(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 293 453 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
14.03.2018 Bulletin 2018/11

(51) Int Cl.:
F21V 29/503 *(2015.01)* ***F21V 29/67*** *(2015.01)*
F21V 29/80 *(2015.01)*

(21) Application number: **16382418.8**

(22) Date of filing: **09.09.2016**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(71) Applicant: **VALEO ILUMINACION**
23600 Martos (ES)

(72) Inventors:
- **GOMEZ, Carlos**
  23005 JAEN (ES)
- **MADORRAN TIL, Gonzalo**
  23600 MARTOS (ES)
- **VALDIVIELSO, JUAN EUGENIO**
  23005 JAEN (ES)
- **MOISY, Eric**
  23009 JAEN (ES)
- **MORENO, Juan-Francisco**
  29620 Torremolinos (ES)

(54) LIGHTING DEVICE WITH A HEAT DISSIPATION ELEMENT

(57) The invention provides a lighting device (1) comprising a light source (2), a heat sink (3) and a heat dissipation element (4). The heat sink (3) being in thermal contact with the light source (2), and the heat dissipation element (4) comprising a plurality of wire loops (41) made of a solid wire, at least one of the wire loops (41) comprising at least one attachment point (42), the at least one attachment point (42) being attached to the heat sink (3).

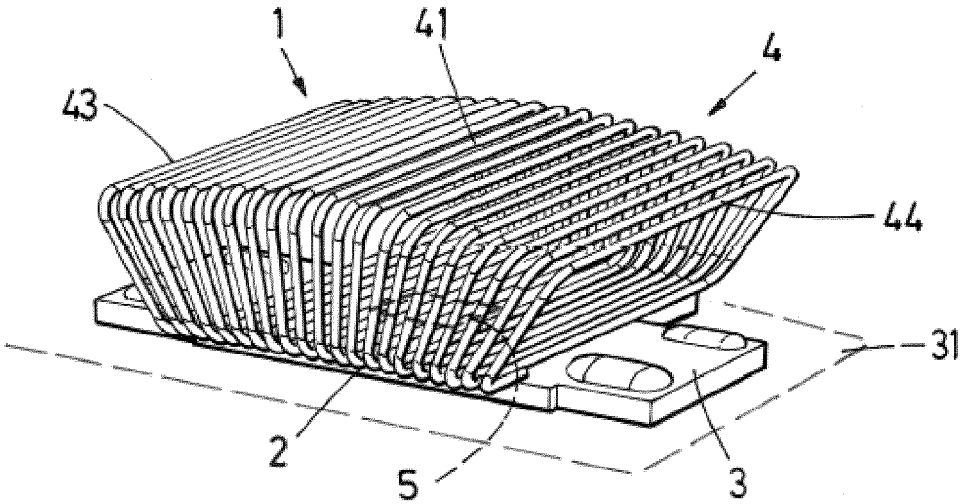

FIG.1c

EP 3 293 453 A1

Description

TECHNICAL FIELD

[0001] This invention belongs to the field of lighting devices which comprises heat dissipation elements, such as radiators.

STATE OF THE ART

[0002] Light sources, such as light-emitting diodes (LEDs), generate heat during its operation. If they overheat, lighting properties may decrease or even fail. These light sources are usually installed on heat sinks, which provide heat dissipation. In some occasions, a heat-dissipating device is required to increase the heat dissipation of the heat sink.

[0003] Several heat-dissipating devices are known in the state of the art. Classic pins arrangement, which are usually disposed perpendicular to the heat sink, cannot normally cope with large amounts of heat, generated by high-intensity light sources.

[0004] An alternative solution is represented by radiators with metal layers, which are bended to achieve a greater contact surface between air and metal.

[0005] However, these solutions might not take advantage of the airflow generated by natural convection, and therefore they normally need a high volume of heat dissipation units to achieve heat dissipation values which are suitable for current lighting devices.

DESCRIPTION OF THE INVENTION

[0006] The invention provides a solution for this problem by means of a heat dissipation element for circuits according to claim 1. Preferred embodiments of the invention are defined in dependent claims.

[0007] In a first inventive aspect, the invention provides a lighting device comprising a light source, a heat sink and a heat dissipation element

the heat sink being in thermal contact with the light source;
the heat dissipation element comprising a plurality of wire loops made of a solid wire; and
at least one of the wire loops comprising at least one attachment point being attached to the heat sink.

[0008] The wire loops are made of solid wire, i.e., a filiform piece which is made of the same material in its entirety (without any cavity, as in the case of heat pipes). This solid wire may be made of metal, such as copper or aluminium, of a composite material, such as graphite fibres embedded in a plastics matrix, or of any other material which are good heat conductors, thus ensuring proper heat dissipation from the heat sink.

[0009] A wire loop may be embodied in different ways. In some embodiments, the heat dissipation element has a helix shape, and that all wire loops are part of the same continuous solid wire. In this way, a wire loop would be one helix turn, and each wire loop usually has one attachment point where each wire loop is attached to the heat sink. In other embodiments, each wire loop is an individual piece of solid wire. In some of these embodiments, each wire loop is closed, such as, for example, a circle or a polygon with rounded vertices. In other of these embodiments, each wire loop is open, and is usually attached to the heat sink in at least two attachment points, the heat sink being the closure of these wire loops.

[0010] The thermal contact between the light source and the heat sink should be understood in the sense that the lighting device enables heat transfer between the light source and the heat sink, either by direct contact or by means of an intermediate element. This thermal contact may be embodied in some different ways. In some embodiments, the lighting device would comprise a plastic substrate with a conductive track directly deposited on it and the light source being placed in direct contact with the heat sink but electrically connected to the conductive track. In some embodiments, the lighting device would comprise a printed circuit board comprising the circuit tracks, with the light source also comprised in it, the light source being in thermal contact with the heat sink by means of this printed circuit board.

[0011] Such a lighting device may be used with high-intensity light sources, as the heat dissipation element with solid wire loops is a cheap, easy-to-manufacture solution (compared to e.g. heat pipes) which, however, achieves proper heat dissipation.

[0012] In some embodiments, the wire of the at least one wire loop comprises metal, such as, for example, copper or aluminium. In other embodiments, the wire of at least one wire loop comprises a composite material comprising a plastic material and graphite fibres. These materials are good heat conductors, thus ensuring proper heat dissipation from the heat sink.

[0013] In some embodiments, the wire of at least one of the wire loops comprises a cross section which is circular. In some embodiments, the wire of at least one of the wire loops comprises a cross section which is elliptic. In some embodiments, the wire of at least one of the wire loops comprises a cross section which has a rectangular shape.

[0014] Circular cross sections are a good solution for heat dissipation from a solid wire. An elliptic cross section and a rectangular cross section are suitable for directing the airflow, depending on the orientation. Depending on the specific use of the lighting device of the invention, one or several of these cross sections maybe suitable for the heat dissipation element.

[0015] In some embodiments, the wire of the wire loop which has a circular cross section with an area comprised between 0.8 and 7 mm^2. This size range is suitable for optimal heat dissipation, considering the standard dimensions of a heat sink in the field of automotive lighting.

[0016] In a particular embodiment, the light source

comprises at least one LED. This kind of light source provides a good lighting power with a very low electric power consumption.

[0017] In some embodiments, the heat dissipation element comprises a first wire loop and a last wire loop in such a way that all the wire loops are located following a tube arrangement between the first wire loop and the last wire loop.

[0018] This tube arrangement should be understood as a way of placing the wire loops, where adjacent wire loops are placed regularly one after the other, following the silhouette of an open tube.

[0019] This arrangement comprising wire loops may allow an airflow run from the first wire loop to the last wire loop in a continuous way, most of the airflow exiting through the last wire loop to open space. This leads to an improved cooling performance of the heat dissipation element.

[0020] In some embodiments, the wire loops define an inner volume and the light source is located inside the inner volume. As an airflow is induced inside the inner volume by convection phenomena, the light source being located inside the airflow allows a more direct cooling of this light source.

[0021] In some embodiments, every wire loop is contained in a loop plane, the heat sink is contained in a sink plane and each loop plane forms between 40° and 140° with respect to the sink plane. This embodiment relates to the wire loops which are separated pieces of solid wire, each wire loop being contained in a loop plane. At least some of the loop planes of this embodiment may form a non-perpendicular angle with the sink plane for causing a specific airflow pattern.

[0022] In some embodiments, the wire loops are part of the same continuous wire. In these embodiments, the manufacture of the wire loops may be easily achieved, by shaping a single wire and attaching it in some attaching points to the heat sink.

[0023] In a more particular embodiment, the lighting device further comprises a fan device, suitable for forcing air to circulate through the inner volume. This fan device, such as a mechanical fan or a compressor, improves the cooling performance of the heat dissipation element included in the lighting device. Hence, even higher intensity light sources may be used, as this improved cooling performance is able to greater heat dissipation.

[0024] In some embodiments, the following features concur:

the heat dissipation element comprises a first region of wire loops and a second region of wire loops;
the first region comprises a first border wire loop, which is the wire loop of the first region that is closer to the second region, the first border wire loop comprising a first attachment point and a first top point, which is the point of the wire loop farthest from the attachment point;
the second region comprises a second border wire loop, which is the wire loop of the second region that is closer to the first region, the second border wire loop comprising a second attachment point and a second top point, which is the point of the wire loop farthest from the attachment point;
between the first top point and the second top point there is a first distance which is greater than a half of a second distance between the first top point and the first attachment point.

[0025] This arrangement leads to an intermediate region between the first region and the second region where there are no wire loops. This intermediate region is usually located near the light source, where the cooling requirements are higher. An arrangement with this intermediate region comprising a lower density of wire loops near the light source has proven to be advantageous for the cooling efficiency of the cooling device comprised in this lighting device.

[0026] In some embodiments, the wire loops are arranged in a symmetrical way with respect to a plane which is perpendicular to a sink plane where the heat sink is contained. This arrangement is adapted for different airflow conditions, as air may flow in one direction or in the opposite direction.

[0027] In some embodiments, the lighting device further comprises a circuit board extending on the heat sink, wherein the light source is electrically connected to the circuit board as part of a circuit. This connection may be embodied in some different ways.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] To complete the description and in order to provide for a better understanding of the invention, a set of drawings is provided. Said drawings form an integral part of the description and illustrate an embodiment of the invention, which should not be interpreted as restricting the scope of the invention, but just as an example of how the invention can be carried out. The drawings comprise the following figures:

Figure 1 shows a lighting device according to the present invention.

Figures 2a, 2b and 2c show three examples of cross sections of the solid wire that form the wire loops.

Figures 3a to 3d show different embodiments of a lighting device according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0029] Figures 1a to 1d show different embodiments of a lighting device 1 according to the invention. In all of these embodiments, the lighting device 1 comprises a light source 2, a heat sink 3 and a heat dissipation element 4. The light source 2 is in thermal contact with the

heat sink 3, i.e. in such a way that heat may be evacuated from the light source 2 to the heat sink 3 by thermal conduction. The heat dissipation element 4 comprises a plurality of wire loops 41 made of a solid wire.

[0030] In these embodiments, the heat dissipation element 4 comprises a first wire loop 43 and a last wire loop 44 in such a way that all the wire loops 41 are located following a tube arrangement between the first wire loop 43 and the last wire loop 44.

[0031] In these embodiments, each wire loop 41 comprises an attachment point 42, this attachment point 42 being attached to the heat sink 3. In this way, heat may be evacuated from the heat sink 3 to the wire loops 41 by conduction. Likewise, in other embodiments the wire loops 41 may contain more than one attachment point 42 to be joined to the heat sink 3.

[0032] In figure 3a, the wire loops 41 are part of the same continuous solid wire, which has the shape of a helix forming the wire loops 41. Each of the wire loops 41 has one attachment point 42 to thermally attach the wire loop 41 to the heat sink 3.

[0033] Figure 3b shows another example of wire loops 41 wherein the wire loops 41 are separate wire loops, each wire loop being contained in a loop plane. In this figure, wire loops 41 have the shape of rectangles with rounded vertices. In other embodiments, these wire loops may have different shapes, such as circles or regular polygons with rounded vertices. Depending on the shape of these wire loops, one or more attachment points may be provided in each wire loop to thermally attach the wire loop to the heat sink.

[0034] In figure 3c, as in the embodiment of the preceding figure, every wire loop is contained in a loop plane and the heat sink 3 is in turn contained in a sink plane 31. In this case, each loop plane forms between 40° and 140° with respect to the sink plane. The first wire loop 43 is the wire loop that forms the smallest angle with respect to the sink plane 31 and the last wire loop 44 is the wire loop that forms the greatest angle with respect to the sink plane 31.

[0035] In figure 3d, the lighting device 1 is similar to the device of figure 3c, except in that there are two regions of wire loops:

a first region, every wire loop of this first region forming between 40° and 70° with respect to the sink plane 31, and

a second region, every wire loop of this second group forms between 110° and 140° with respect to the sink plane 31.

[0036] The first region includes the first wire loop 43 and a first border wire loop 45, which is the wire loop of this first region which is closer to the second region.

[0037] The second region includes the last wire loop 44 and a second border wire loop 46, which is the wire loop of this second region which is closer to the first region.

[0038] Each wire loop 41 comprises an attachment point 42 and a top point, which is the point of the wire loop 41 which is farthest from the attachment point 42. Particularly, the first border wire loop 45 comprises a first top point 48, and the second border wire loop 46 comprises a second top point 49.

[0039] Between the first top point 48 and the second top point 49 there is a first distance d1 which is greater than a half of a second distance d2 between the first top point 48 and the attachment point of the first border wire loop 45.

[0040] As a consequence, there is a zone of the heat dissipation element 4 with no wire loops. Placing this zone in the vertical projection of the lighting source 2 has proven to be advantageous. As may be seen in this figure, the wire loops 41 are arranged in a symmetrical way with respect to a symmetrical plane 47 which is perpendicular to a sink plane 31 where the heat sink 3 is contained. This feature is common to many embodiments, although in this case there is also a space between the wire loops of the first region and the wire loops of the second region.

[0041] The attachment between the attachment points and the heat sink is carried out by a process which ensures the thermal contact between the heat dissipation element and the heat sink, e.g., by welding, brazing or curing.

[0042] In some of the embodiments shown in these figures, the lighting devices comprise a circuit board 5. The circuit board 5 extends on the heat sink 3, and the light source 2 is electrically connected to the circuit board 5, because it is part of a circuit. The light source 2 comprises one LED, but may also comprise two or three LEDs. In other embodiments, the circuit board extends on two opposite faces of the heat sink 3, in such a way that the heat sink 3 delimits an upper volume and a lower volume of the lighting device, each volume comprising at least one light source.

[0043] Regardless the wire loops arrangement, an inner volume may be defined by the wire loops. This inner volume is limited by parallel straight lines which join adjacent wire loops. In some embodiments, the light source is arranged inside this inner volume.

[0044] In some embodiments, the lighting device further comprises fan device, suitable for forcing air to circulate through the inner volume.

[0045] Regarding the cross section of the solid wire, some embodiments comprise a solid wire with a circular cross section, some embodiments incorporate a solid wire with an elliptic cross section and some embodiments incorporate a solid wire with a rectangular cross section. In some embodiments, some of the wire loops are made of solid wire with circular cross section, other wire loops are made of solid wire with elliptic cross section and other wire loops are made of solid wire with rectangular cross section. Even in some embodiments, there are wire loops with a solid wire that comprises a portion with a cross section which is circular and a portion with a cross section which is elliptic or rectangular. Figures 2a, 2b and 2c

show these three examples of cross sections of the solid wire that form the wire loops.

[0046] In the embodiments shown in these figures, the wire of the wire loops 41 has a cross section with an area comprised between 0.8 and 7 mm^2, which is suitable for their correct operation.

[0047] In the embodiments shown in the aforementioned figures, the loops were made of metal, such as copper or aluminium. In other embodiments, other materials may be used, such as composite materials, e.g., graphite fibres embedded in a plastics matrix.

[0048] The invention is obviously not limited to the specific embodiments described herein, but also encompasses any variations that may be considered by any person skilled in the art (for example, as regards the choice of materials, dimensions, components, configuration, etc.), within the general scope of the invention as defined in the claims.

Claims

1. Lighting device (1) comprising:

a light source (2),
a heat sink (3), the heat sink (3) being in thermal contact with the light source (2), and
a heat dissipation element (4),
the heat dissipation element (4) comprising a plurality of wire loops (41) made of a solid wire, at least one of the wire loops (41) comprising at least one attachment point (42), the at least one attachment point (42) being attached to the heat sink (3).

2. A lighting device (1) according claim 1, wherein the wire of at least one wire loop (41) comprises a metal, such as copper or aluminium.

3. A lighting device (1) according to claims 1 or 2, wherein the wire of at least one wire loop (41) comprises a composite material, such as graphite fibres embedded in a plastics matrix.

4. A lighting device (1) according to any of claims 1-3, wherein the wire of at least one of the wire loops (41) comprises a cross section which is circular, elliptic or with rectangular shape.

5. A lighting device (1) according to any of claims 1-5, wherein the wire of the wire loops (41) has a cross section with an area comprised between 0.8 and 7 mm^2.

6. A lighting device (1) according to any of preceding claims, wherein the light source (2) comprises at least one LED.

7. A lighting device (1) according to any of preceding claims, the heat dissipation element (4) comprising a first wire loop (43) and a last wire loop (44) in such a way that all the wire loops (41) are located following a tube arrangement between the first wire loop (43) and the last wire loop (44).

8. A lighting device (1) according to any of preceding claims, wherein every wire loop (41) is contained in a loop plane, the heat sink (3) is contained in a sink plane (31) and each loop plane forms between 40° and 140° with respect to the sink plane (31).

9. A lighting device (1) according to any of claims 1 to 7, wherein the wire loops (41) are part of the same continuous wire.

10. A lighting device (1) according to any of the preceding claims, wherein the wire loops (41) define an inner volume and the light source (2) is located inside the inner volume.

11. A lighting device (1) according to any of preceding claims, wherein the wire loops (41) define an inner volume and the lighting device further comprises fan means, suitable for forcing air to circulate through the inner volume.

12. A lighting device (1) according to any of preceding claims, wherein

the heat dissipation element (4) comprises a first region of wire loops and a second region of wire loops;
the first region comprises a first border wire loop (45), which is the wire loop of the first region that is closer to the second region, the first border wire loop (45) comprising a first attachment point and a first top point (48), which is the point of the first border wire loop (45) farthest from the first attachment point;
the second region comprises a second border wire loop (46), which is the wire loop of the second region that is closer to the first region, the second border wire loop (46) comprising a second attachment point and a second top point (49), which is the point of the second border wire loop (46) farthest from the second attachment point; and
between the first top point (48) and second the top point (49) there is a first distance (d1) which is greater than a half of a second distance (d2) between the first top point (48) and the first attachment point.

13. A lighting device (1) according to any of preceding claims, wherein each wire loop (41) has a circular shape or a substantially polygonal shape with round-

ed vertices.

14. A lighting device (1) according to any of preceding claims, wherein the wire loops (41) are arranged in a symmetrical way with respect to a symmetrical plane (47) which is perpendicular to a heat sink plane (31) where the heat sink (3) is contained in such a way that an equal number of wire loops is provided on each side of the symmetrical plane.

15. A lighting device (1) according to any of preceding claims, further comprising a circuit board (5) extending on to the heat sink (3), wherein the light source (2) is electrically connected to the circuit board (5) as part of a circuit.

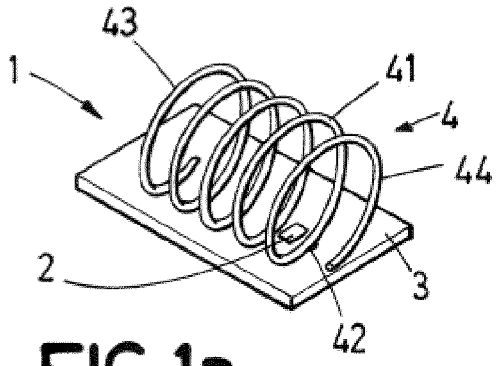

FIG.1a

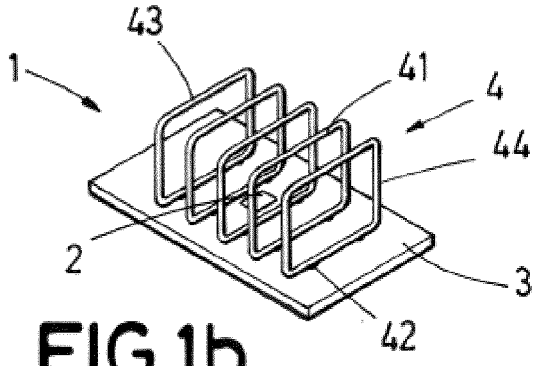

FIG.1b

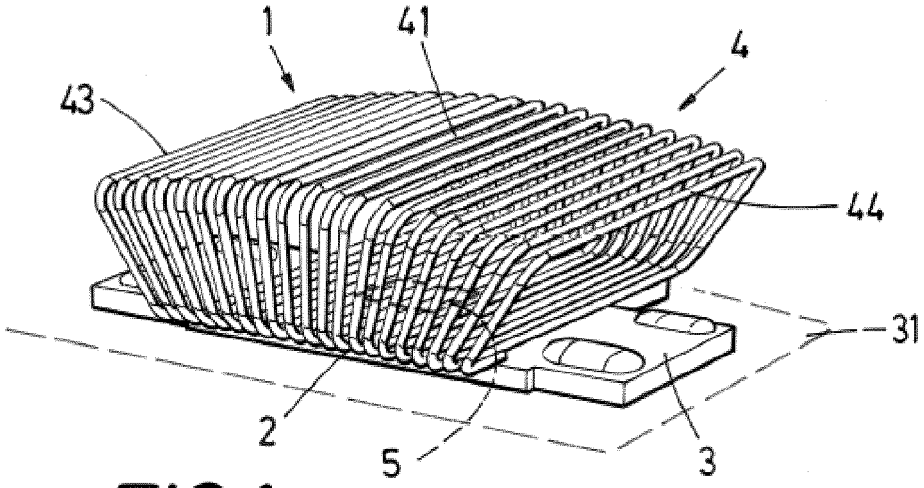

FIG.1c

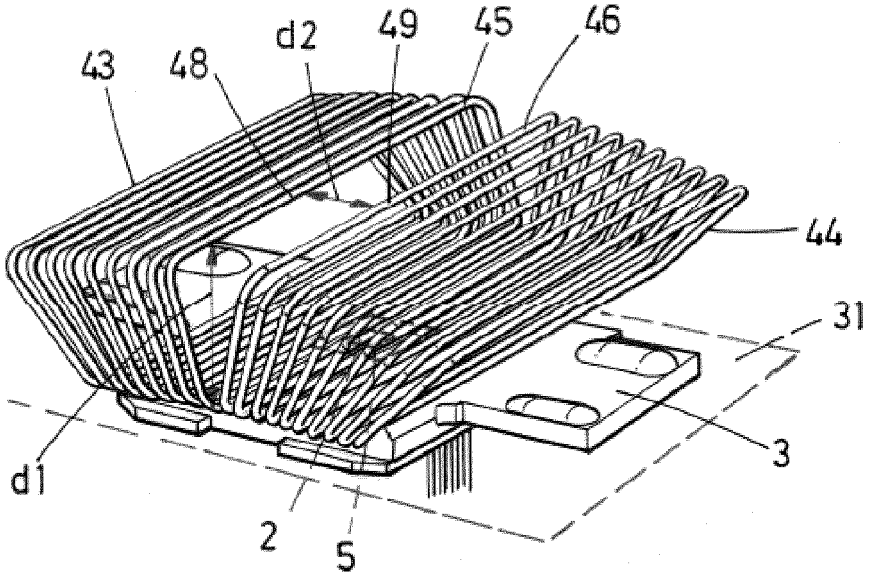

FIG.1d

FIG.2a

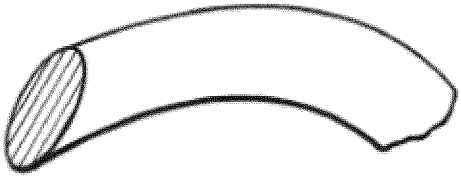

FIG.2b

FIG.2c

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 16 38 2418

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2009/005285 A2 (FAWOO TECHNOLOGY CO LTD [KR]; YOO YOUNG HO [KR]) 8 January 2009 (2009-01-08) * paragraphs [0077], [0078]; figures 1-8,10,12-18 *	1,2, 4-10, 12-14	INV. F21V29/503 F21V29/67 F21V29/80
X	JP H06 275746 A (HITACHI LTD) 30 September 1994 (1994-09-30) * paragraphs [0008], [0009], [0015]; figures 1,2,5-8,11 *	1-3,5,7, 9-11,14, 15	
X	EP 1 737 035 A1 (JISOUKEN CO LTD [JP]) 27 December 2006 (2006-12-27)	1,2,5,7, 9,12,14, 15	
A	* figures 1-8 *	10	
X	US 2013/188317 A1 (HO HSIN-YIN [TW]) 25 July 2013 (2013-07-25) * figures 1-8,10-14 *	1,2,4-6, 9,13,15	
X	JP H11 54676 A (EBARA DENSEN KK) 26 February 1999 (1999-02-26) * figures *	1-15	TECHNICAL FIELDS SEARCHED (IPC) F21V
X	JP 2007 165846 A (USUI KOKUSAI SANGYO KK) 28 June 2007 (2007-06-28) * figures 1,2,12,20,21 *	1-15	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	7 November 2016	Kebemou, Augustin

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 38 2418

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

07-11-2016

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2009005285 A2	08-01-2009	AU 2008271463 A1	08-01-2009
		BR PI0811798 A2	11-11-2014
		CA 2691738 A1	08-01-2009
		CN 101690441 A	31-03-2010
		EP 2168412 A2	31-03-2010
		JP 2010531536 A	24-09-2010
		KR 20090004673 A	12-01-2009
		US 2011012494 A1	20-01-2011
		WO 2009005285 A2	08-01-2009
JP H06275746 A	30-09-1994	NONE	
EP 1737035 A1	27-12-2006	CN 1938847 A	28-03-2007
		EP 1737035 A1	27-12-2006
		JP 4601610 B2	22-12-2010
		KR 20070007312 A	15-01-2007
		US 2007223195 A1	27-09-2007
		WO 2005096376 A1	13-10-2005
US 2013188317 A1	25-07-2013	NONE	
JP H1154676 A	26-02-1999	NONE	
JP 2007165846 A	28-06-2007	JP 4969973 B2	04-07-2012
		JP 2007165846 A	28-06-2007

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82