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(71) Applicant *(for all designated States except US)*: **WHITECASTLE INVESTMENTS LTD.** [—/NL]; Burgemeester de Manlaan 2, POB 4794, NL-4837 BN Breda (NL).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **BRENNER, Zvi** [IL/IL]; Apartment 9, 102 Rothschild Boulevard, 65224 Tel Aviv (IL).

(74) Agent: **APPELFELD & CO.**; America House, 35 Shaul Ha'Melech Blvd., P.O.B 18253, 61182 Tel Aviv (IL).

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Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) Title: LED LAMP FITTING HAVING AN INTEGRAL COOLING FAN

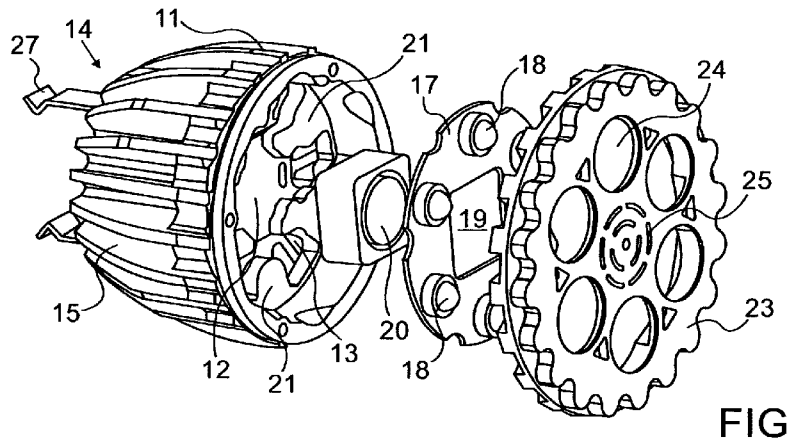

FIG. 1

(57) Abstract: A compact light emitting diode (LED) lamp fixture including: a thermally conductive housing having a base containing a plurality of rear air vents; a heat sink depending from a rear surface of the base for dissipating heat from air passing out of the rear air vents; a thermally conductive lamp support element for supporting one or more LEDs and having an aperture for accommodating a miniature fan; at least two spacing elements on a front surface of the base for mounting the lamp support element thereon; a cover having an equal number of lenses as there are LEDs; and a plurality of vent holes in the cover for passing air sucked by the fan from outside the lamp fixture into the housing so as to strike the base whereupon the air is deflected directly on to a rear surface of the lamp support element.

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LED lamp fitting having an integral cooling fan

FIELD OF THE INVENTION

This invention relates to lamp fittings having an integral cooling fan.

BACKGROUND OF THE INVENTION

Light-emitting diodes (LEDS) are gradually replacing halogen lamps as the preferred choice for low power, high intensity spots. When a halogen lamp rated at 35/50W is replaced by LEDs, a lamp fitting that can accommodate several power LEDs is required in order to provide equivalent illumination. A power LED gets extremely hot at its rear surface and the heat must be dissipated in order to prevent damage to the LED as well avoid the risk of fire. When several power LEDs are mounted on a common circuit board, the heat is imparted to the circuit board, which becomes very hot and must be dissipated.

One way in which heat is dissipated is by the use of a miniature fan that is embedded within the lamp casing. For example, CN 200810218685 discloses an LED lamp fitting that comprises a thermally conductive base plate in thermal contact with a heat sink, a shell and a drive circuit board component. The base plate is fixedly connected with at least one LED chip and the heat sink is connected to the base plate for heat dissipation. The drive circuit board component is positioned inside the shell and the heat sink is positioned between a radiating fan and the base plate.

US 7,344,279 assigned to Philips Solid-State Lighting Solutions, Inc. also describes with reference to Fig. 85 a thermal facility for removing heat from a LED lighting unit. The thermal facility may be any facility for managing the flow of heat, such as a fan or similar mechanism for providing air flow to the lighting unit. A fan or other convection facility can be under control of a processor and a temperature sensor such as a thermostat to provide cooling when necessary and to remain off when not necessary. Fig. 91 shows an embodiment that employs a thermally conductive plate in combination with a micro-fan.

US20060232984 discloses air flow management of a compact fluorescent lamp fixture wherein passive and/or active lamp chamber ventilation is provided through the use of vents in the lamp chamber and/or the use of a fan to induce air flow.

Although the use of a miniature fan that is embedded within the lamp casing is known *per se*, in known configurations the fan is located near the base of the lamp behind the circuit board on which the lamps are mounted so as to draw heated air out of the lamp housing.

SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved configuration for cooling a lamp housing wherein, instead of using a fan to ventilate hot air, a fan is used to suck in cold air directly on to the circuit board on which the lamps are mounted.

In accordance with one aspect of the invention there is provided a compact light emitting diode (LED) lamp fixture comprising:

a thermally conductive housing having a base containing a plurality of rear air vents,

a heat sink depending from a rear surface of the base for dissipating heat from air passing out of the rear air vents,

a thermally conductive lamp support element for supporting a number of spaced apart LEDs and having a substantially central aperture for accommodating a miniature fan that is mounted so as to suck in air from a front of the lamp fixture,

at least two spacing elements on a front surface of the base for mounting the lamp support element thereon so as to form a hollow chamber behind the lamp support element,

a cover having an equal number of spaced apart lenses each for propagating light emitted by a corresponding one of the LEDs, and

a plurality of vent holes in the cover for passing air sucked by the fan from outside the lamp fixture into the housing so as to strike the base whereupon the air is deflected directly on to a rear surface of the lamp support element, circulates within the hollow chamber and exits through the rear air vents.

In accordance with another aspect of the invention there is provided a method of improving the efficiency of a compact LED lamp assembly that includes a housing, a lamp support element, and a front cover, the method comprising:

providing a ventilation passage from the front cover through the lamp support to a hollow chamber at a rear of the housing so that air drawn through the front cover strikes the rear of the housing and is deflected directly on to a rear surface of the lamp support element, circulates within the hollow chamber and exits through rear air vents formed in the rear of the housing;

providing a miniature fan disposed in spatial relationship to the lamp support element and the hollow chamber so as to suck in ambient air through said ventilation passage; and

dissipating hot air exiting from the rear air vents of the housing.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 is an exploded pictorial representation of a lamp fixture according to the invention;

Fig. 2 is an exploded pictorial representation of the lamp fixture shown in Fig. 1 showing direction of air flow during use;

Fig. 3 is an exploded rear view of the lamp fixture shown in Fig. 1;

Fig. 4 is partial section of the lamp fixture shown in Fig. 1 in its assembled state; and

Fig. 5 is partial section of the lamp fixture shown in Fig. 1 in its assembled state showing direction of air flow during use.

DETAILED DESCRIPTION OF EMBODIMENTS

In the following description of some embodiments, identical components that appear in more than one figure or that share similar functionality will be referenced by identical reference symbols.

Referring to the figures there is shown a compact LED lamp fixture 10 comprising a thermally conductive housing 11 having a base 12 containing a plurality of rear air vents 13. A heat sink 14 having a plurality of thermally conducting vanes 15 depends from a rear surface 16 of the base for dissipating heat from air passing out of the rear air vents 13.

A thermally conductive lamp support element 17 is configured for supporting a plurality of spaced apart LEDs 18 and has a substantially central aperture 19 for accommodating a miniature fan 20 that is mounted so as to suck in air from a front of the lamp fixture 10. At least two thermally conductive spacing elements 21 are provided on a front surface of the base for mounting the lamp support element thereon so as to form a hollow chamber 22 behind the lamp support element 17. Fixed to the front of the housing is a removable cover 23 having an equal number of spaced apart lenses 24 each for propagating light emitted by a corresponding one of the LEDs. A plurality of vent holes 25 are formed in the cover 23 for passing air sucked by the fan 20 from outside the lamp fixture into the housing 11 so as to strike the base 12. Air striking the base is deflected directly on to a rear surface of the lamp support element 17, circulates within the hollow chamber 22 and exits through the rear air vents 13 where it is dissipated by the heat sink 14. In circulating within the hollow chamber 22, the cool air also cools the spacing elements 21, which are preferably equal in number of the number of LEDs and are disposed directly underneath a corresponding LED. In such an arrangement, the cool air that is sucked in by the fan 20, cools the spacing elements 21 by direct impact and cools the hot spots on the lamp support element 17 via direct thermal contact with the thermally conductive spacing elements 21.

This is quite different from hitherto-proposed lamp fixtures. Thus, for example, in CN 200810218685 the fan is disposed proximate the inner metal surface of the housing behind the lamp circuit board. To this extent, the air that is circulated by the fan is the air which is already in the vicinity of the lamp circuit board and this air is already hot on account of the heat dissipated by the LEDS mounted on the lamp circuit board. The circulation of air thus serves to cool the lamp by convection only, since it allows a constant stream of hot air to exit through the rear vent holes in the lamp housing.

However, in the present invention the fan is located so as to suck in a constant stream of cool air that impinges directly on the thermally conductive spacing elements that are in direct thermal contact with the hot spots of the lamp support element. This allows more efficient cooling since heat is dissipated not only by convection but also by conduction and radiation away from the hot spots.

The housing 11 and the heat sink 14 are formed of a good thermally conductive material such as aluminum. The spacing elements 21 may likewise be formed of aluminum and may be formed together with the housing and the heat sink as a single

unit. An equal number of spacing elements 21 is provided as there are LEDs, and the spacing elements 21 are spaced so that a portion of the lamp support element 17 directly behind each LED 18 is seated directly on its own spacing element 21. By such means, local areas of the lamp support element 17 subjected to the greatest heat by virtue of their being in direct thermal contact with a LED are able to conduct the heat directly to the base. This objective would, of course, be realized by abutting the lamp support element 17 directly against the base. However, owing to the hollow chamber 22 that is formed between the base 12 and the lamp support element 17 by virtue of the spacing elements 21, which displace the lamp support element 17 from the base 12, air is able to flow behind the lamp support element 17. This greatly improves heat convection, which is even further assisted by the fan, which ensures that a constant stream of relatively cold ambient air is sucked into the hollow chamber 22 to assist in cooling the lamp support element 17 and in ensuring a constant circulation of the now-heated air through the rear vent holes.

The invention also contemplates a lamp assembly comprising the lamp fixture 10 accommodating a number of LEDs. Typically, two or more LEDs are mounted in equally angularly-spaced relationship around the lamp support assembly. However, the number of LEDs is not itself a principal feature of the invention, which resides in the combined direct cooling of the lamp support element by cool ambient air and the provision of a hollow chamber in which cool air can circulate prior to and after striking the rear surface of the lamp support element 17. The same principle could also be used with a single high power LED. Each LED 18 may be mounted on the lamp support element 17 via an annular bead 26 that supports the LED while allowing its connection wires (not shown) to be passed through an aperture in the lamp support element 17 to a power supply terminal (not shown).

Mounting clips 27 are fixed to a rear surface of the housing 12 for removably attaching the lamp fixture 10 to a support bracket (not shown) in a manner that is known *per se*.

CLAIMS:

1. A compact light emitting diode (LED) lamp fixture comprising:

a thermally conductive housing having a base containing a plurality of rear air vents,

a heat sink depending from a rear surface of the base for dissipating heat from air passing out of the rear air vents,

a thermally conductive lamp support element for supporting one or more LEDs and having an aperture for accommodating a miniature fan that is mounted so as to suck in air from a front of the lamp fixture,

at least two spacing elements on a front surface of the base for mounting the lamp support element thereon so as to form a hollow chamber behind the lamp support element,

a cover having an equal number of lenses as there are LEDs, each lens for propagating light emitted by a corresponding one of the LEDs, and

a plurality of vent holes in the cover for passing air sucked by the fan from outside the lamp fixture into the housing so as to strike the base whereupon the air is deflected directly on to a rear surface of the lamp support element, circulates within the hollow chamber and exits through the rear air vents.

2. The lamp fixture according to claim 1, wherein the housing and the heat sink are formed of aluminum.

3. The lamp fixture according to claim 2, wherein the spacing elements are formed of aluminum.

4. The lamp fixture according to claim 3, wherein the housing, the heat sink and the spacing elements are formed as a single unit.

5. The lamp fixture according to any one of claims 1 to 4, including a plurality of spaced apart LEDs and wherein the aperture is formed substantially centrally in the lamp support element.

6. The lamp fixture according to any one of claims 1 to 5, wherein there is an equal number of spacing elements as LEDs and each spacing element is located directly beneath a connection point on the lamp support element for a corresponding LED.

7. A lamp assembly comprising the compact light emitting diode (LED) lamp fixture according to any one of claims 1 to 6, accommodating a number of LEDs.

8. The lamp assembly according to claim 7, wherein more than two LEDs are supported in the lamp assembly.

9. A method of improving the efficiency of a compact LED lamp assembly that includes a housing, a lamp support element, and a front cover, the method comprising:

providing a ventilation passage from the front cover through the lamp support to a hollow chamber at a rear of the housing so that air drawn through the front cover strikes the rear of the housing and is deflected directly on to a rear surface of the lamp support element, circulates within the hollow chamber and exits through rear air vents formed in the rear of the housing;

providing a miniature fan disposed in spatial relationship to the lamp support element and the hollow chamber so as to suck in ambient air through said ventilation passage; and

dissipating hot air exiting from the rear air vents of the housing.

10. The method according to claim 9, including:

providing a respective thermally conductive spacing element for each LED and locating each spacing element directly beneath a connection point on the lamp support element for a corresponding LED;

whereby cool air striking the spacing elements directly cools the connection points via conduction.

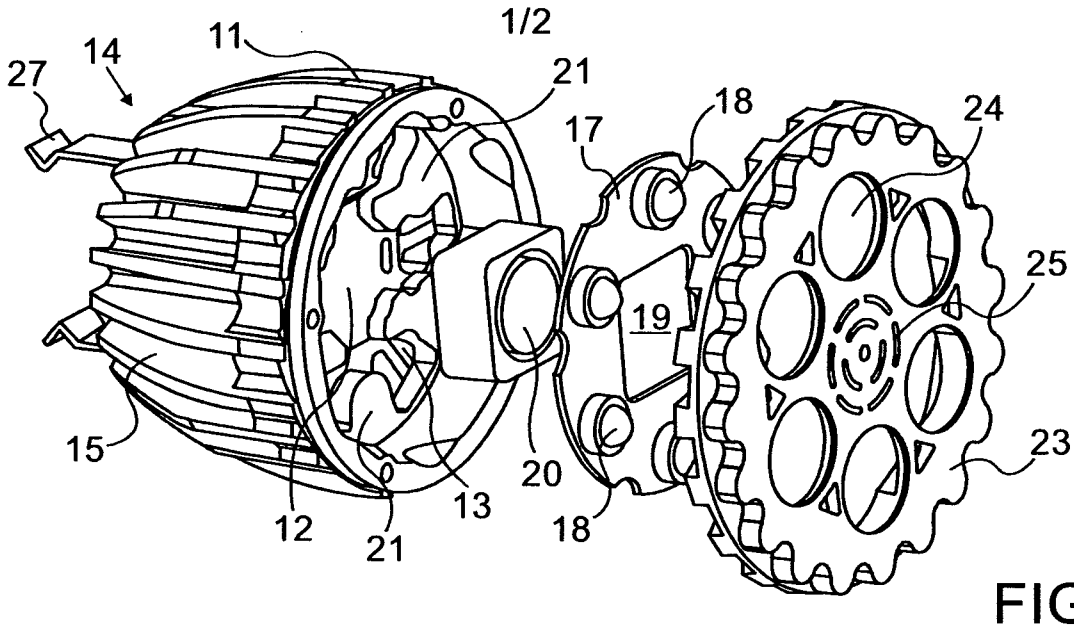

FIG. 1

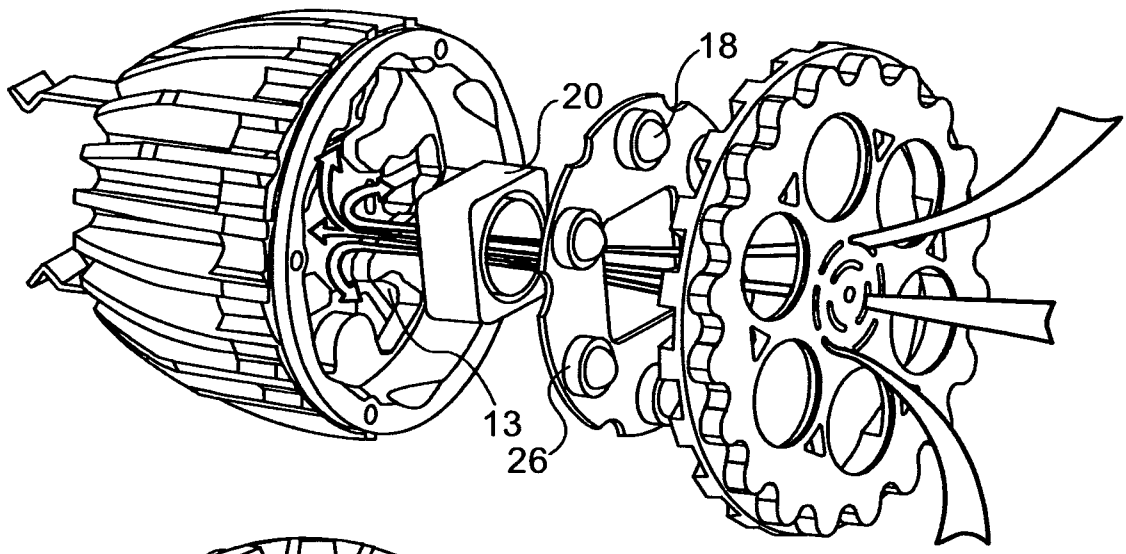

FIG. 2

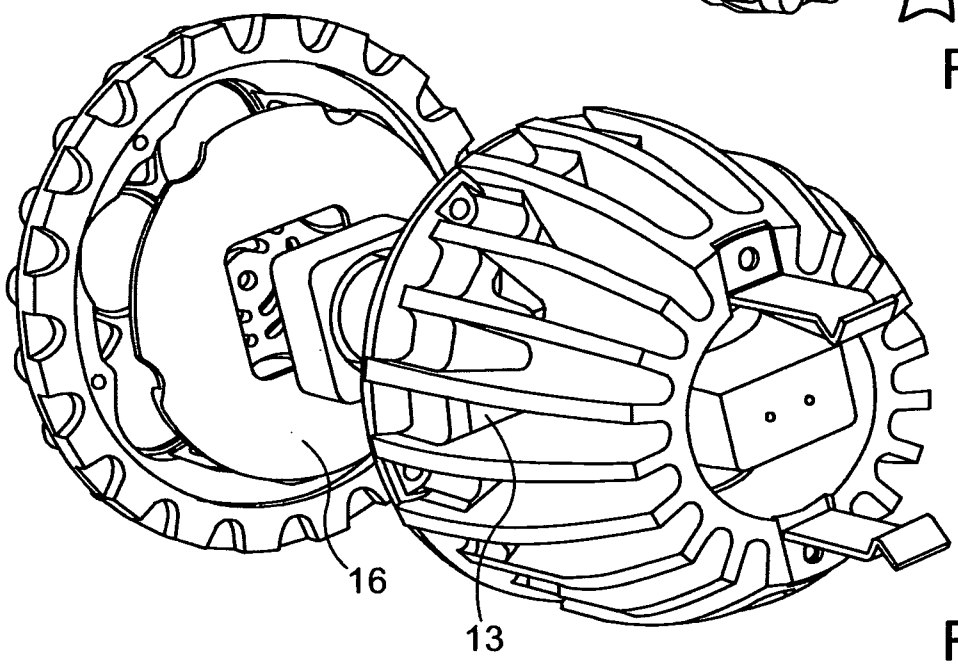

FIG. 3

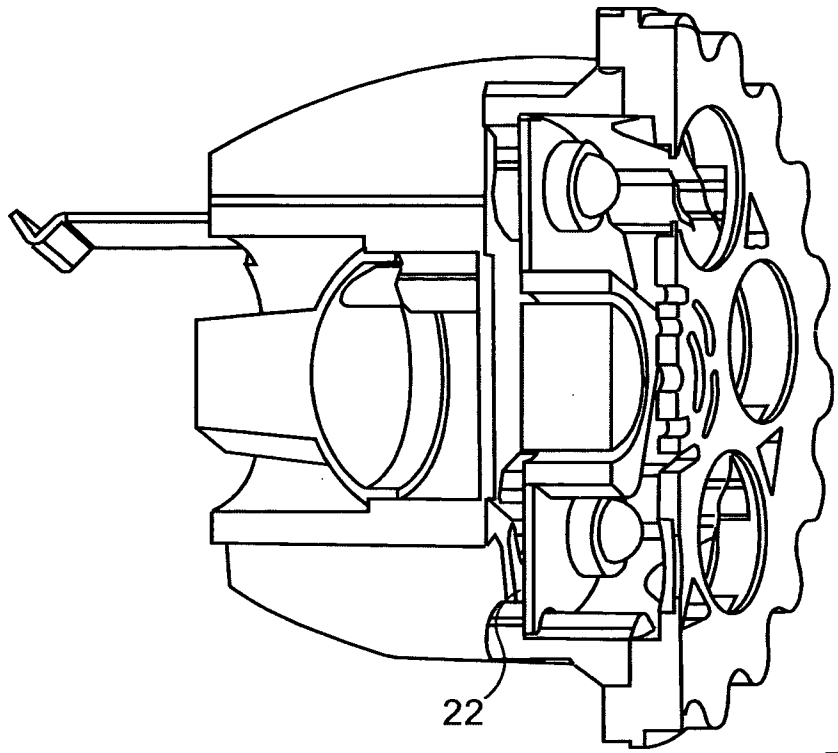

FIG. 4

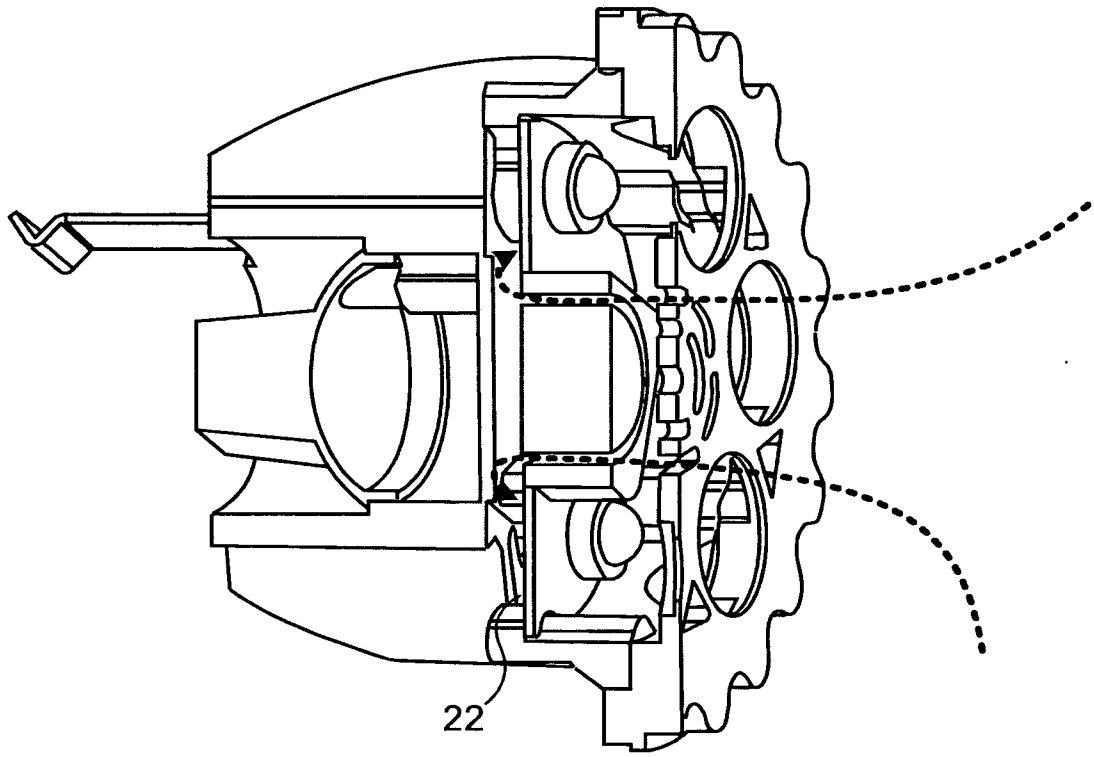

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL 11/00171

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H01J 1/02 (2011.01)
USPC - 313/46
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): H01J 1/02 (2011.01)
USPC: 313/46

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC(8): H01J 1/02 (2011.01)
USPC: 313/46; 257/E33.075; 362/234

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST; PGPB, USPT, EPAB, JPAB; Google Scholar; Google Patent; Search Terms: LED OLED light emitting diode circulator vent fan micro-fan minuature heat sink air aperture hole aluminum metal lens cover reflector fin rib flow cool thermal heat PCB circuit board support socket housing base internal inside hollow

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 2009/0046465 A1 (Hashimoto et al.) 19 February 2009 (19.02.2009) para. [0001] through [0031], Fig. 1-13	9 and 10 --------- 1-5
Y	US 2005/0174780 A1 (Park) 11 August 2005 (11.08.2005) para. [0010] through [0043], Fig. 1-10	1-5
Y	US 2008/0253125 A1 (Kang et al.) 16 October 2008 (16.08.2008) para. [0024] through [0027], Fig. 1-7	5
A	US 2009/0195159 A1 (Smith) 06 August 2009 (06.08.2009) entire document	1-5, 9 and 10
A	US 2007/0279921 A1 (Alexander et al.) 06 December 2007 (06.12.2007) entire document	1-5, 9 and 10

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 June 2011 (28.06.2011)	08 JUL 2011
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL 11/00171

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 6-8
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.