



(51) International Patent Classification:
F21V 13/00 (2006.01)

(21) International Application Number:
PCT/US2009/066527

(22) International Filing Date:
3 December 2009 (03.12.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
TO2008A000900 4 December 2008 (04.12.2008) IT

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, 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, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))
- of inventorship (Rule 4.17(iv))

Published:

- with international search report (Art. 21(3))

(54) Title: LED LAMP, IN PARTICULAR FOR INTERNAL LIGHTING OF AN ELECTRIC HOUSEHOLD APPLIANCE

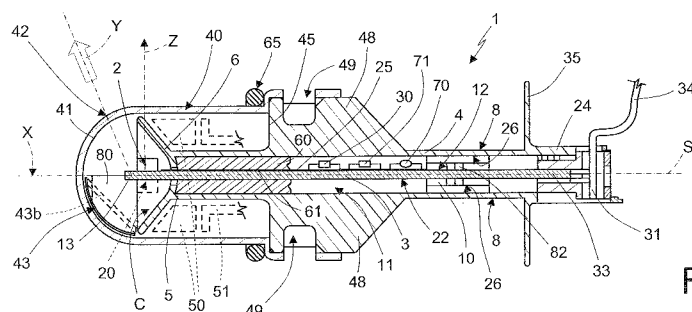


Fig.1

(57) Abstract: A lamp (I) for internal lighting of an electric household appliance including at least one light source (2) consisting of a LED, a printed circuit (3) for supporting and powering the light source and a supporting body (4) for the printed circuit made of an electrically non-conductive material and provided, at one first end (5) thereof, with a reflecting/diffusing element (6) of the light emitted by the light source and defining an optical axis (X) arranged substantially parallel to a longitudinal axis of the supporting body; wherein the at least one light source (2) is mounted at a first end (13) of the printed circuit, fixed to a first flat face (12) thereof, with a light diffusion axis (Z) thereof oriented substantially perpendicular to the first face; the printed circuit (3) being supported inside the body (4), which is tubular in shape, with the first face (12).

**LED LAMP, IN PARTICULAR FOR INTERNAL LIGHTING
OF AN ELECTRIC HOUSEHOLD APPLIANCE**

TECHNICAL FIELD

5 The present invention relates to a LED lamp, particularly designed for internal lighting of electric household appliances.

BACKGROUND ART

10 It is known that many electric household appliance (such as ovens and refrigerators) use lamps for internal lighting. Nowadays and increasingly in future, these lamps are also intended to equip electric household appliances, such as washing machines and dishwashers, for internally lighting the washing tank.

15 A cost reduction of LEDs and a parallel increase in emitted light power has nowadays made them a possible alternative light source for these lamps. However, their application for internal lighting of electric household appliance implies the solution of several problems, firstly that of allowing an easy dissipation of the heat generated by the LEDs in use while correctly exploiting all the produced light energy. Compactly structured, easily assembled and relatively low-cost lamps are thus needed.

20

DISCLOSURE OF INVENTION

25 It is an object of the present invention to solve the aforesaid problems, by providing a lamp for electric household appliances using a highly compact, reliable, relatively low-cost light source of the LED type which is easy to be assembled and mountable on different types of electric household appliances, from refrigerators to washing machines, while always ensuring an effective disposal of the heat produced

by the LED in use.

The present invention thus relates to a LED lamp for an electric household appliance, as defined in claim 1.

In particular, the lamp according to the invention comprises at least a first
5 light source consisting of a LED, a printed circuit for supporting and powering the
light source and a supporting body for the printed circuit made of an electrically non-
conductive material and provided, at one first end thereof, with a reflecting/diffusing
element of the light emitted by the at least one light source and defining an optical
axis arranged substantially parallel to a longitudinal symmetry axis of the supporting
10 body; the at least a first light source being firmly carried on a first flat face of the
printed circuit and mounted at a first end of the printed circuit, with a light diffusion
axis thereof oriented substantially perpendicular to the first face; in combination with
these features, the supporting body has a tubular shape and the printed circuit is
supported inside the body, with the first face arranged substantially coplanar with the
15 optical axis of the reflecting/diffusing element and the first end overhangingly
protruding from the first end of the supporting body, within a concavity of the
reflecting/diffusing element, so that the same may collect at least part of the light
emitted by the at least one first light source.

According to an important aspect of the invention, the printed circuit extends
20 over the entire length of the supporting body, to a second end thereof which is
opposite to the first, and on at least the first face, it is provided with electrically and
thermally conductive tracks connected to the at least a first light source, which tracks
are exposed in use to a convective cooling motion of the environmental air through
respective longitudinal slots made through at least one side wall of the supporting
25 body, at a predetermined distance from the first end and, preferably, towards the
second end.

According to a further aspect of the invention, the lamp further comprises a cup-shaped, optical element fitted over the first end of the supporting body so as to accommodate, at a concave bottom wall thereof, the reflecting/diffusing element; at least a first portion of the concave bottom wall, facing the reflecting/diffusing element on the side of the at least a first light source is pervious to light and at least a second portion of the concave bottom wall, opposite to the first, is made as being at least partially reflecting, so as to intercept at least part of the light emitted by the at least one light source to reflect it towards the reflecting/diffusing element.

Thereby, a lamp with a light source consisting of a LED is obtained, which is extremely compact and simple in structure, and relatively cost-effective to be implemented, which does not require wiring for supplying power to the LED light and which is especially able to easily dissipate the heat generated by the LED in use. Furthermore, the main light beam may be emitted towards a prevalent direction and no fraction of the light power emitted by the LED is lost, thus allowing a favorable light/electric consumption ratio. Furthermore, the LED lamp according to the invention may be easy waterproofed simply by filling the first end of the supporting body with a resin in which a portion of the printed circuit close to the first end thereof is embedded. Finally, a two-faced printed circuit may be used by installing a LED on both faces, both at the first end of the printed circuit, and additional electronic components may be mounted to the printed board, such as dusk, temperature or humidity sensors, an NTC for controlling a RGB LED so as to be able to further change the colour of the emitted light, a freshener, etc.

BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages of the present invention will be apparent from the following description of a preferred embodiment, exclusively provided by

way of non-limitative example, with reference to the accompanying drawings, in which:

- figure 1 shows a longitudinal, elevation cross-section view, taken along the axis, of a lamp according to the invention; and

5 - figure 2 shows an external, front three-quarter axonometric view of the lamp in figure 1.

BEST MODE FOR CARRYING OUT THE INVENTION

With reference to figures 1 and 2, numeral 1 indicates as a whole a lamp for
10 internal lighting of an electric household appliance of any known type (not shown), from refrigerators to washing machines.

Lamp 1 comprises at least a first light source 2 consisting of a LED, a printed circuit 3 for supporting and powering the LED 2 and a supporting body 4 for the printed circuit 3 made of an electrically non conducting material, preferably by
15 molding a synthetic plastic material.

At a first end 5, body 4 is provided with a reflecting/diffusing element 6 of the light emitted by LED 2 and defining an optical axis X (e.g. if the element 6 has a parabolic, hyperbolic or parabolic-hyperbolic shape, defined by the geometric axis of the parabola or hyperbola formed thereby) arranged substantially parallel to - and in
20 this case, coinciding with - a longitudinal symmetry axis S of the supporting body 4.

The latter has a tubular conformation and a generally prismatic (parallelepiped) shape being delimited by pairs of flat side walls 8 and 10 arranged perpendicular to each other and delimiting therebetween a longitudinal seat 11 coaxial to the axes X and S within the body 4.

25 LED 2 is fixedly carried on a first flat face 12 of the printed circuit 3, and is

mounted at a first end 13 of the printed circuit 3, with a light diffusing axis Z thereof oriented substantially perpendicular to the face 12; according to an aspect of the invention, in combination with these structural features, the printed circuit 3 is supported within the body 4, in the seat 11, with the laying plane thereof parallel to
5 faces 8 and to axes X and S, and in particular with the face 12 parallel to faces 8 and arranged substantially coplanar with the optical axis X of the reflecting/diffusing element 6.

The printed circuit 3 (hereinafter also indicated as PCB) then has its first end 13 overhangingly protruding from the first end 5 of the supporting body 4, within a
10 concavity C of the reflecting/diffusing element 6, so that the same may collect at least part of the light emitted by LED 2.

By virtue of such an arrangement, according to a possible variant of lamp 1, it may also be provided with more than one light source, in particular with a second LED 20, shown in dashed line in figure 1, supported at the first end 13 of the printed
15 circuit 3, on a second face 22 thereof, parallel and opposite to face 12; LED 20 also has the light diffusing axis coinciding with axis Y and thus perpendicular to the printed circuit, and is mounted to be arranged within the concavity C of the reflecting/diffusing element 6, so that it may also collect at least part of the light emitted by LED 20, in addition to that emitted by LED 2.

20 According to an important aspect of the invention, the printed circuit 3, shaped and placed as described with respect to the body 4, extends over the entire length of the supporting body 4, to a second end 24 thereof, opposite to end 5. Furthermore, on at least face 12 and on both faces 12 and 22 if a second LED 20 is present, the printed circuit 3 is provided with electrically and thermally conductive
25 tracks 25, obtained in one piece by means of known techniques on PCB 3, connected to LED 2 (and to LED 20 if present).

According to the invention, tracks 25 are exposed in use to a convective cooling motion of the environmental air, due to the body 4 being provided with respective longitudinal slots 26 made through at least one side wall 8,10 (in this case through all the walls 8,10, at the longitudinal edges joining the same), at a
5 predetermined distance from end 5 and, preferably, towards the end 24, so as to be spaced in use from the point of using the LED(s) 2/20; in this case, the environmental air present about the body 4, and particularly close to the rear end 24, may enter into the seat 11 to lap on the tracks 25; as being conductive, the latter conduct the heat generated in use by LED 2 (and 20) along the same towards the end 24, whereby the
10 environmental air may remove this heat by lapping on the tracks 25, thus generating a convective motion through the slots 26, which cools the whole printed circuit 3.

For this purpose, the slots 26 are made both above and below the optical axis X and parallelly thereto, so that some of them face the first face 12 of the printed circuit 3 and others face the second face 22 thereof, which is obtained by forming
15 them at the joining edges of the walls 8,10.

Specifically, if only one LED is present (typically LED 2), this may be an RGB-type LED, so as to be able to emit light having a different spectrum; in this case, the printed circuit 3 also carries electronic means 30 (typically an NTC) on-board for controlling the RGB LED 2, connectable in use to the control unit of the
20 electric household appliance (not shown). For this purpose, and for supplying the required voltage to the tracks 25 for operating LED 2 (and 20 if present), end 24 of body 4 is provided with a series of standard connectors 31 integrated with a corresponding end 33 of the printed circuit 3 placed at the end 24. In order to protect the connectors 31, which may be connected in use to electric power supply and
25 control wires 34, the end 24 is provided with a screen 35, e.g. circular in shape.

According to a further aspect of the invention, lamp 1 also comprises a cup-

shaped, optical element 40 fitted over the end 5 of the supporting body 4 so as to accommodate the reflecting/diffusing element 6 at a concave bottom wall 41 thereof.

At least a first portion 42 of the concave bottom wall 41, facing the reflecting/diffusing element 6 on the side of LED 2 is pervious to light; while at least
5 a second portion 43 of wall 41, opposite to portion 42, is made (e.g. by inserting a metallized layer or by the provision of appropriate prisms) as being at least partially reflecting, so as to intercept at least part of the light emitted by LED 2 (and by LED 20, if present) to reflect it towards the reflecting/diffusing element 6.

The portions 42 and 43 of the bottom wall 41 are preferably asymmetric and
10 portion 43 is made as a flat surface 43b (shown in dashed line in figure 1) obliquely arranged with respect to the optical axis X, so as to acquire reflecting power (for certain light angles) even if it is pervious to light.

Therefore, the reflecting/diffusing element 6 is shaped so as to collect the light reflected by the portion 43 of the concave bottom wall 41 of the cup-shaped
15 optical element 40, and at least part of the direct light emitted by LED 2 (and by LED 20, if present), so as not to loose any fraction of the light produced by the LEDs 2,20. Even more preferably, element 6 is shaped to direct both the directed light and the light reflected by portion 43 of the wall 41 towards portion 42 of the wall 41, which portion is pervious to light (transparent), so as to form a prevalent light beam
20 (indicated by the arrow in figure 1) having oblique axis Y placed in a solid angle delimited by optical axis X and diffusion axis Z of the light of LED(s) 2/20.

According to another aspect of the invention, in order to reduce production costs, the reflecting/diffusing element 6 is at least partially pervious to light, in the sense that it is not coated on the side of the concavity C, with a reflecting metallized
25 layer totally impervious to light but may be simply made of a synthetic, white plastic material, which is thus naturally reflecting but which lets part of the light rays to

escape therethrough; the supporting body 4 is then provided on the side of the second end 24 (but before the slots 26, i.e. closer to the end 5 of the latter) with a reflecting screen 45, e.g. defined by a continuous annular ridge obtained on the walls 8,10 and not necessarily provided with a reflecting layer, but simply made of a white synthetic plastic, for example. And, the optical element 40 extends with a tubular portion 46 thereof pervious to the light and obtained in one piece with the bottom wall 41, to the screen 45, so that the light which escapes back through the element 6 (which for this reason is not simply defined as a reflecting element, but as a reflecting/diffusing element) is collected and reflected by the screen 45 and may be emitted outwards through the optical element 6, thus contributing the main light beam.

Furthermore, at screen 45, the body 4 is also provided with connecting means 48 for the cup-shaped, optical element 6 arranged immediately adjacent to the screen 45 on the side of end 24, and defined by fins which are bayonet-coupled with specific circumferential slots 49 of the optical element 6, for example.

According to a further aspect of the invention, the reflecting/diffusing element 6 is formed so as to completely overhangingly protrude, in the direction of the optical axis X, from the first end 5 of the supporting body 4, with which it is formed in one piece and from a synthetic plastic material, so as it may be produced with a selectively variable opening angle, by simply replacing respective inserts 50 of a mould 51 (illustrated in dashed line, figure 1) for forming the body 4.

In case of applications requiring waterproofing, e.g. the application in the tank of a washing machine/dishwasher, at least the end 5 of the tubular body 4 is internally filled with an electrically insulating resin 60 which is poured into the seat 11 once the printed circuit 3 has been placed therein, so that a portion 61 thereof which is immediately close/adjacent to the end 13, is embedded in the resin 60, so as to seal the end 13 of the supporting body 4 in a substantially fluid-tight manner. In

addition to this contrivance, the optical element 6 may be externally provided with a sealing ring 65 at the screen 45.

By virtue of its arrangement over the length of body 4, the printed circuit 3 preferably carries electronic means 70,71, in addition to the possible NTC 30 for
5 controlling LED 2 (or 20) if this is an RGB LED. For example, these electronic means may be selected in the group consisting of: dusk sensor 70, evaporation freshener 71, self-powered battery, humidity sensor, temperature sensor, or combinations thereof.

Finally, given the overhanging arrangement of the end 13 of the printed
10 circuit 3 within the concavity C, the optical element 6 may be provided with a supporting fin 80 carried by the reflecting portion 43. Further rail-shaped supporting fins 82, in which the sliding printed circuit 3 may be inserted, may be obtained in one piece with body 3, e.g. at the slots 26.

CLAIMS

1. A lamp (1) for internal lighting of an electric household appliance, of the type comprising at least one light source (2;20) consisting of a LED, a printed circuit (3) for supporting and powering the light source and a supporting body (4) for the printed circuit made of an electrically non-conductive material and provided, at one first end (5) thereof, with a reflecting/diffusing element (6) of the light emitted by at least one light source and defining an optical axis (X) arranged substantially parallel to a longitudinal symmetry axis (S) of the supporting body (4), the at least one first light source (2;20) being firmly carried on a first flat face (12) of the printed circuit; **characterized in that** said at least one first light source (2;20) is mounted at one first end (13) of the printed circuit, with a light diffusion axis (Z) thereof oriented substantially perpendicular to the first face (12); said supporting body (4) having a tubular shape and the printed circuit (3) being supported inside the body, with the first face (12) arranged substantially coplanar with the optical axis (X) of the reflecting/diffusing element (6) and the first end (13) thereof overhangingly protruding from the first end of the supporting body, within a concavity (C) of the reflecting/diffusing element (6), so that the latter may collect at least part of the light emitted by the at least one first light source; the printed circuit (4) extending over the entire length of the supporting body, to a second end (24) of the same, opposite to the first.

2. A lamp according to claim 1, characterized in that said printed circuit (3) is provided, on at least the first face (12), with electrically and thermally conductive tracks (25) connected to the at least one first light source (2;20), which tracks are exposed in use to a convective cooling motion of the environmental air

through respective longitudinal slots (26) made through at least one side wall (8,10) of the supporting body, at a predetermined distance from the first end (5) and, preferably, towards the second end (24).

3. A lamp according to claim 2, characterized in that said slots (26) are made both above and below the optical axis (X) and parallelly to the same, so that some of them are facing the first face (12) of the printed circuit and other slots are facing a second face (22) of the printed circuit opposite to the first.

4. A lamp according to claim 3, characterized in that said second face (22) of the printed circuit is also provided with respective electrically and thermally conductive tracks (25) and supports, at the first end of the printed circuit, at least one second light source consisting of a LED (20), also having the light diffusion axis (Z) perpendicular to the printed circuit (3) and arranged within the concavity (C) of the reflecting/diffusing element (6).

5. A lamp according to any one of the preceding claims, characterized in that said LED (2;20) is an RGB-type LED, said printed circuit (3) carrying onboard electronic control means (30) for the same.

6. A lamp according to any one of the preceding claims, characterized in that it further comprises a cup-shaped optical element (40) fitted over said first end (5) of the supporting body so as to accommodate, at a concave bottom wall (41) thereof, said reflecting/diffusing element (6); at least one first portion (42) of said concave bottom wall, facing said reflecting/diffusing element (6) on the side of said at least one first light source (2) being pervious to light; and at least one second portion (43) of said concave bottom wall, opposite to the first, being made as being at

least partially reflecting, so as to intercept at least part of the light emitted by said at least one light source (2) to reflect it towards the reflecting/diffusing element (6).

7. A lamp according to claim 6, characterized in that said first (42) and second (43) portions of the concave bottom wall (41) of the cup-shaped optical element (40) are asymmetric, said second portion (43) of the concave bottom wall being preferably made as a flat surface (43b) obliquely arranged with respect to the optical axis (X).

8. A lamp according to claim 6 or 7, characterized in that said reflecting/diffusing element (6) is shaped so as to collect the light reflected by the second portion (43) of the concave bottom wall (41) of the cup-shaped optical element (40) and at least one part of the direct light emitted by at least one first light source (2;20) for directing both of them towards the first portion (42) of the concave bottom wall, so as to form a predominant lighting beam having oblique axis (Y) and placed at a solid angle delimited by the optical axis (X) and by said light diffusion axis (Z) of said at least one first light source.

9. A lamp according to any one of the claims from 6 to 8, characterized in that the reflecting/diffusing element (6) is at least partially pervious to light; said supporting body (4) being provided, on the part of the second end (24), with a reflecting screen (45) and with corresponding connecting means (48) for the cup-shaped optical element (40) arranged at the reflecting screen (45), immediately adjacent thereto on the side of the second end (24).

10. A lamp according to any one of the preceding claims, characterized in that said reflecting/diffusing element (6) is formed so as to completely overhangingly

protrude, in the direction of the optical axis (X), from the first end (5) of the supporting body (4), with which it is integrally formed in a synthetic plastic material, so that it may be formed with a selectively variable opening angle, simply by replacing respective inserts (50) of a mould (51) for forming the body (4).

11. A lamp according to any one of the preceding claims, characterized in that at least said first end (5) of the tubular body is internally filled with an electrically insulating resin (60) in which a portion (61) of the printed circuit (3) close to its first end (13) is embedded, so as to seal the first end (5) of the supporting body (4) in a substantially fluid-tight manner.

12. A lamp according to any one of the preceding claims, characterized in that said printed circuit (3) carries electronic means (70, 71) selected in the group consisting in: dusk sensor, evaporation freshener, self-powered battery, humidity sensor, temperature sensor or combinations thereof.

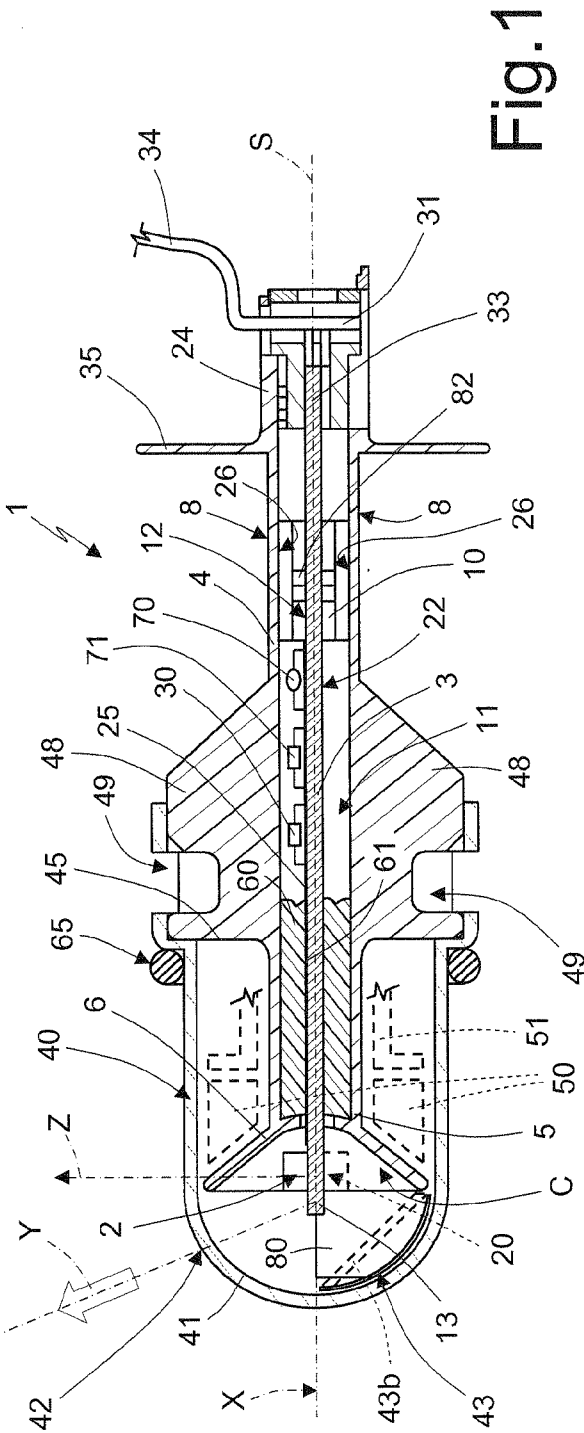


Fig. 1

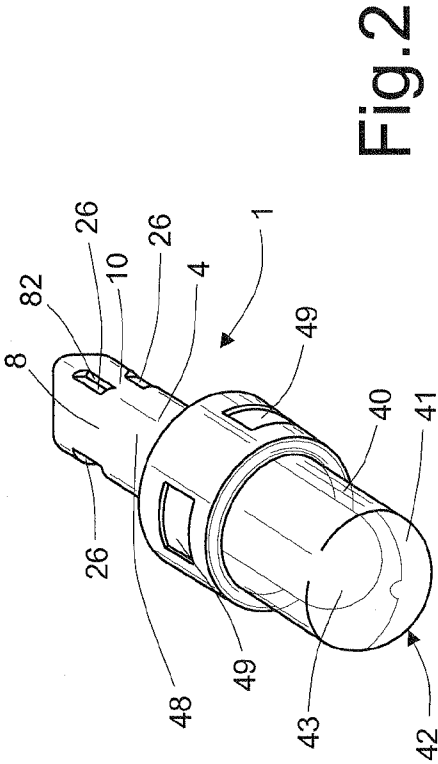


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2009/066527

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - F21V 13/00 (2010.01)

USPC - 362/800

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) - F21V 13/00 (2010.01)

USPC - 313/116, 318.11, 323; 362/249.02, 311.02, 612, 800, 600, 602, 608-09, 631-34, 89, 257, 296.05-08, 311.04, 311.06-09

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)

MicroPatent, IP.com, DialogPro, IEEEXplore, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2003/0235055 A1 (LODHIE) 25 December 2003 (25.12.2003) see document	1-5
A	US 2007/0195527 A1 (RUSSELL) 23 August 2007 (23.08.2007) see document	1-5
A	US 7,252,402 B2 (GOTZ et al) 07 August 2007 (07.08.2007) see document	1-5
A	US 2005/0270794 A1 (OKAMOTO et al) 08 December 2005 (08.12.2005) see document	1-5
A	US 7,300,183 B2 (KIYOMOTO et al) 27 November 2007 (27.11.2007) see document	1-5

☐ 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

15 January 2010

Date of mailing of the international search report

05 FEB 2010

Name and mailing address of the ISA/US

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2009/066527

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.: 6-12
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.