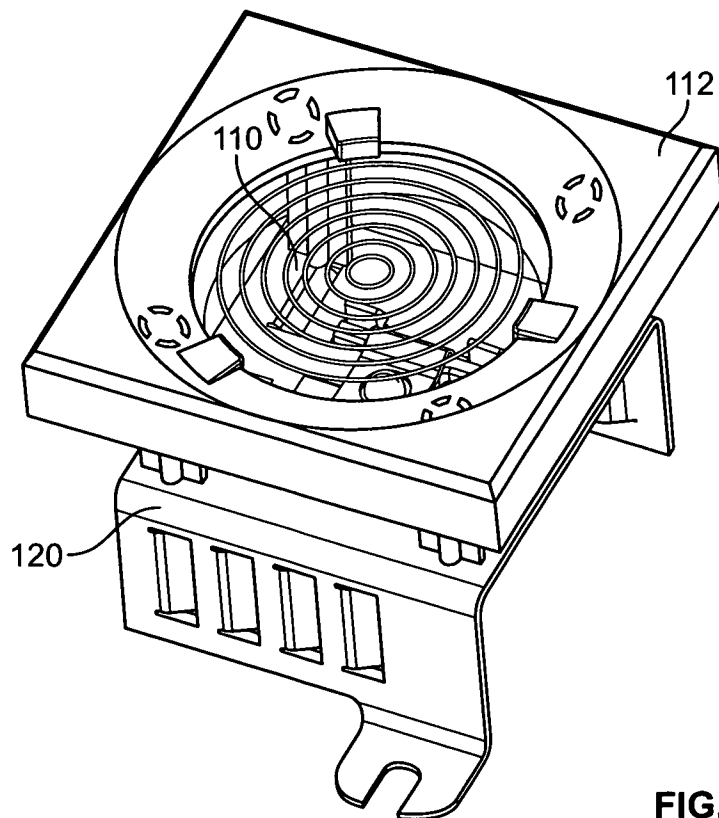


FIG. 4

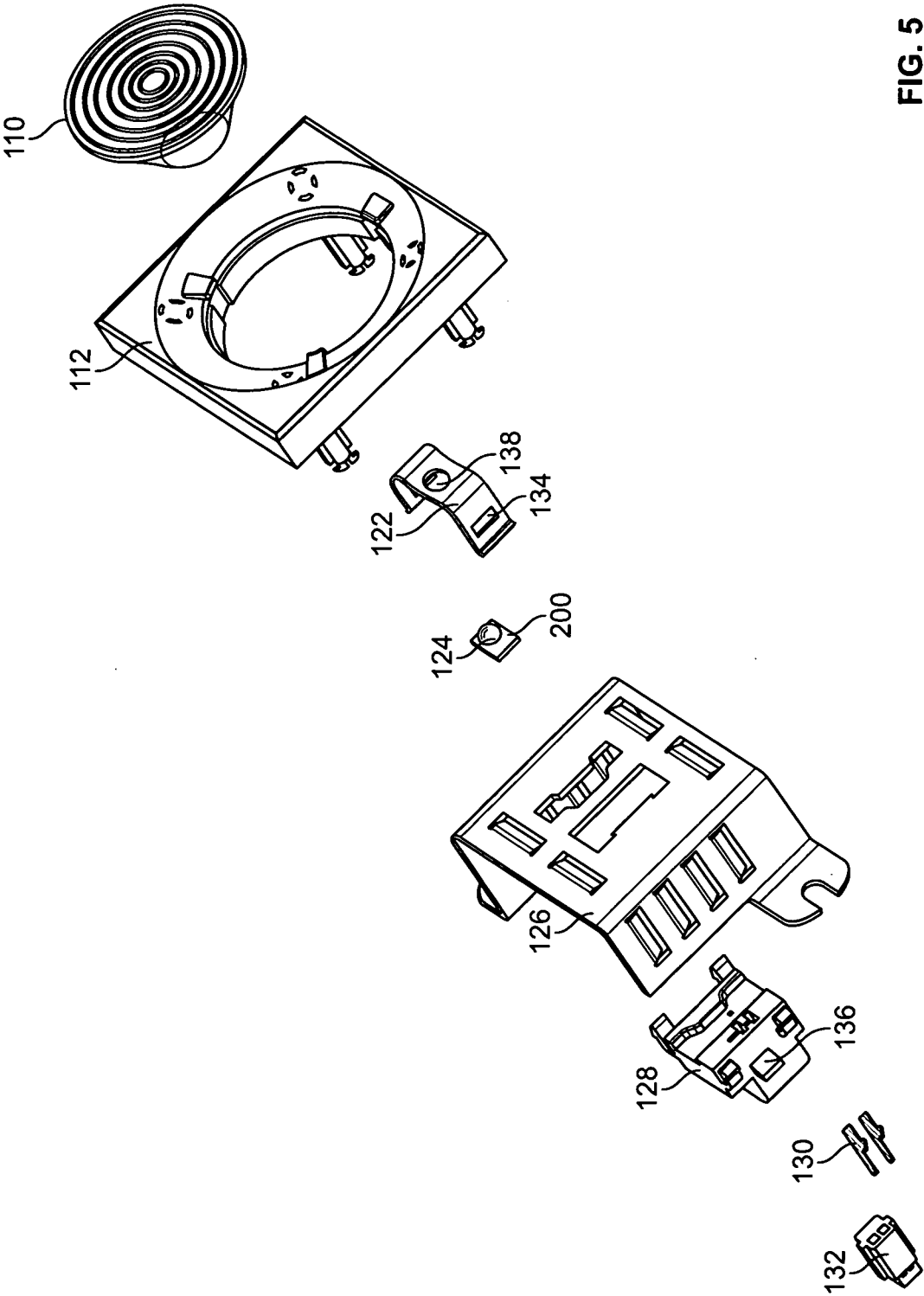


FIG. 5

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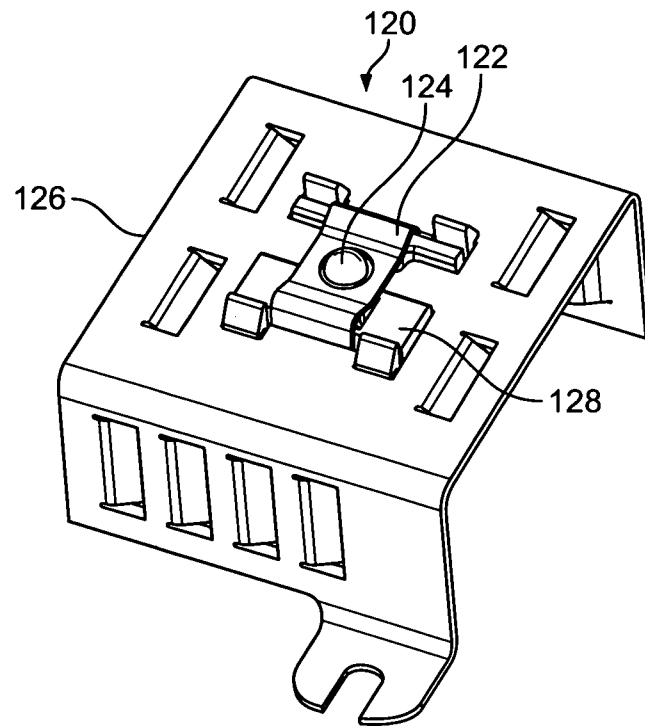


FIG. 6

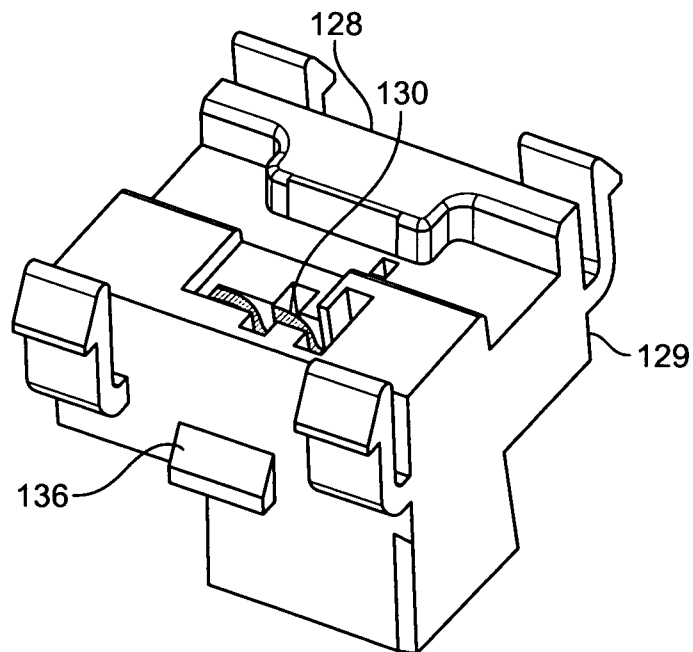


FIG. 7

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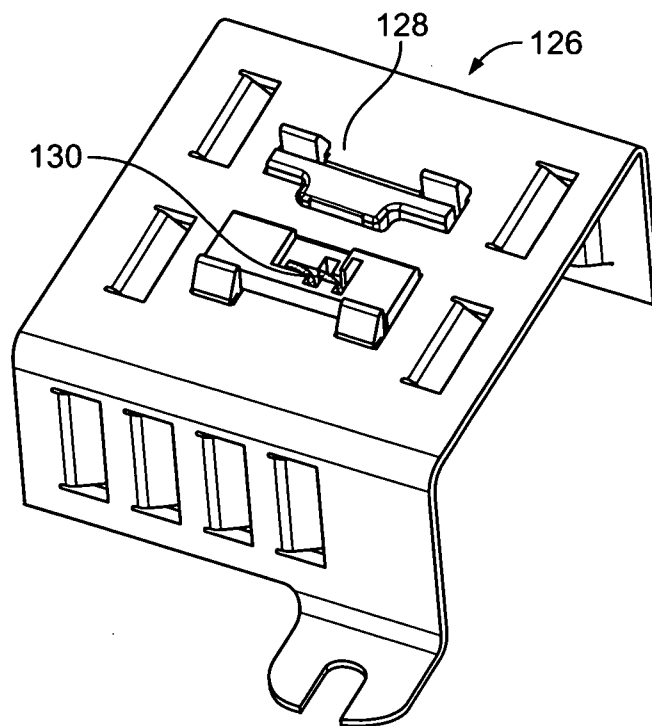


FIG. 8

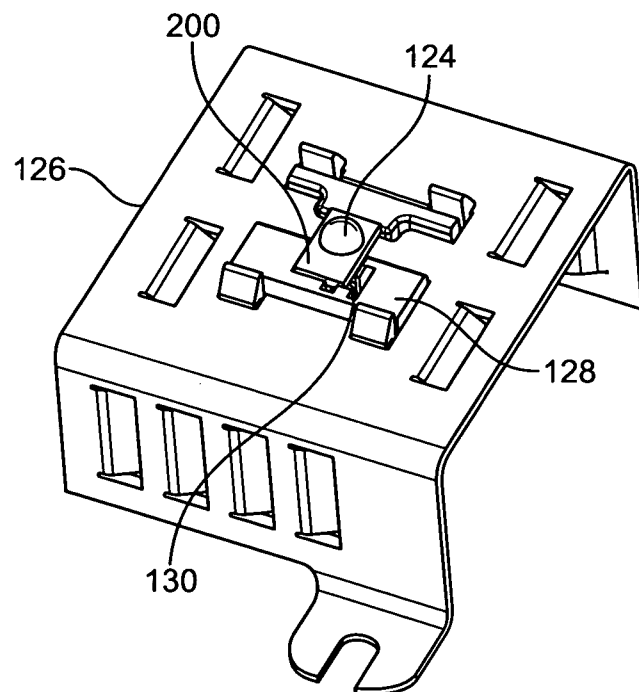


FIG. 9

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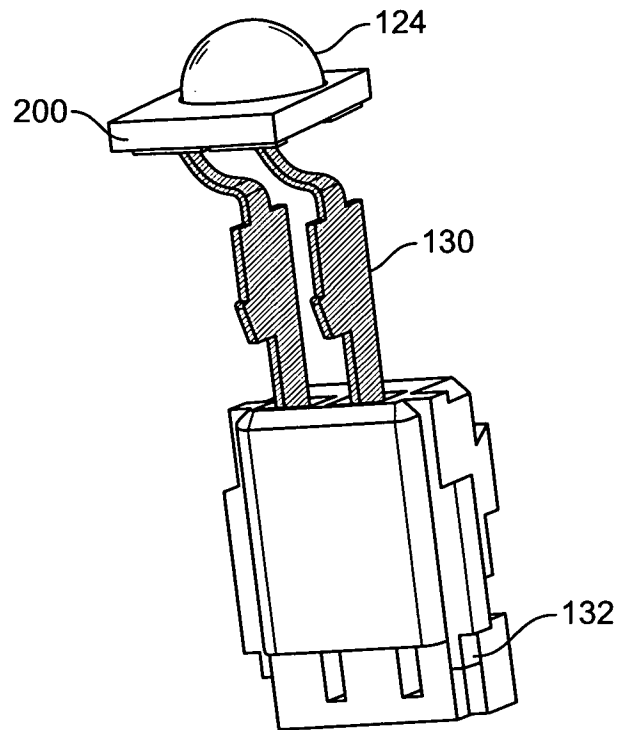


FIG. 10

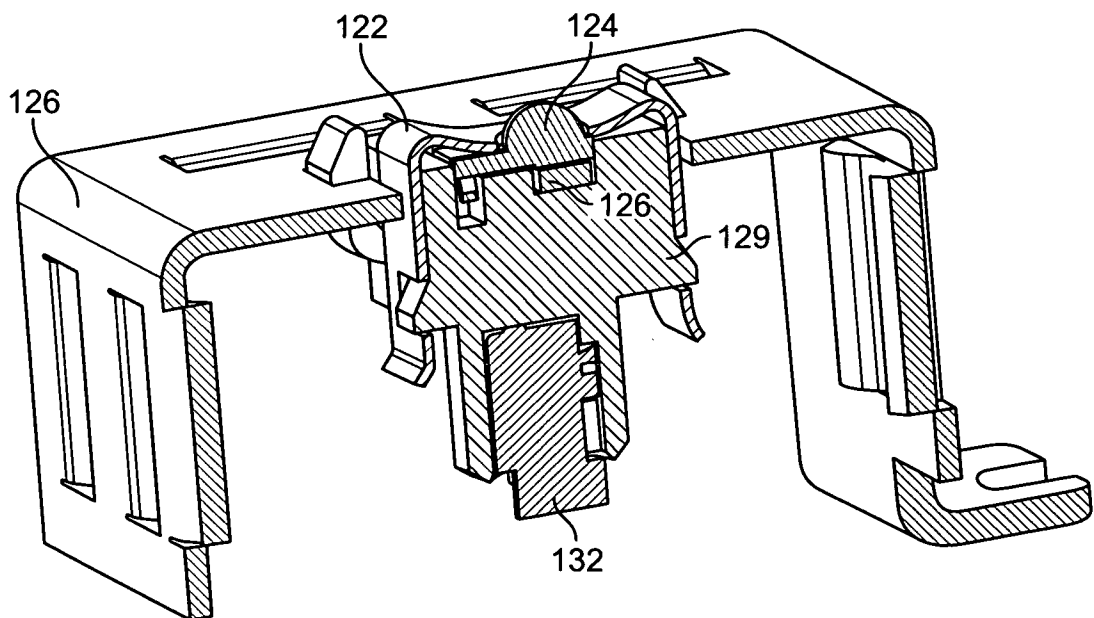


FIG. 11

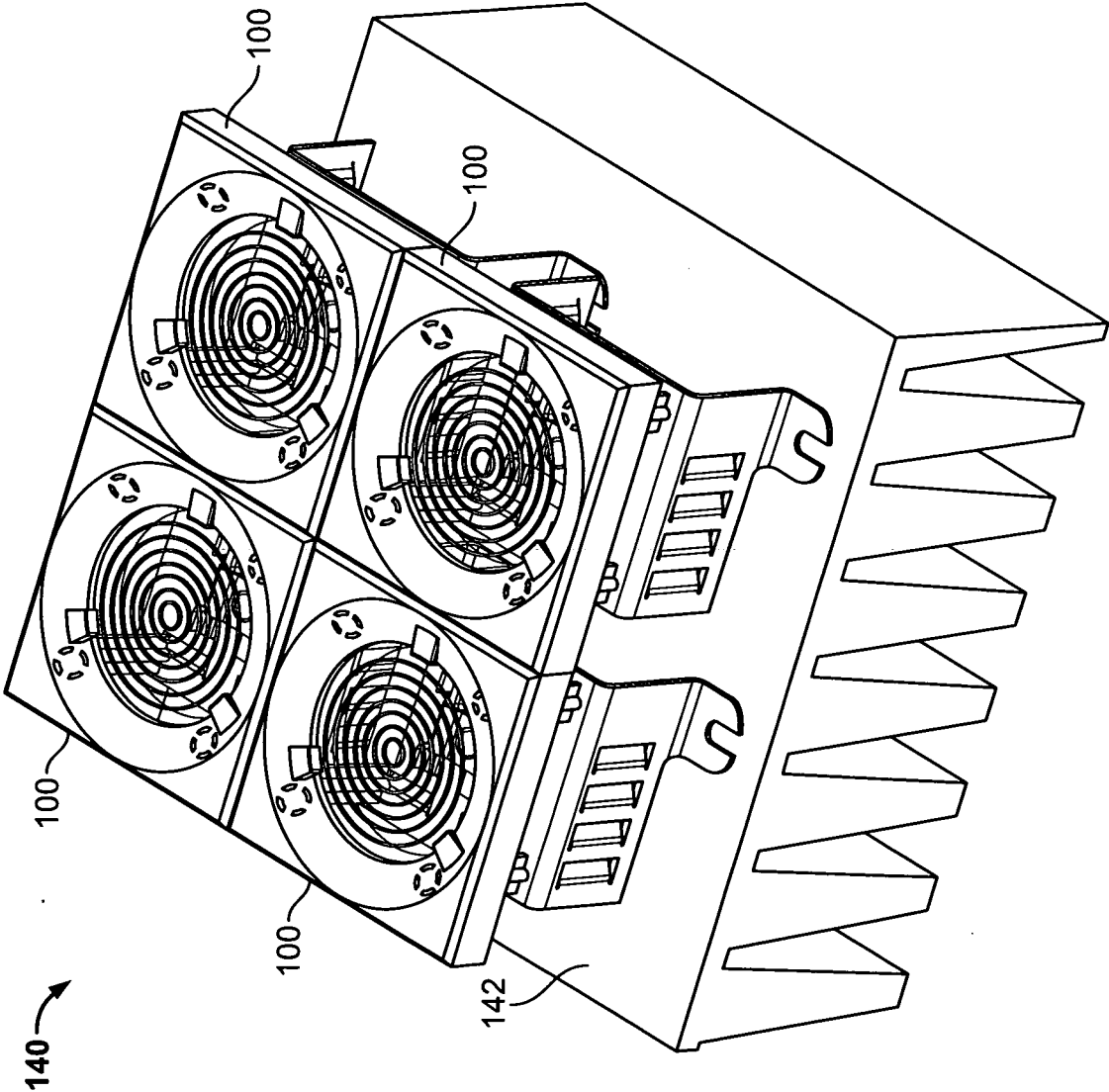


FIG. 12

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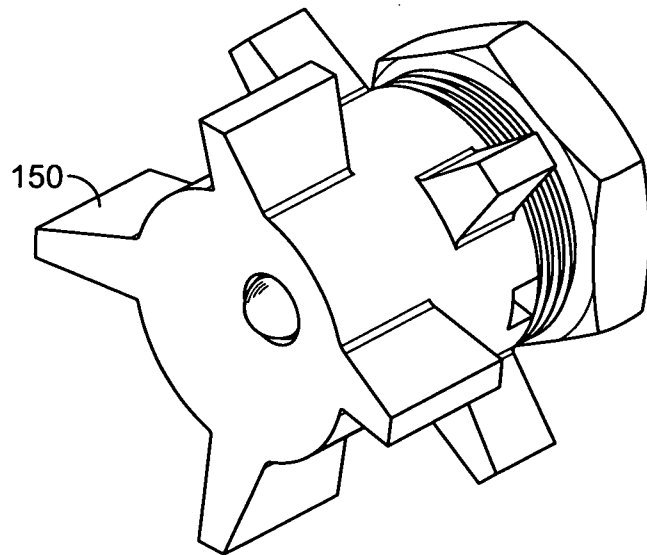


FIG. 13

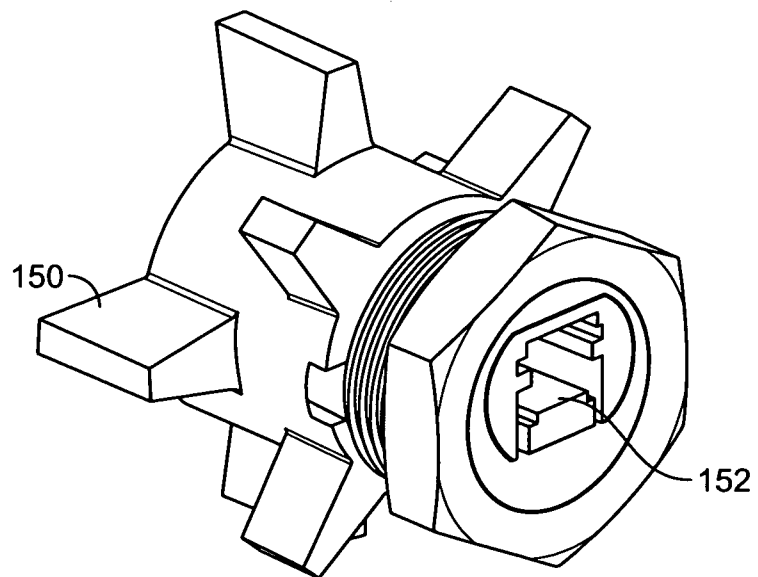


FIG. 14

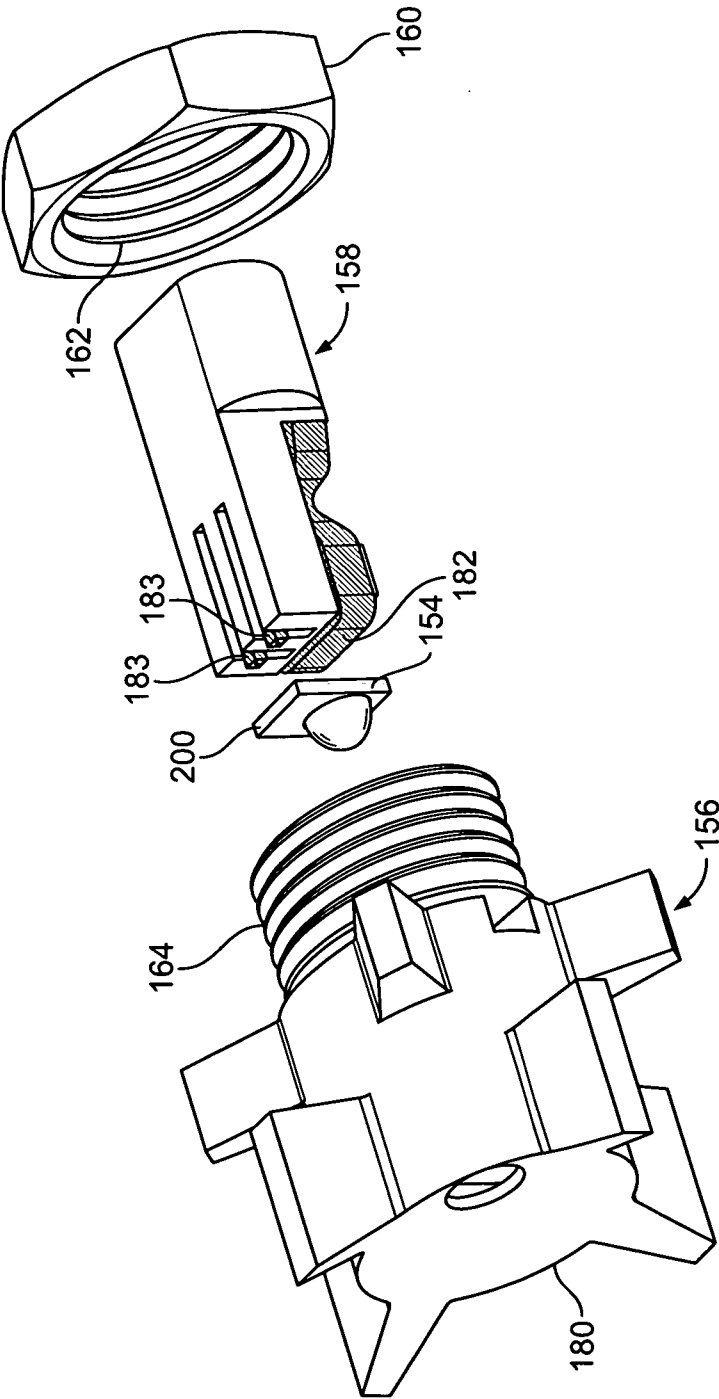


FIG. 15A

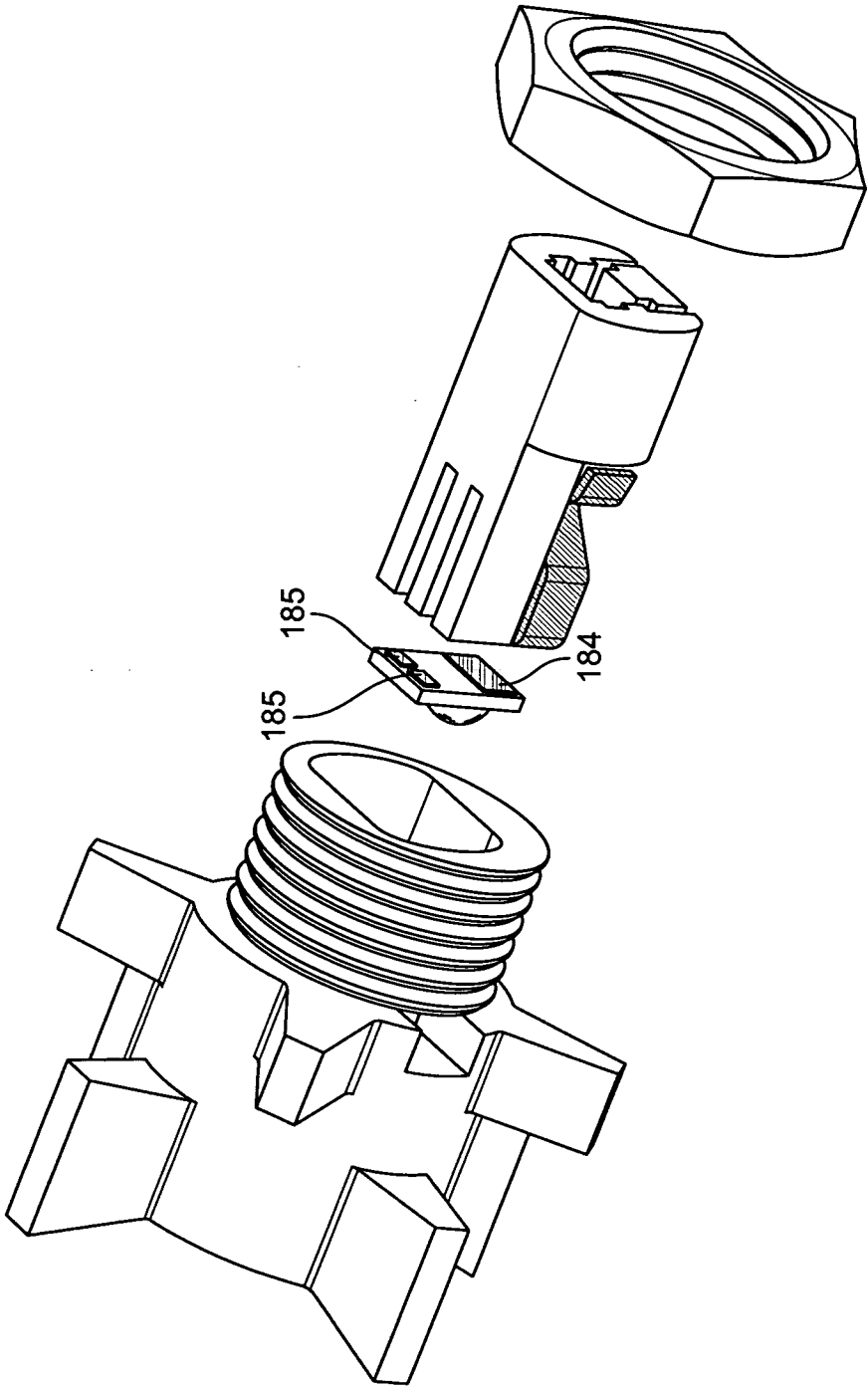


FIG. 15B

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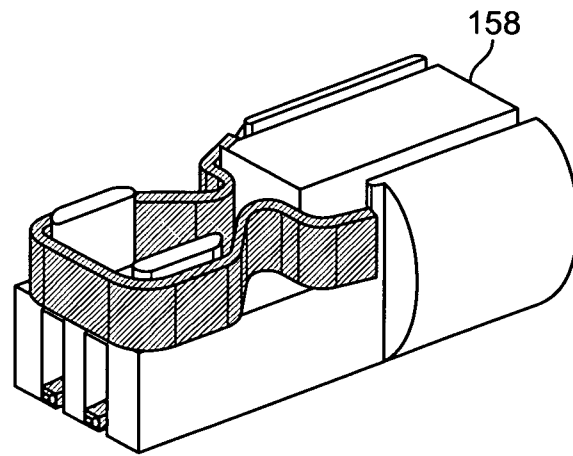


FIG. 16

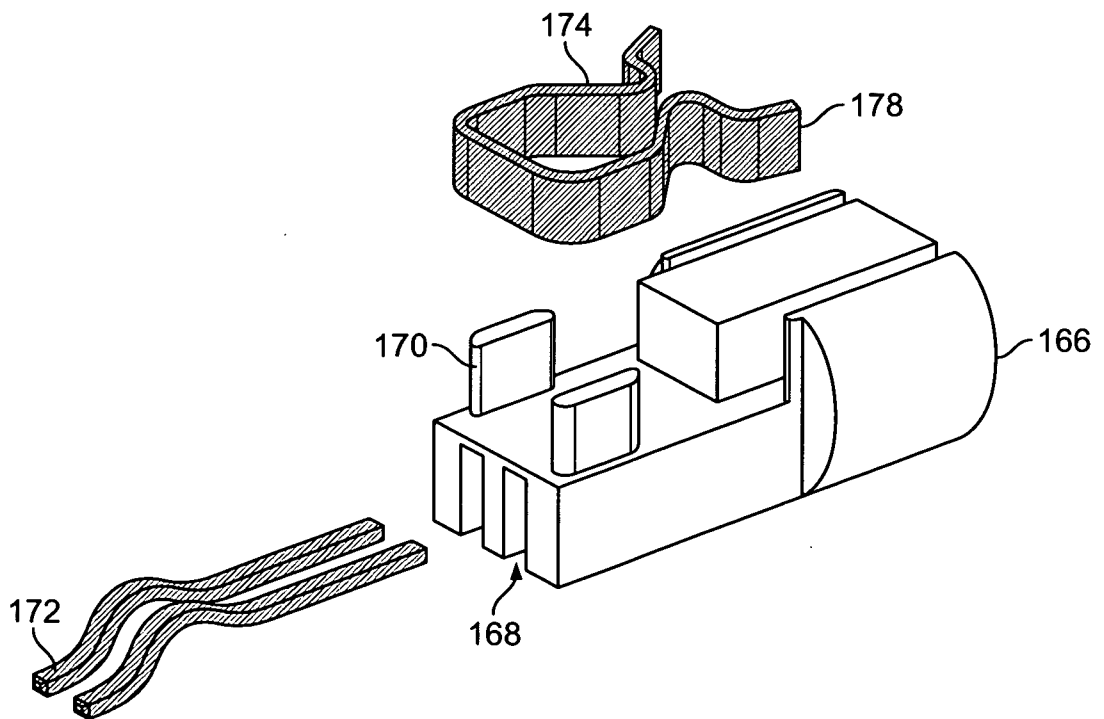


FIG. 17

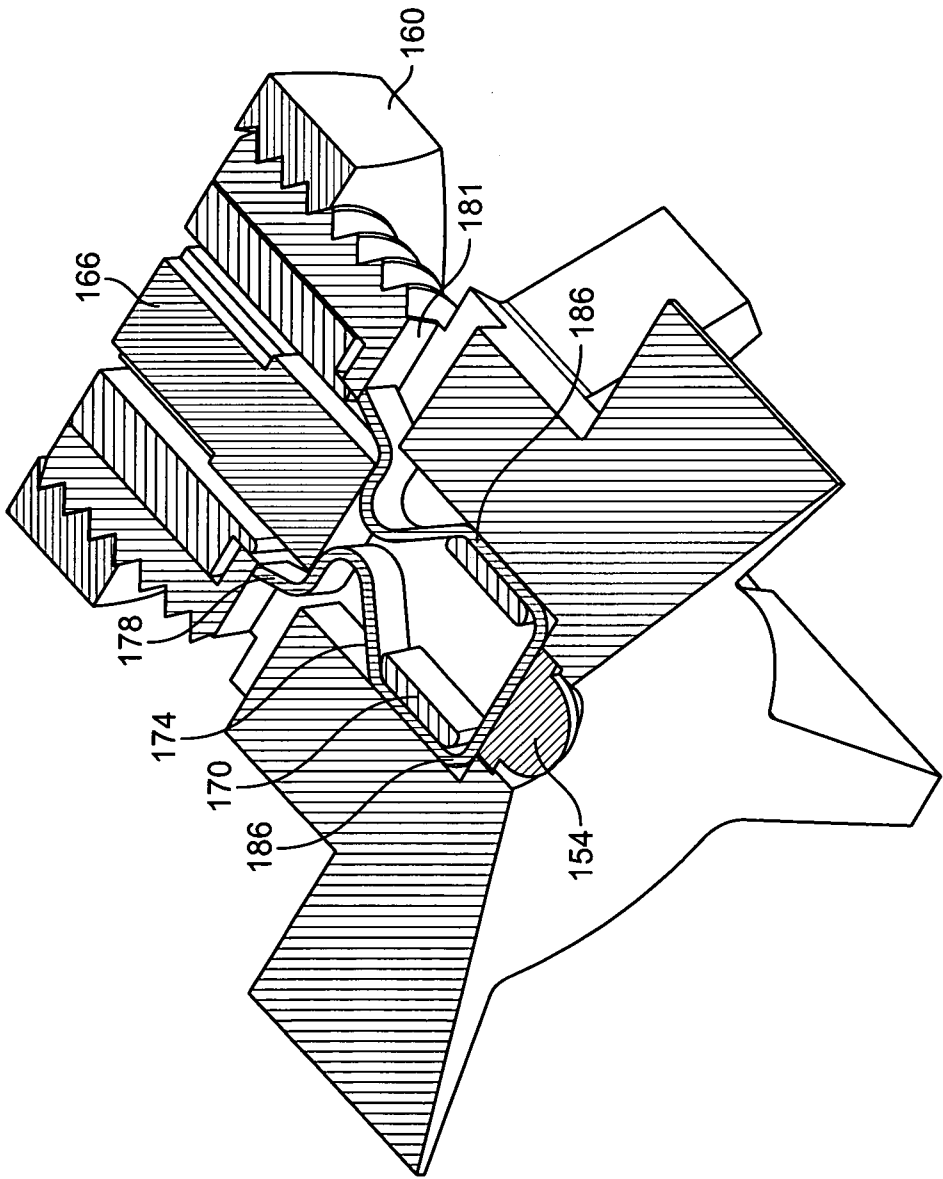


FIG. 18

## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2008/013941

## A. CLASSIFICATION OF SUBJECT MATTER

INV. F21K7/00  
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)  
F21K 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. |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | US 2006/002125 A1 (KIM HYUNG S [KR] ET AL<br>KIM HYUNG SUK [KR] ET AL)<br>5 January 2006 (2006-01-05)<br>paragraph [0031]<br>paragraph [0034]<br>figures 1-3 | 1                     |
| A         | WO 2007/034361 A (PHILIPS INTELLECTUAL<br>PROPERTY [DE]; KONINKL PHILIPS ELECTRONICS<br>NV [NL] 29 March 2007 (2007-03-29)<br>abstract<br>page 8             | 1                     |
| A         | US 2005/024864 A1 (GALLI ROBERT D [US])<br>3 February 2005 (2005-02-03)<br>figure 4<br>paragraph [0034]                                                      | 1                     |
|           | -----<br>-/--                                                                                                                                                |                       |

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

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## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2008/013941

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                   | Relevant to claim No. |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | WO 2006/118457 A (GEMEX CONSULTANCY B V<br>[NL]; ROOYMANS JOHANNES OTTO [NL])<br>9 November 2006 (2006-11-09)<br>page 7, line 18 - line 30<br>figures 4a-4c<br>----- | 1                     |

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2008/013941

| Patent document<br>cited in search report |    | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|----|---------------------|----------------------------|---------------------|
| US 2006002125                             | A1 | 05-01-2006          | KR 20060002092 A           | 09-01-2006          |
| WO 2007034361                             | A  | 29-03-2007          | CN 101268305 A             | 17-09-2008          |
|                                           |    |                     | JP 2009509309 T            | 05-03-2009          |
|                                           |    |                     | KR 20080063337 A           | 03-07-2008          |
|                                           |    |                     | US 2008253127 A1           | 16-10-2008          |
| US 2005024864                             | A1 | 03-02-2005          | NONE                       |                     |
| WO 2006118457                             | A  | 09-11-2006          | CN 101228393 A             | 23-07-2008          |
|                                           |    |                     | EP 1869365 A1              | 26-12-2007          |
|                                           |    |                     | KR 20070118171 A           | 13-12-2007          |
|                                           |    |                     | NL 1028678 C2              | 03-10-2006          |