(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 June 2020 (25.06.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/127134 A1

(51) International Patent Classification:
F21S 45/43 (2018.01)

(21) International Application Number:
PCT/EP2019/085471

(22) International Filing Date:
17 December 2019 (17.12.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
18214707.4 20 December 2018 (20.12.2018) EP

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

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, 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, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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

(54) **Title:** HEAT EXCHANGER FOR ELECTRONIC COMPONENTS

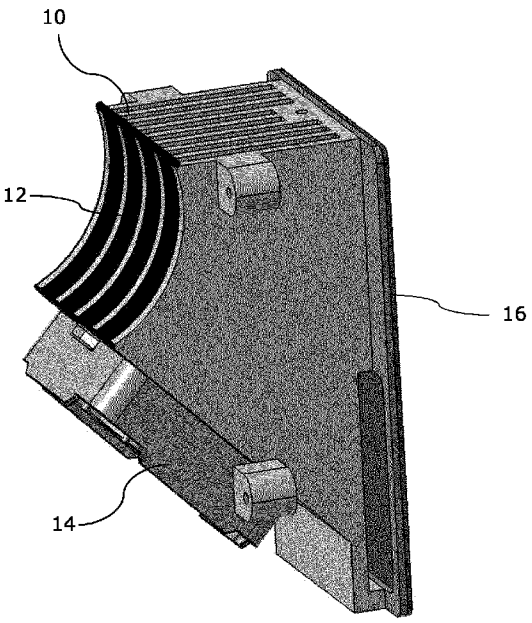


FIG. 1

(57) **Abstract:** The present invention relates to a heat exchange system for a lighting device of a automobile. The heat exchange system comprises heat transfer airfoils (10), a plenum (12) and a blower module (14). The plenum (12) and the inner surface of the heat exchange system together form an air channel (20). The air channel (20) passes through the heat transfer airfoils (10) and has a variable cross sectional area from the inlet portion to the outlet portion. A blower module (14) is arranged the inlet portion of the air channel (20) and is aligned to provide high velocity air on the heat zone of the system.

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HEAT EXCHANGER FOR ELECTRONIC COMPONENTS

TECHNICAL FIELD

The present invention relates to a heat exchange system for a lighting device, and more particularly to a heat exchange system for a LED lighting device for an automobile, with an embedded air channel for heat removal.

STATE OF THE ART

Lighting devices are used in automobiles and the like, for lighting the path ahead. These lighting devices of modern times use different types of LED light sources owing to their high efficiency better lighting.

Even though the LED light devices are highly efficient, they generate tremendous amount of heat during operation. As LED based lighting devices have negative temperature coefficient aspects, the performance of LEDs is particularly sensitive to heat and excessive temperatures, in addition to reducing the light output of an LED it also shortens the operating life significantly. Thus, there is the need to dissipate significant quantities of heat generated by the LED based lighting devices, which have LED of higher power densities. And, it is critical that heat generated by the LED be transferred away from the LED constantly.

The lighting device using LED light sources employ various methods and solutions to mitigate the problem. Known solutions, such as heat sinks with large fins or active cooling mechanisms and cooling blowers are used. These solutions are bulky and add to overall weight, space and cost of the LED lighting devices. To effectively regulate the heat in the entire lighting system, these known solutions are made larger and proportioned to the LED power density of lighting device adding to overall weight. Thus, the efficiency of the heat sink is not optimal per gram weight of the heat sink and requires larger overall volume.

There have attempts made to ensure better heat transfer in the heat sinks by providing air ducts to direct the air from the blower towards the heat sink. These systems employ addition for air duct of different shapes and in various orientations. In some cases the heat sink are placed inside of such air ducts. As

these prior known arts uses addition of an air duct, they add up to the overall weight and space of the lighting device.

The prior arts and the conventional methods have various disadvantages as described earlier. Hence, there is a need for an heat exchange system which can overcome the above limitations and provide an effective heat transfer mechanism for the lighting device and weighing less than the available solution.

SUMMARY OF THE INVENTION

An object of the present invention is to solve the disadvantages described above of known lighting devices. In particular, it is the object of the present invention is to provide a lighting device with a heat exchange system for a lighting device.

Another object of the invention is to provide a lighting device with a heat exchange system comprising an integrated air channel.

Another object of the invention is to provide a lighting device with a heat exchange system comprising an integrated air channel passing through the airfoils of the heat exchange system.

Another object of the invention is to provide a lighting device with a heat exchange system capable of having both forced convection heat exchange and natural convention heat exchange.

According to an embodiment of the present invention, there is provided a lighting device, comprising a heat exchange system to transfer heat away from the light source of the lighting device. The lighting device comprises a heat exchanger with an integral air channel passing through the fins. Additionally, the lighting device comprises a blower for blowing air through the air channel of the heat exchange system.

In an embodiment, the heat transfer system has a plenum fixed to it forming the outside portion of the air channel.

In another embodiment, the heat exchange system of the present invention is provided with a set of external fins extending outside of the air channel formed by the plenum.

The invention relates to a lighting device for an automobile comprising a light source for producing a light beam; and a heat exchange system for transferring heat away from the light source, the heat exchange system comprising a plurality of heat transfer airfoils an air channel passing through the plurality of heat transfer airfoils having at least one air inlet portion and at least one air outlet portion, the air channel comprises a plenum forming the outer portion of the air channel and a blower module arranged on the at least one air inlet portion of the air channel, wherein the axis of the blower module is inclined towards the heat zone of the heat exchange system.

The invention is also defined by the further features, taken separately or in combination:

- the heat exchange system is assembled on the rear side of the light source using base plate ;

- heat transfer airfoils extend outwards and away from the base plate.

- the air channel characterizes variable cross sectional area at the at least one air inlet portion and at the at least one air outlet portion.

- the variable cross sectional area of the air channel ranges from a ratio of 1:0.7 to 1:0.3 across the at least one air inlet portion and the at least one air outlet portion.

- the air channel has a curvilinear profile from the at least one air inlet portion towards the at least one air outlet portion.

- the outer curve of the air channel is tangential with the heat zone of the heat transfer system.

- the air channel and the blower module are arranged to ensure maximum air flow on the heat zone of the heat exchange system.

- the plenum is made of a synthetic polymer or the like.

- the plenum is attached to the plurality of heat transfer airfoils by bonding means., such as adhesive bonding, friction spot joining, or welding

- the light source is a monolithic LED.

BRIEF DESCRIPTION OF THE INVENTION

To complete the description and to provide 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 construed as restricting the scope of the invention, but only as an example of how the invention can be carried out. The drawings comprise the following characteristics.

Figure 1 shows a perspective view of a heat exchange system in accordance with the present invention for a lighting device.

Figure 1a shows an exploded view of the heat exchange system and the plenum shown in Figure 1 for a lighting device, according to an embodiment of the present invention.

Figure 2 shows another perspective view of a heat exchange system in accordance with the present invention for a lighting device showing the heat exchange airfoils and plenum arrangement.

Figure 3 shows a side view of the heat exchange system for a lighting device indicating an air channel and air flow direction, according to an embodiment of the present invention.

Figure 4 shows a perspective view of another embodiment of heat exchange system for a lighting device, according to an embodiment of the present invention.

Figure 5 shows a top view of the heat exchange system shown in Figure 4, according to an embodiment of the present invention.

Figure 6 shows a side view of the heat exchange system shown in Figure 4 for a lighting device indicating an air channel and air flow direction, according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, embodiments of the present invention will be described with reference to the accompanying drawings.

Figure 1 shows a perspective view of a heat exchange system of a lighting device, according to an embodiment of the present invention.

Figure 1a shows an exploded view of a heat exchange system (100) showing the air channel (20) and a plenum (12).

Figure 2 shows the heat exchange system (100) according to an embodiment of the present invention comprising a heat transfer airfoils (10), plenum (12) attached to the heat transfer airfoils (10) and a blower module (14). The plenum (12) according to the embodiment is attached to the heat transfer airfoils (10) of the heat exchange system by means of suitable bonding means such as adhesive bonding, heat friction spot joining, welding or any other suitable means. The plenum (12) is made of a synthetic polymer or the like. The plenum (12) arrangement on the heat transfer airfoils (10) creates an air channel (20) (shown in Figure 3). The air channel (20) passes through the heat transfer airfoils (10) of the heat exchange system; the air channel (20) further has a curvilinear profile. In a preferred embodiment, the outer curve of the air channel (20) is tangential with the hot heat zone (30) of the heat transfer system (100). The air channel (20) has a variable cross sectional area with reducing ration of 0.3 to 0.7 at the outlet portion of the air channel (20) as compared to the inlet portion of the air channel (20). The blower module (14) is assembled at the inlet portion of the air channel (20).

Figure 3 shows the side view of the heat exchange system (100) according to the embodiment of the present invention. The figure shows the blower module (14) assembled in relation to the air channel (20). The blower module (14) is assembled such that maximum air is directed to the high heat regions (30) of the heat exchange system (100). According to the invention, the axis (A) of the blower module (14) is inclined towards the heat zone (30) of the heat exchange system (100). The high heat region (30) is formed on the base plate (16) directly behind

the light source (32). The light source (32) and the high heat region (30) here are depicted for clarity and reference purpose and should not be taken as restricting the scope of the invention. In a preferred embodiment, the light source (32) is a monolithic LED. The blower module (14) blows the air through the air channel (20) and due to the profile of the air channel (20) and the arrangement of the blower module (14) maximum air is directed on the heat zone at high velocity. The high velocity air passing over the heat zone takes away the heat away from the heat region and out of the heat exchange system through the outlet. Additionally, the heat transfer airfoils (10) which extend outwards from the base plate (16) also carry heat away from the high heat region through conduction. The air channel (20) by design as per the present invention passing through the heat transfer airfoils (10) directs air over the heat transfer airfoils. Due to the passing of the high velocity air over the heat transfer airfoils (10) heat is transferred by means of forced convection. The curvilinear profile and section reduction of the air channel (20) ensures high velocity air across the air channel with minimum turbulence created in the system.

Figure 4 shows another embodiment of heat exchange system for a lighting device, of the present invention. The figure shows the plenum (12) attached to the heat transfer airfoils (10). Additionally, the figure shows secondary heat transfer airfoils (18) extending out of the plenum (12). The secondary heat transfer airfoils (18) aid in further heat transfer by means of natural convection. The arrangement increases the heat transfer rate giving more efficiency to the system.

Figure 5 shows the top view of the heat exchange system (100) of figure 4, according to the embodiment of the present invention. The figure depicts the air channel (20) passing through the heat transfer airfoils (10). The secondary heat transfer airfoils (18) are also shown in the figure.

Figure 6 shows the air flow direction for heat transfer as per the present invention. The embodiment as shown in figure 6 works similar to the way the embodiment of Figure 3 works. Additionally, the current embodiment has secondary heat transfer airfoils (18) extending outwards of the plenum (12). These secondary heat transfer airfoils (18) increase the rate of heat transfer.

The present invention can be adapted and modified to perform heat transfer in electronic system. In one embodiment the blower module (14) can be mounted on the outlet of the air channel (20). The blower accordingly can be modified to perform suction of air for heat transfer of the system. The system though effective will have lesser efficiency than the one with blower at inlet of air channel. In yet another embodiment of the present invention, the profile or the air channel can be adapted to form different profiles without deviating from the scope of present invention.

Claims

1. A lighting device for an automobile comprising:

   a light source (32) for producing a light beam; and

   a heat exchange system (100) for transferring heat away from the light source, the heat exchange system (100) comprising:

   a plurality of heat transfer airfoils (10);

   an air channel (20) passing through the plurality of heat transfer airfoils (10) having at least one air inlet portion and at least one air outlet portion, the air channel (20) comprises a plenum (12) forming the outer portion of the air channel (20); and

   a blower module (14) arranged on the at least one air inlet portion of the air channel, wherein the axis (A) of the blower module (14) is inclined towards the heat zone (30) of the heat exchange system (100).

2. A lighting device as claimed in claim 1, wherein the heat exchange system (100) is assembled on the rear side of the light source (32) using base plate (16).

3. A lighting device as claimed in claim 1, wherein heat transfer airfoils (10) extend outwards and away from the base plate (16).

4. A lighting device as claimed in claim 1, wherein the air channel (20) characterizes variable cross sectional area at the at least one air inlet portion and at the at least one air outlet portion.

5. A lighting system as claimed in claim 4, wherein the variable cross sectional area of the air channel (20) ranges from a ratio of 1:0.7 to 1:0.3 across the at least one air inlet portion and the at least one air outlet portion.

6. A lighting device as claimed in claim 4, wherein the air channel (20) has a curvilinear profile from the at least one air inlet portion towards the at least one air outlet portion.

7. A lighting device as claimed in claim 6, wherein the outer curve of the air channel (20) is tangential with the heat zone (30) of the heat transfer system (100).

8. A lighting device as claimed in any of the preceding claims, wherein the air channel (20) and the blower module (14) are arranged to ensure maximum air flow on the heat zone (30) of the heat exchange system (100).

9. A lighting device as claimed in claim 1, wherein the plenum (12) is made of a synthetic polymer or the like.

10. A lighting device as claimed in claim 1, wherein the plenum (12) is attached to the plurality of heat transfer airfoils (10) by bonding means.

11. A lighting device as claimed in claim 10, wherein the bonding means for attaching the plenum (12) on to the plurality of heat transfer airfoils (10) is adhesive bonding, friction spot joining, or welding.

12. A lighting device as claimed in claim 1, wherein the light source (32) is a monolithic LED.

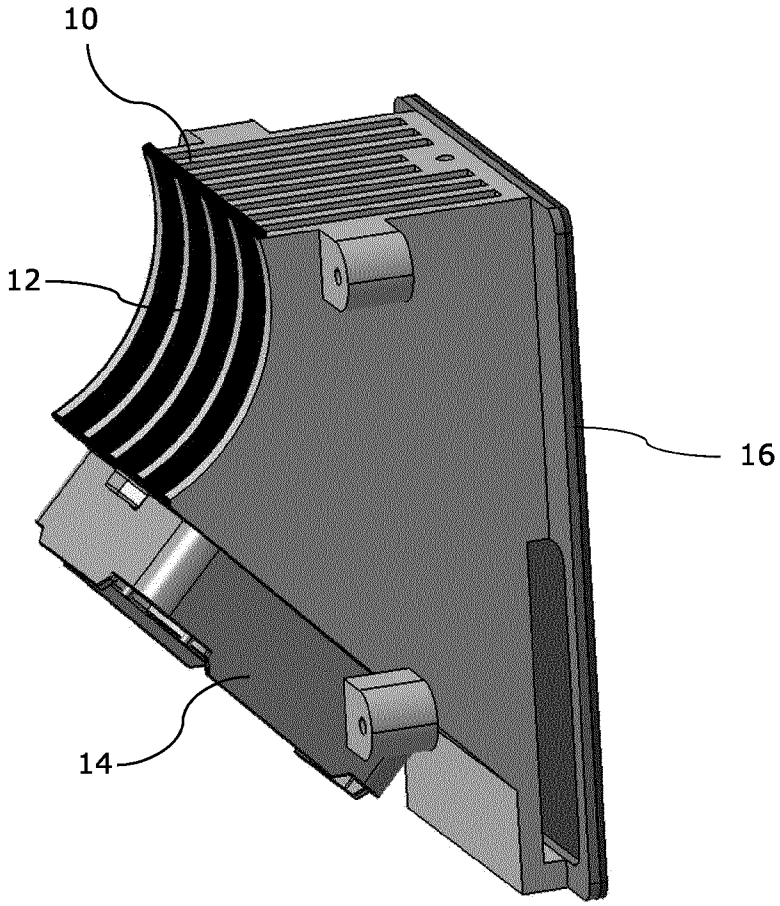


FIG. 1

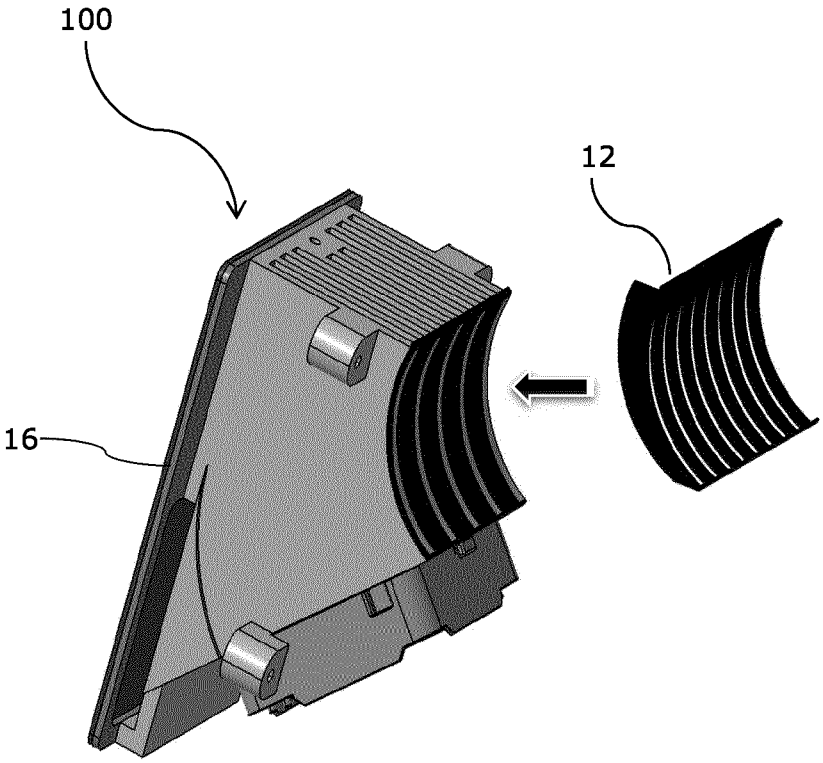


FIG. 1a

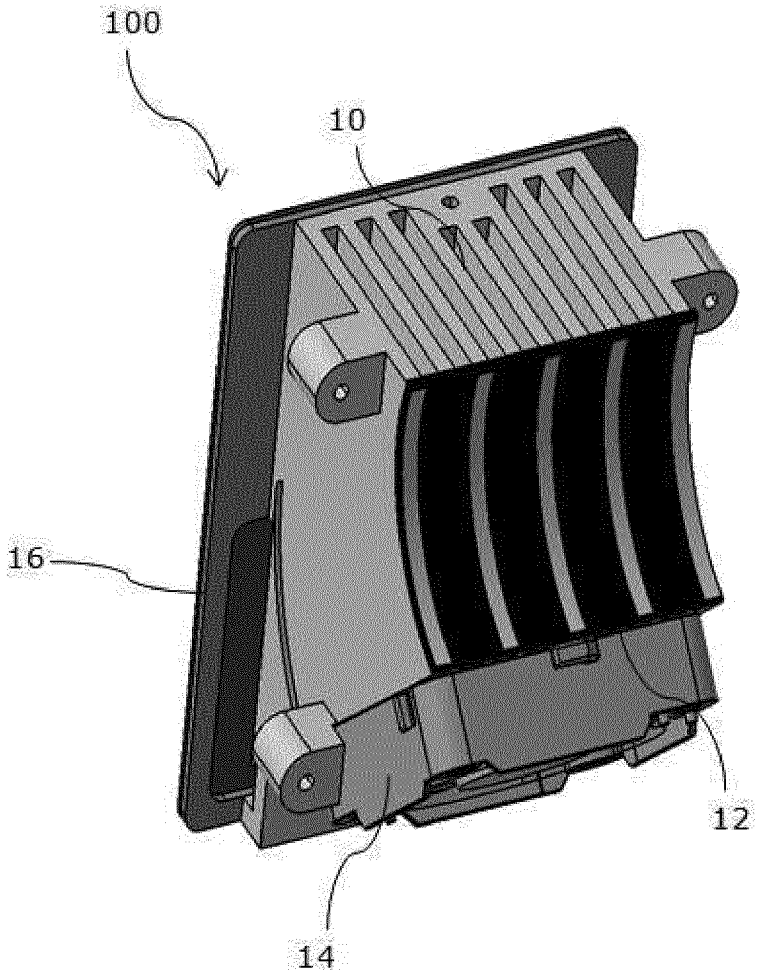


FIG. 2

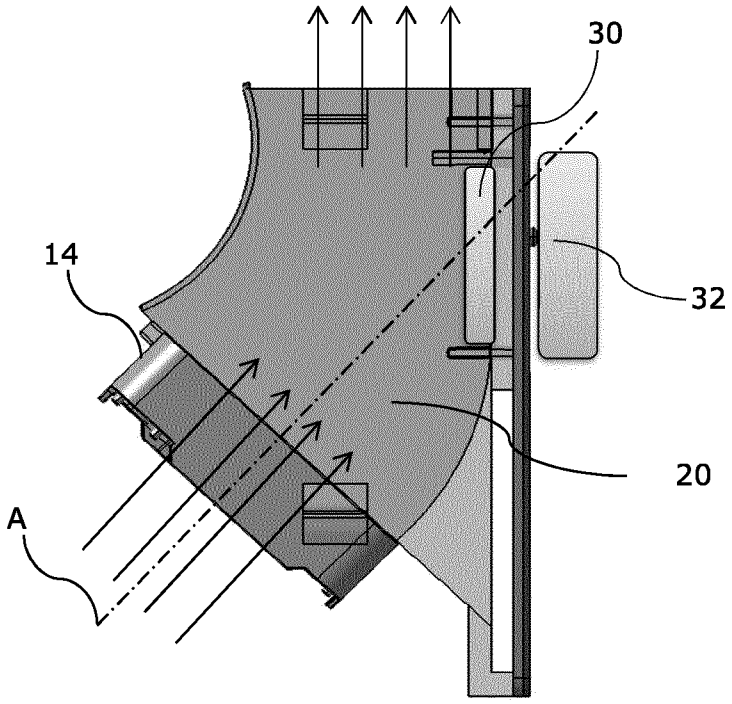


FIG. 3

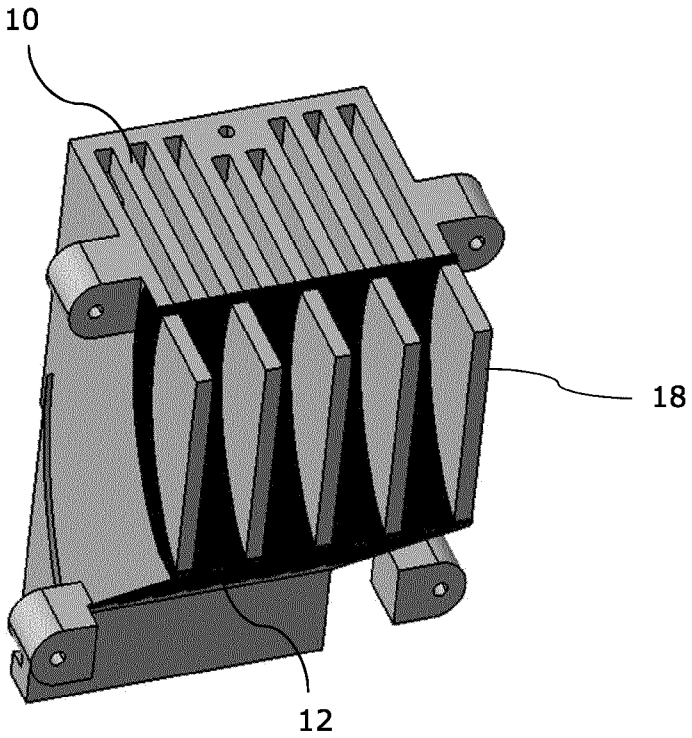


FIG. 4

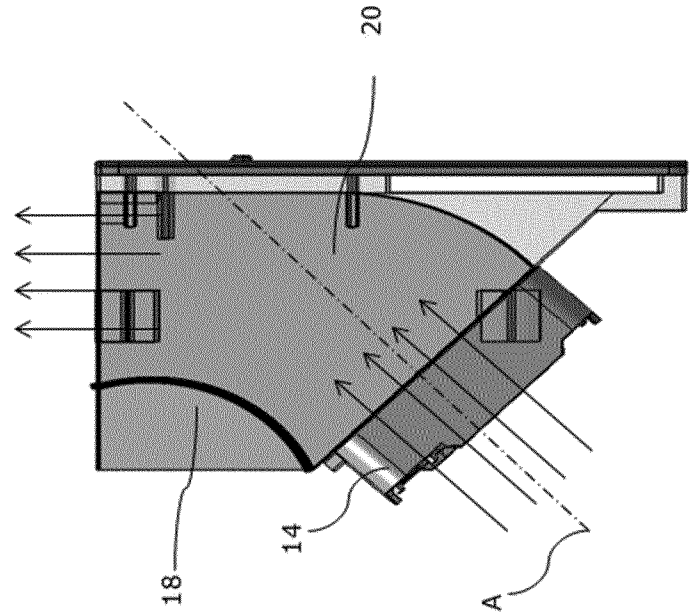


FIG.6

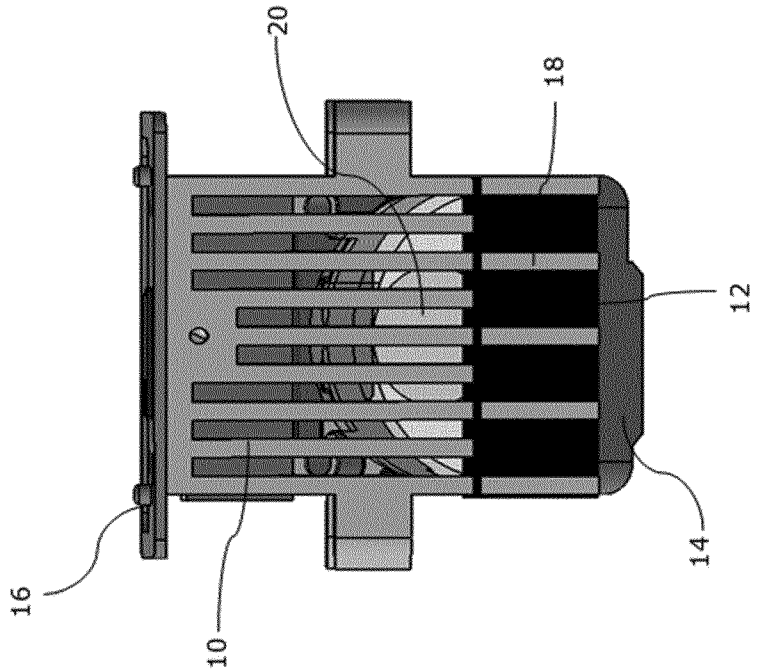


FIG.5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/085471

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21S45/43
ADD.

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)
F21S

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2007 043961 A1 (AUTOMOTIVE LIGHTING REUTLINGEN [DE]) 19 March 2009 (2009-03-19) paragraph [0052] - paragraph [0074] figure 3a	1-11
X	EP 3 147 556 A1 (STANLEY ELECTRIC CO LTD [JP]) 29 March 2017 (2017-03-29) paragraph [0026] - paragraph [0075] page 4	1-12
X	EP 3 043 107 A1 (VALEO VISION [FR]) 13 July 2016 (2016-07-13) paragraph [0024] - paragraph [0030] figure 2	1-3,8,9, 12

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* 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

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"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

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"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

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Date of the actual completion of the international search	Date of mailing of the international search report
30 March 2020	08/04/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Schulz, Andreas

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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2010 002664 A1 (OSRAM GMBH [DE]) 8 September 2011 (2011-09-08) paragraph [0027] - paragraph [0041] figure 3 -----	1-3,8,9, 12

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2019/085471

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