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(54) **LIGHTING DEVICE FOR VEHICLES PROVIDED WITH LED LIGHTING MODULES**

(57) Rotating lighting module (5) designed to equip a lighting device (1) for vehicles, including at least one first LED light source (6), at least one first reflector (7) and at least one first actuator (8) to rotate the first reflector relative to the first LED light; wherein a framed support (4) holds rigid in a fixed position the at least one first LED light source (6) and bears in idling manner said first reflector (7); the at least one first LED light source (6) being operatively associated with the framed support in such a manner to transfer thereto by heat conduction at least a major part of a thermal flow (F) generated in operation by the first LED light source; and the framed support (4) being made entirely of a heat conductive metal or metal alloy and being designed to behave as a thermal dissipator.

FIG. 1

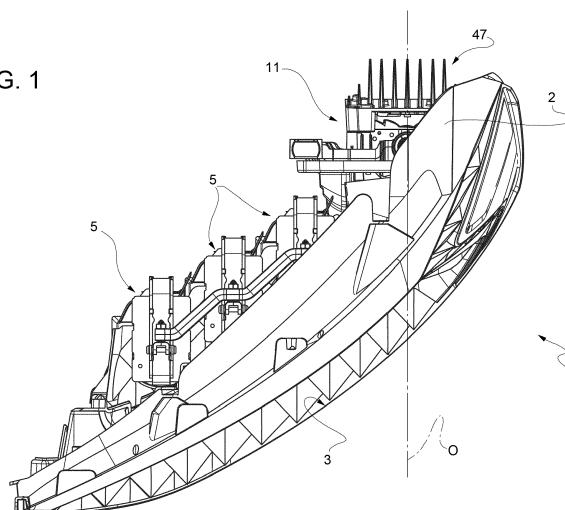
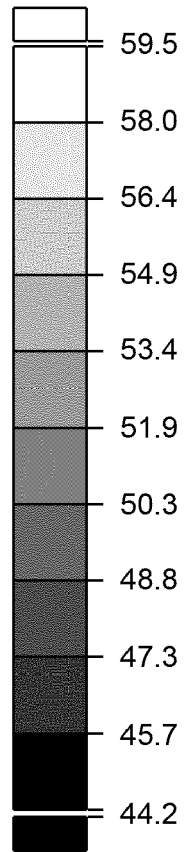


FIG. 4



Temperature (Solid) [°C]

## Description

### Technical field of the invention

[0001] The present invention relates to a lighting device equipped with one or more lighting modules using LEDs as a light source and having rotation capabilities in order to provide selectively more than one optical functions, like signaling functions as position light, direction light, welcome light, DRL (Daytime Running Light), and/or lighting functions like a forward low beam (cross beam) or fog beam eventually provided with advanced adaptive functions like AFS (Adaptive Function System) and DBL (Dynamic Bending Light).

### Technical Background

[0002] Lighting devices for vehicles provided with rotating LED lighting modules are known in the art.

[0003] For example, EP2902701 discloses a device wherein a lighting module comprises a light source and at least one reflector and wherein the reflector is motorized and the light source is a LED; the reflector consists of a rotating support having two opposite faces, one constituting the reflector and the other realizing a second function, e.g. an aspect function; a fixed motor rotates the support with respect to the fixed LED light source in order to bring selectively the two faces on the front side of the device facing toward the direction of motion of the vehicle; the support also bears at its opposite faces two light guides operatively associated with a second LED.

[0004] In devices like that one of EP2902701 it is however difficult to dissipate the heat produced by the LED light source by means of the usual finned dissipating elements which are thermally coupled with the printed circuit board bearing the LEDs. Such a dissipating element, which is usually a fair large one, may in fact interfere with the moving parts of the lighting module and in any case increases considerably the bulk of the lighting module to such an extent to be impractical. The alternative solution actually adopted is to use a smaller dissipating element, which however is not able to maintain the temperature of the LEDs to a sufficiently low value to avoid the efficiency of the LEDs to decrease dramatically.

### Summary of the invention

[0005] The object of the present invention is to provide a lighting device for vehicles having one or more lighting modules using LEDs as the light source that is compact, simple and cost-effective in construction and highly reliable, while ensuring at the same time an optimal dissipation of the heat generated by the LEDs.

[0006] According to the invention, therefore, a lighting module and a lighting device for vehicles including one or more such lighting modules are provided having the features set out in the appended claims.

### Brief description of the drawings

[0007] Further features and advantages of the present invention will become more apparent from the following description of one non-limiting embodiment thereof, made with reference to the figures in the accompanying drawings, in which:

- figure 1 shows schematically a plan view from the top of a lighting device according to the invention;
- figure 2 shows in an enlarged scale, a side elevation view of a rotating lighting module according to the invention of the lighting device of figure 1;
- figure 3 shows schematically and in perspective view from the bottom a constructive element of the rotating lighting module of figure 2; and
- figure 4 shows a temperature diagram showing the temperature distribution in the lighting module of figure 2.

### Detailed description

[0008] With reference to figure 1, reference numeral 1 indicates as a whole a lighting device consisting, in the non-limiting embodiment shown, in a vehicle headlight, which is only in part and only schematically shown. It is however to be intended that what will be described can be applied to any vehicle lighting device.

[0009] The lighting device 1 comprises a generally cup-shaped housing 2 designed to be mounted on a vehicle, known and shown only in part for sake of simplicity. Housing 2 is made of synthetic plastic material by injection molding and has a front inlet opening 3 in use facing opposite to the vehicle and along a driving direction of the vehicle, closed by a transparent cover, known and not shown for sake of simplicity.

[0010] According to the present invention, housing 2 carries at the interior thereof at least one rotating lighting module 5 shown in details in figure 2. Of course, housing 2 may carry within it more than one lighting module 5 (e.g. two or three, arranged side by side) that may be visible from the outside through the inlet opening 3 and, preferably, at least one stationary lighting module 11.

[0011] One lighting module 5 is shown in more details in figure 2 and is arranged facing the front transparent screen/cover closing the inlet opening 3 of the cup-shaped housing 2.

[0012] The lighting module 5 is of the rotating type and is designed to specifically equip a lighting device for vehicles like lighting device 1.

[0013] The rotating lighting module 5 comprises at least one first light source 6, at least one first reflector 7 and at least one first actuator 8 (Figure 2) to rotate the first reflector 7 relative to the first light source 6 around a first axis A.

[0014] The rotating lighting module 5 further comprises a framed support 4 holding rigid in a fixed position the

first light source 6 and bearing in idling manner the first reflector 7; the framed support 4 also bears the first actuator 8, which may consists in a rotating electric motor.

**[0015]** The rotating lighting module 5 further comprises a lens 9 placed in front of the first reflector 7 and assembled angularly rigid therewith to rotate rigid with the first reflector 7 and eccentrically to axis A, so that both lens 9 and first reflector 7 forms together a rotating unit 10 powered by the first actuator 8.

**[0016]** The first light source 6 is a LED; moreover, the lighting module 5 further comprises a couple of second light sources 13 and a third light source 14, all constituted by different LEDs; the LEDs 6, 13, 14 constituting the first, second and third light sources are assembled all together on a printed circuit board 15 in specific positions and the printed circuit board 15 is carried in a fixed manner by the framed support 4 directly above the rotating unit 10 and on the side opposite to the first actuator 8.

**[0017]** The first light source 6 is arranged substantially aligned with the first axis A and faces the first reflector 7, this latter being designed to collect the light emitted by the first light source 6 and to deviate it as a shaped light beam 16 (shown schematically in dotted lines in figure 2) through the lens 9. The direction of propagation of the light beam 16 when the lighting module 5 is not rotated, is arranged parallel to an optical axis O of the lighting module 11 and of the whole lighting device 1 (figure 1), which optical axis O is directed parallel to the running forward direction of the vehicle on which the lighting device 1 is mounted

**[0018]** According to a preferred embodiment of the invention, the rotating unit 10 further comprises a backing holder 18 for the first reflector 7, which backing holder 18 is angularly rigid with the reflector 7 and with the lens 9 and is arranged on the rear of the first reflector 7, on the side opposite to the lens 9 in relation to the first reflector 7; the backing holder 18 is wider than the first reflector 7 so as to flank the first reflector 7 on both lateral sides of the lens 9.

**[0019]** Moreover, the rotating unit 10 further comprises a flange element 21 (figure 2) which mechanically connects on the side opposite to the first actuator 8 an upper end 22 of the lens with the backing holder 18; the flange element 21 is wider than the lens 9 so as to flank the first reflector 7 on both lateral sides thereof.

**[0020]** A bottom end 26 of the lens 9 facing opposite to the upper end 22 and the flange element 21 is also connected rigid with the reflector 7 and the backing holder 18 thereof, so as the flange element 21, lens 9, reflector 7 and backing holder 18 realize a rigid frame structure constituting the rotating unit 10, freely rotatable around axis A.

**[0021]** The flange element 21 is also provided with a through hole 23 facing the first LED light source 6. The lens 9 is preferably optically neutral so as the light beam 16 is shaped according to the required photometric characteristics solely by the reflector 9.

**[0022]** The light source 6 and reflector 7 may be de-

signed in order to generate a low (cross-) beam function having AFS (Adaptive Function System) and DBL (Dynamic Bending Light) capabilities, which capabilities may be obtained by merely rotating the rotating unit 10 around axis A.

**[0023]** The second light sources 13 may be associated with a light guide (not shown) integrated in the periphery of lens 9.

**[0024]** The printed circuit board 15 has in a plan view a rectangular shape and bears the third LED light source 14 at a rear end 29 thereof opposite to LED light source 6; LED light source 14 is an RGB LED and the framed support 4 bears at a middle section thereof a second reflector 30, which is fixed in relation to the rotating unit 10 and is rigid with the framed support 4 arranged in such a position to be operatively associated with the third light source 14; reflector 30 is laterally quite wider than lens 9, in order to laterally project beyond the lateral sides thereof.

**[0025]** Owing to the second reflector 30 the lighting module 5 is able to implement, other than a low beam function with AFS and/or DBL capabilities, also a welcome light function by means of the RGB light source 14 and the reflector 30.

**[0026]** According to the main aspect of the invention, the at least one first LED light source 6 is operatively associated with the framed support 4 in such a manner to transfer thereto by heat conduction at least a major part of a thermal flow F generated in operation by the LED light source 6. In particular, in the preferred embodiment shown, it is the whole printed circuit board 15 with all the LED light sources 6, 13, 14 supported thereby, that is operatively associated with the framed support 4 in such a manner to transfer thereto by heat conduction at least a major part of a thermal flow F generated in operation by all the LED light sources 5, 13, 14.

**[0027]** In combination with this first feature, the framed support 4 is made entirely of a heat conductive metal or metal alloy and is designed to behave as a thermal dissipator. Preferably, the framed support 4 is made entirely of a press-molded alloy of aluminum or of another light alloy, possibly including copper.

**[0028]** In order to increase the capacity of heat conduction and of heat dissipation (figure 3), at least a first section 31 of the framed support 4, which section 31 is closer to the at least one first LED light source 6, has a solid cross-section (i.e. without empty parts within its perimeter) provided with projecting lateral extensions 32. In the preferred embodiment shown, the framed support 4 is formed by the side by side junction, e.g. via removable transversal fixing elements like pins, screws, brackets, well known and not shown for sake of simplicity, of two specular symmetric structural elements 33, 34, each comprising a first end section 35 and a middle section 36 having C-shaped solid cross-sections and a second end section 37, opposite the first and shaped like an half shell.

**[0029]** The first end sections 35 of the two structural

elements 33,34, when joined, form the first section 31 of the framed support 4 which is the part of the framed support 4 closer to the first LED light source 6 and in fact bearing the printed circuit board 15.

**[0030]** In this manner, the first section 31 has a double T cross-section formed by the joined two C-shaped cross sections of the two sections 35 of the structural elements 33,34 arranged facing opposite to each other.

**[0031]** The middle sections 36 of the two structural elements 33,34, when joined, form a middle section 38 of the framed support 4; such a middle section 38 also has a double T cross-section formed by the joined two C-shaped cross sections of the two middle sections 36 of the structural elements 33,34 arranged facing opposite to each other.

**[0032]** The second end sections 37 of the two structural elements 33,34, when joined, form a second section 39 of the framed support 4 (cut away in figure 2 for sake of simplicity); the second section 39 is the part of the framed support 4 farthest away from the first LED light source 6 and has a box-like shape in order to idly receive the rotating first reflector 7.

**[0033]** According to an aspect of the invention, the printed circuit board 15 carrying the LEDs 6,13,14 is assembled onto the first section 31 of the framed support 4 against a bottom face thereof formed by two projecting extensions 32 and facing towards the second section 39; in particular the printed circuit board 15 is assembled onto the first section 31 in thermal contact therewith.

**[0034]** This may be accomplished merely by realizing a very close mechanical contact obtained by applying a pressure, e.g. by using screws (not shown) for assembling the printed circuit board 15 against the bottom projecting extensions 32 of the two structural elements 33,34 (e.g. screwed into holes 40 shown in figure 3); or a thermal adhesive 41 (figure 2) may be interposed between a face of the printed circuit board opposite to that bearing the LEDs 6,13,14 and the bottom projecting extensions 32 of the two structural elements 33,34. Eventually, both the solutions (screws and thermal adhesive 41) may be adopted.

**[0035]** In order to further improve heat transmission, a thermal adhesive 41 which is not electrically conductive may be used and conductive metallic tracks 42 for electrically feeding the LEDs 6,13,14 (e.g. via a flat insulated flexible conductor cable 43) may be provided on the face of the printed circuit board 15 opposite to that bearing the LEDs 6, 13, 14 (i.e. facing the section 31) and connected to the LEDs 6,13,14 through the thickness of the printed circuit board.

**[0036]** The second reflector 30 operatively associated with the third LED light source 14 is made preferably of a metal and in that case may be mounted in thermal contact with the middle section 38 of the framed support 4 in order to contribute to the thermal dissipation.

**[0037]** As shown in figure 3, the first section 31 of the framed support 4 is provided with a receiving seat 44 for the printed circuit board 15 obtained by making the first

section 31 thinner than the middle section 38 so as to provide a step 45 between the first and middle sections 31, 38.

**[0038]** The lighting device 1 comprises, as already stated, a stationary lighting module 11 and two or more (in the example shown three) rotating lighting modules 5 arranged side by side; each rotating lighting module 5 has its own framed support 4 mechanically connected to a transverse rail 46 (figure 1) preferably made of metal and arranged substantially parallel to a width of the inlet opening 3.

**[0039]** While the lighting module 11, which also uses LED light sources, is provided with a usual thermal (finned) dissipator arranged on the rear of the light module 11, the light modules 5 according to the invention do not need a traditional dissipator like dissipator 47 arranged in contact with the printed circuit board 15; in fact the structural element 4 also act as a thermal dissipator and with its double T cross-section in the first section 31 and in the middle section 38 dissipate by radiation the heat that it conduces along itself very easily being made of conductive metal; therefore the heat cannot accumulate and is dispersed in an efficient manner along a very broad exchange surface constituted by the whole outer surface of the framed support 4.

**[0040]** The efficiency of the framed support 4 as a thermal dissipator has been experimentally tested using a framed support 4 made of aluminum. The distribution of temperatures with all the LEDs 6,13,14 switched on is shown in figure 4: as it may be seen, the temperature close to the LEDs, i.e. in the section 31 (top part of the diagram of figure 4) is lower than 60°C, so ensuring a high efficiency to the LEDs and is around 40°C at the bottom of the framed support 4, i.e. at the section 39.

**[0041]** All the aims of the invention are therefore accomplished.

## Claims

1. A rotating lighting module (5) designed to equip a lighting device (1) for vehicles, comprising at least one first LED light source (6), at least one first reflector (7) and at least one first actuator (8) to rotate the first reflector relative to the first LED light source around a first axis (A); wherein a framed support (4) holds rigid in a fixed position said first LED light source (6) and bears in idling manner said first reflector (7); **characterized in that**

i)- the at least one first LED light source (6) is operatively associated with the framed support in such a manner to transfer thereto by heat conduction at least a major part of a thermal flow generated in operation by the first LED light source; and **in that**, in combination,

ii)- the framed support (4) is made entirely of a heat conductive metal or metal alloy and is de-

signed to behave as a thermal dissipator.

2. A rotating lighting module (5) as claimed in claim 1, **characterized in that**

iii)- at least a first section (31) of the framed support closer to the at least one first LED light source (6) has a solid cross-section provided with projecting lateral extensions (32).

3. A rotating lighting module (5) as claimed in claim 1 or 2, **characterized in that** the framed support (4) is made entirely of a press-molded alloy of aluminum or of another light alloy, possibly including copper.

4. A rotating lighting module (5) as claimed in anyone of the preceding claims, **characterized in that** the framed support (4) is formed by the side by side junction, via removable transversal fixing elements, of two specular symmetric structural elements (33,34), each comprising a first end section (35) and a middle section (36) having C-shaped solid cross-sections and a second end section (37), opposite the first and shaped like an half shell; the first end sections (35) of the two structural elements, when joined, forming a first section (31) of the framed support, closer to the first LED light source and having a double T cross-section formed by the joined two C-shaped cross sections of the two structural elements (33,34) arranged facing opposite to each other, while the middle sections of two structural elements, when joined, forming a middle section (38) of the framed support, also having a double T cross-section formed by the joined two C-shaped cross sections of the two structural elements arranged facing opposite to each other; the second end sections of the two structural elements, when joined, forming a second section (39) of the framed support, farthest away from the first LED light source and having a box-like shape in order to idly receive the said first reflector (7).

5. A rotating lighting module as claimed in claim 4, **characterized in that** it further comprises a couple of second LED light sources (13) and a third LED light source (14), wherein all the said first, second and third LED light sources (6,13,14) are assembled on a printed circuit board (15) which is carried in a fixed manner by said framed support (4) directly above the rotating first reflector and on the side opposite to said first actuator (8); the printed circuit board (15) being assembled onto said first section (31) of the framed support, in thermal contact therewith.

6. A rotating lighting module according to claim 5, **characterized in that** the third LED light source (14) is an RGB LED and is arranged at a rear end (29) of the printed circuit board (15) opposite to the couple

of second light sources (13), the first LED light source being arranged between the second and third LED light sources; the framed support (4) bearing at the middle portion thereof a second reflector (30) operatively associated with the third light source (14) and arranged on the rear of the first reflector (7) and spaced apart thereof; the second reflector (30) being made preferably of a metal.

7. A rotating lighting module (5) as claimed in anyone of the preceding claims 5 or 6, **characterized in that** said first section (31) of the framed support (4) is provided with a receiving seat (44) for the printed circuit board (15) obtained by making the first section thinner than the middle section (38) so as to provide a step (45) between the first and middle section.

8. Lighting device (1) for a vehicle such as a headlight or a headlamp, **characterized in that** it comprises at least one rotating lighting module (5) according to anyone of the preceding claims arranged within a cup-shaped housing (2) designed to be mounted on a vehicle body and facing a front inlet opening (3) of the cup-shaped housing.

9. Lighting device (1) according to claim 8, **characterized in that** it comprised two or more rotating lighting modules (5) according to anyone of the preceding claims arranged side by side, each rotating lighting module having its own framed support (4) mechanically connected to a transverse rail (46) preferably made of metal and arranged substantially parallel to a width of the inlet opening.

10. Vehicle provided with a lighting device (1) according to claim 8 or 9.

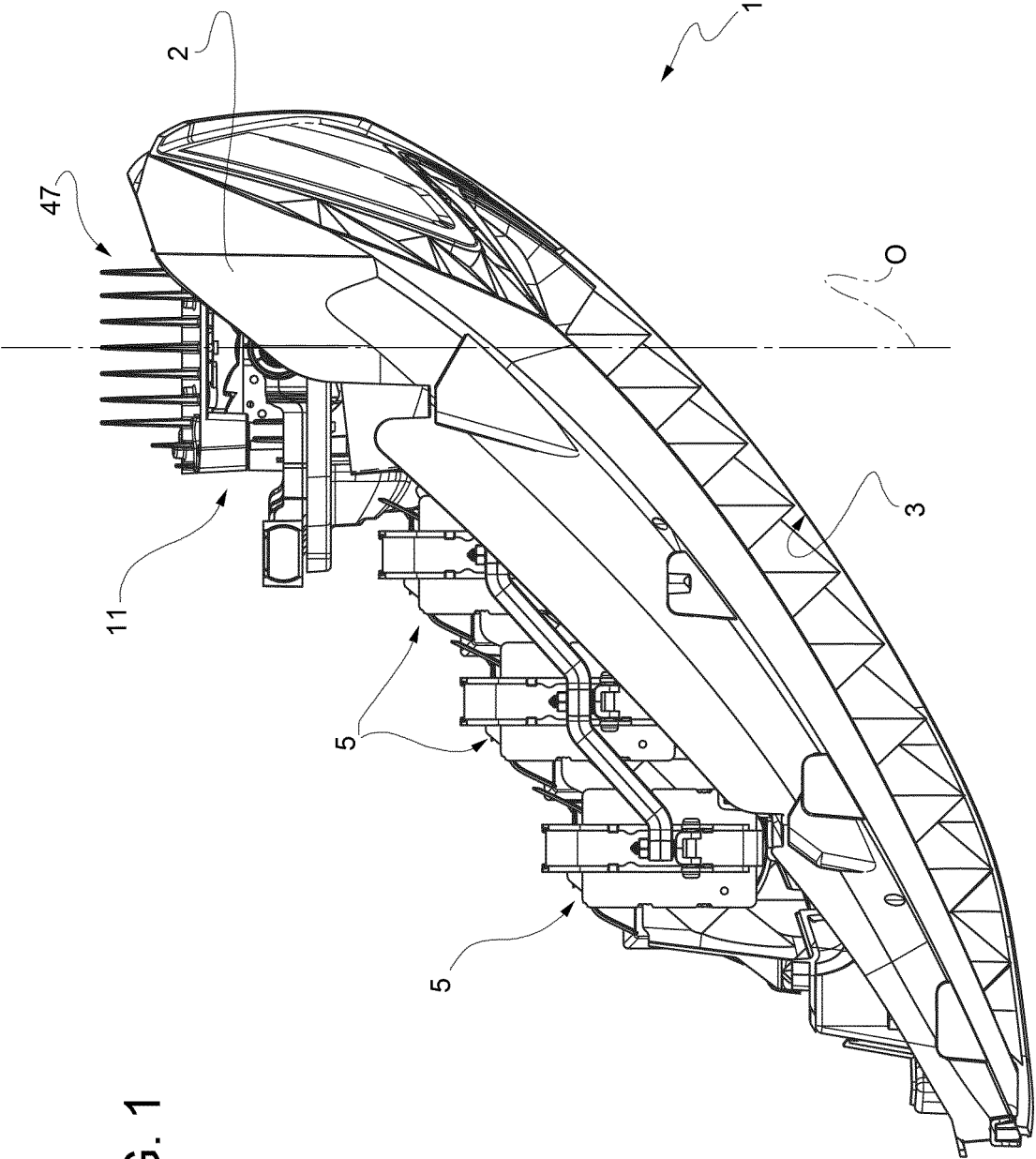


FIG. 1

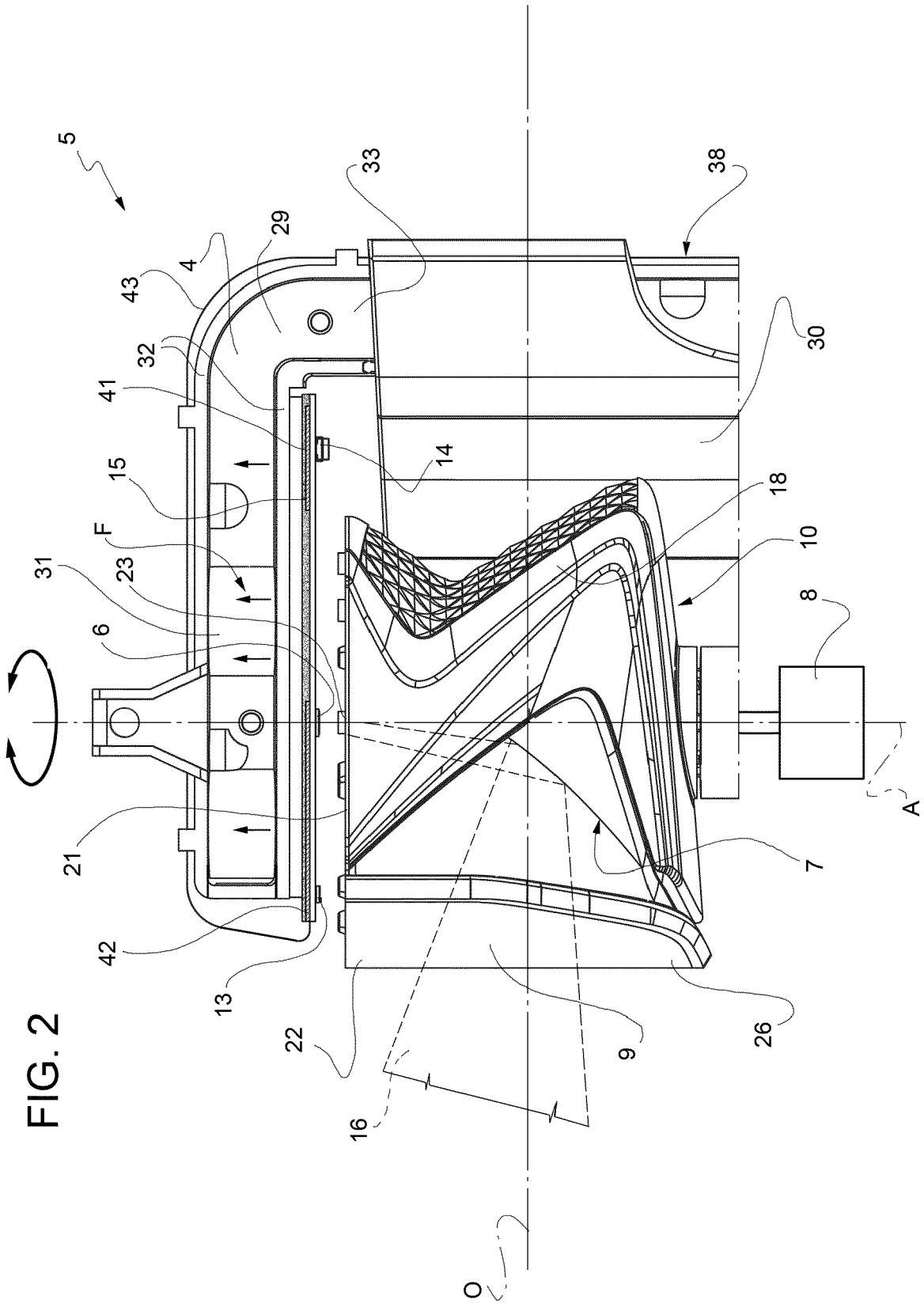




FIG. 3

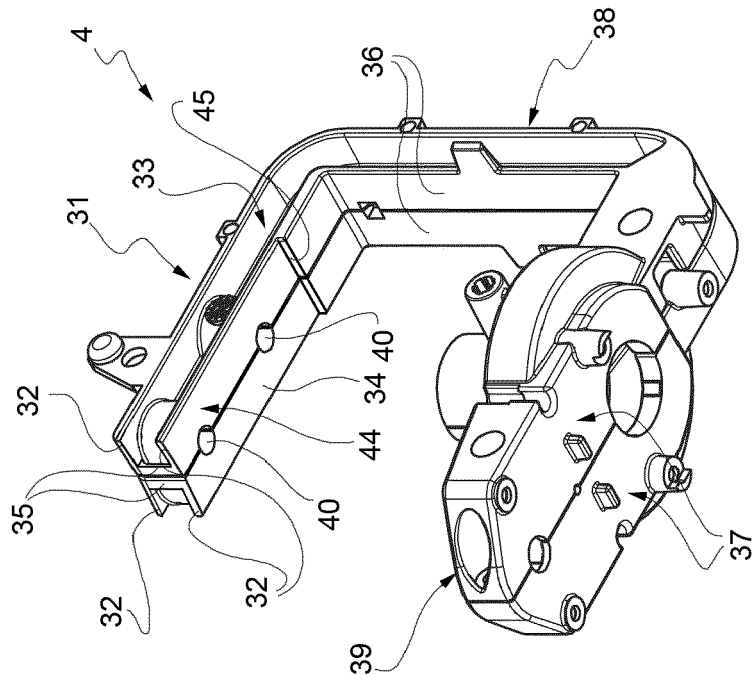
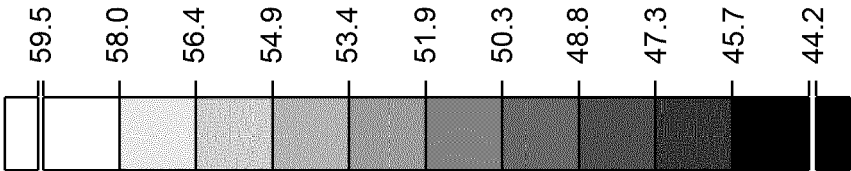


FIG. 4



Temperature (Solid) [°C]



## EUROPEAN SEARCH REPORT

Application Number  
EP 17 15 4083

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EPO FORM 1503 03.82 (P04C01)

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The present search report has been drawn up for all claims			
Place of search <b>Munich</b>		Date of completion of the search <b>12 July 2017</b>	Examiner <b>Schulz, Andreas</b>
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