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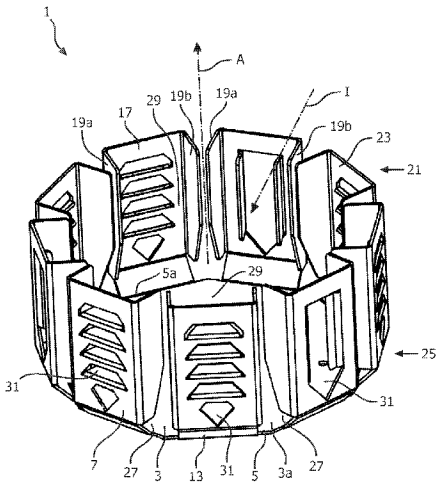


FIG. 1

(57) Abstract: The invention relates to a heat dissipation structure (1) for dissipating heat from a light source. The structure formed from one single piece of sheet material has a central area (3) surrounded by axial cooling segments (7). Such a cooling element has 1) a central portion (17) axially extending and extending accordingly the circumferential edge, 2) two side portions (19a;19b) axially extending and extending in an inward direction (I), 3) a first end portion (21) provided with a first opening (23), and 4) a fixed second end portion (25) located oppositely to the first end portion and provided with an aperture (27) adjacent to the circumferential edge. The central portion and the two side portions of a cooling segment form a chimney (29) from the aperture to the first opening allowing a cooling air stream through the cooling segment.

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A Heat Dissipation Structure, a Lighting Device Provided with the Same and a Method of Manufacturing the Same

FIELD OF THE INVENTION

The invention relates to a heat dissipation structure for dissipating heat from a light source, particularly a light emitting diode (LED), which structure is provided with a plate-like central area having a circumferential edge and a plurality of cooling segments arranged along the circumferential edge of the central area, wherein the central area and the cooling segments are substantially formed from one single piece of heat-conducting sheet material, wherein the cooling segments each have a fixed end portion forming an integral connection with the central area and wherein the plurality of cooling segments define an interior space.

BACKGROUND OF THE INVENTION

The international patent application WO 2011/124386 A1 discloses a heat dissipation structure for removing heat from light emitting diodes (LEDs). This known structure comprises a central body and a plurality of cooling ribs. The central body and cooling ribs are formed as a single integrated piece. The central body comprises an outer side for accommodating the LEDs and an inner side. The cooling ribs each have a first end and a second end. The first ends are connected to the central body and the second ends are disposed distant from and facing the inner side of the central body. The cooling ribs extend in a radial direction outwardly from the central body and in an axial direction away from the inner side of the central body. The central body and the cooling ribs enclose an interior space with open channels to enable air flow from outside the structure into the interior space and back out of the interior space. Compared to conventional designs with heat sink structures, the cooling ribs reduce the surface of the heat sink. The openness of the structure aims at allowing convective air flow in a direction parallel to the ribs as well as convective air flow in a direction perpendicular to the ribs. The heat dissipation structure disclosed in said international patent application is made by using a stamping process, a casting process or an injection moulding process.

SUMMARY OF THE INVENTION

It is an object of the invention to provide an easy to manufacture heat dissipation structure providing a high capability of heat dissipation.

This object is achieved by the heat dissipation structure as described in the present disclosure. More particularly, the heat dissipation structure according to the invention is a heat dissipation structure for dissipating heat from a light source, which structure is provided with a plate-like central area having a circumferential edge and a plurality of cooling segments arranged along the circumferential edge of the central area, wherein the central area and the cooling segments are substantially formed from one single piece of heat-conducting sheet material, which cooling segments at least substantially extent in an axial direction with regard to the central area, wherein the cooling segments each have a first end portion and a fixed second end portion located oppositely to the first end portion, seen in said axial direction, and forming an integral connection with the central area, wherein the plurality of cooling segments defines an interior space, which cooling segments each are provided with a central portion at least substantially extending in said axial direction and extending accordingly to said circumferential edge, two side portions each at least substantially extending in said axial direction and in an inward direction oriented towards said interior space, wherein the first end portion is provided with a first opening, and the second end portion is provided with at least one aperture adjacent to the circumferential edge of the central area, wherein the central portion and the two side portions of each cooling segment form a chimney from the at least one aperture to the first opening of each cooling segment.

The light source may be a solid state light emitter. Examples of solid state light emitters are Light Emitting Diodes (LEDs), Organic Light Emitting diode(s) OLEDs, or, for example, laser diodes.

In the heat dissipation structure according to the invention, each cooling segment has a chimney structure allowing cooling air going through the cooling segment from the at least one aperture to the first opening. During use, wherein a lighting source is provided on the heat dissipation structure according to the invention, heat produced by the light source is absorbed and conducted by the heat dissipation structure. Particularly, the cooling segments of the heat dissipation structure are effectively cooled by the cooling air rising through the chimneys. Cold air inters the cooling segments via the at least one aperture, whereafter the rising cooling air skims along the central portions and the inwardly oriented side portions of the cooling segments and simultaneously takes away heat from these portions. The heated air leaves the cooling segments via their first openings. Due to these features the heat dissipation structure

according to the invention has a high cooling performance and is very suitable for application into a lighting device provided with one or more light emitting diode (LEDs). Low cost, light weight and an environmentally friendly fabrication are further advantages of the heat dissipation structure according to the invention. The single piece of heat-conducting sheet material may be a sheet of aluminum, tin, copper or another heat-conducting material. The number of cooling segments depends among others on the dimensions of the dissipation structure and the cooling segments. A practical embodiment has nine cooling segments.

It is to be noted that the international patent application WO 2011/029724 A1 discloses a lighting device having a heat sink for cooling a set of LEDs. This known heat sink comprises bent sheet metal parts, in particular punched sheet metal parts. The patent application WO 2011/029724 A1 further discloses a method for producing a heat sink. This known method comprises the steps of blanking radially extending clearances at an edge of a sheet metal and bending up the segments that remain between the clearances at a central contact area. In one of the disclosed embodiments each segment is provided with a radially outward bent cooling lamella.

The heat dissipation structure disclosed in WO 2011/124386 A1 as well as the heat-sink disclosed in WO 2011/029724 A1 does not comprise a chimney structure as applied into the heat dissipation structure according to the invention.

In a preferred embodiment of the heat dissipation structure according to the invention, the central portion of at least a number of the cooling segments, preferably each cooling segment is provided with at least one open window. This at least one window offers an additional entrance for cold air. This structure produces an improved chimney effect, whereby the cooling air flowing through the chimneys more efficiently takes heat away. The at least one open window preferably has a rectangular shape, a triangular shape, a round shape, a trapezium shape or a louver shape, or a combination of two or more of these shapes. Such an embodiment allows optimal apertures together with optimal thermal conducting portions.

In a preferred embodiment of the heat dissipation structure according to the invention, the at least one open window has a tapered shape, which is larger towards the first end portion of the cooling segment and is smaller towards the second end portion of the cooling segment.

Applying open windows having said tapered shapes facilitates entering cold air into the cooling segments and thereby improves the cooling ability of the structure.

In a preferred embodiment of the heat dissipation structure according to the invention, at least a number of the cooling segments, preferably each cooling segment, is provided with more than one open window. By applying more open windows the cooling effectiveness is improved. The windows may have mutually different shapes in order to optimize the dissipation structure.

In a preferred embodiment of the heat dissipation structure according to the invention, at least a number of the cooling segments, preferably each cooling segment, has a second opening provided into the fixed second end portion. In this embodiment cold air has an increased entrance resulting into an enhanced cooling effect. Preferably, the second opening partly extends into the central area. In this way cold air can also enter the heat dissipation structure through openings into the central area for further improving the cooling result.

In a practical embodiment of the heat dissipation structure according to the invention, the circumferential edge of the central area is a substantially circular edge. Nevertheless, the central area may have any other suitable circumferential edge, if desired, e.g. the central area may by square or triangular.

In a practical embodiment of the heat dissipation structure according to the invention, the cooling segments are substantially perpendicularly oriented with regard to the plate-like central area. Nevertheless, the cooling segments may make small angles with respect to the perpendicular to the central area, i.e. the cooling segments may be slightly oriented outwards or inwards with respect to the central area.

The invention also relates to a heat dissipation device. The heat dissipation device according to the invention comprises the heat dissipation structure according to the invention and a further heat dissipation structure accommodated into the interior space of the heat dissipation structure according to the invention, which further heat dissipation structure has the characteristics of the heat dissipation structure according to the invention. Both heat dissipation structures are coaxially arranged with respect to each other.

The heat dissipation device according to the invention has a multilayer structure to dissipate heat. Such a multilayer structure is able to dissipate more heat in a certain zone with respect to the same zone of a single layer structure, because multilayer structures increase thicknesses of contact areas and increase areas of heat dissipation.

In an embodiment of the heat dissipation device according to the invention, both heat dissipation structures are arranged in an axially rotated position with respect to each other. In this embodiment, a curling effect of the air flows occurs, during use, which effect can be used for improving the effectiveness of the heat dissipation device. The rotation angle depends e.g. on the number of cooling segments. Experiments have been done with an embodiment of which each of the heat dissipation structures is provided with of nine cooling segments, wherein a rotation angle of about 20 degrees has been applied.

The invention also relates to a lighting device. The lighting device according to the invention comprises the heat dissipation structure according to the invention or the heat dissipation device according to the invention and comprises an electronic driver unit at least partially accommodated into said heat dissipation structure or heat dissipation device, wherein the lighting device is configured for comprising one or more solid state light emitters, particularly light emitting diodes (LEDs), provided on an outer face of the central area of said heat dissipation structure. The lighting device may be marketed with one or more mounted LEDs or without LEDs. Examples of solid state light emitters are Light Emitting Diodes (LEDs), Organic Light Emitting diode(s) OLEDs, or, for example, laser diodes. In some embodiments the solid state light source may be a blue light emitting LED, such as GaN or InGaN based LED, for example emitting primary light of the wavelength range from 440 to 460 nm. Alternatively, the solid state light source may emit UV or violet light which is subsequently converted into light of longer wavelength(s) by one or more wavelength converting materials.

According to the recent trend, LEDs become the mainstream in the lighting field because of their outstanding characteristics in comparison with the conventional incandescent or fluorescent light sources. LED lamps have a high light output and a long lifetime. LED luminaires however need an effective heat spreader, as the performance of a LED is influenced by its temperature and should be relatively low. By applying the heat dissipation structure according to the invention or the heat dissipation device according to the invention an effective cooling is achieved during use of the lighting device. Characteristics of the heat

dissipation structure according to the invention and the heat dissipation device according to the invention can be found in foregoing paragraphs. The lighting device according to the invention is suitable for use in a variety of lighting applications, such as office lighting, industrial lighting, home lighting, supermarket lighting and road lighting. Generally, the lighting devices have, after mounting, a vertical or substantially vertical orientation, wherein the LED or LEDs are downwardly or substantially downwardly directed.

The invention also relates to a method of manufacturing a heat dissipation structure, in particular the heat dissipation structure according to the invention. The method according to the invention comprises the following steps: providing a single piece of heat-conducting sheet material; removing material from said single piece of sheet material to create a plate-like central area with a circumferential edge provided with a plurality of outwardly extending sheet elements, each sheet element being provided with an aperture adjacent the circumferential edge and having a free first end portion, a fixed second end portion forming an integral connection with the central area, and a central portion extending between the fixed end portion and the free end portion, wherein the central portion is bordered by two side portions; bending the two side portions of each sheet element towards one and the same side, wherein each side portion is bent around a first fold line located between the central portion and the relevant side portion and extending from the free end portion of the sheet element towards the central area to create two opposite side portions; bending the sheet elements towards said one and the same side, wherein each sheet element is bent around at least one second fold line located in or near the fixed end portion and extending substantially perpendicular to the first fold lines to create a plurality of cooling segments, which cooling segments at least substantially extent in an axial direction with regard to the central area, wherein the plurality of cooling segments define an interior space, which cooling segments each are provided with said central portion at least substantially extending in said axial direction and extending accordingly to said circumferential edge, and two side portions at least substantially extending in said axial direction and extending in an inward direction oriented towards said interior space.

The method according to the invention is a quite simple, environmentally-friendly and inexpensive method, which nevertheless results into a very effective heat dissipation structure. The method according to the invention mainly comprises a step of removing material from a single piece of sheet material and steps of bending well-defined portions in

order to obtain cooling segments having specific chimneys. These steps may be ordinary cutting and folding steps, respectively, well-known in the field of sheet metalworking.

In a preferred embodiment of the method according to the invention the step of removing material comprises the sub-step of removing material from said sheet elements to create a window into the central portion of at least a number of the sheet elements, preferably each sheet element. In this way an even more effective heat dissipation structure is obtained.

A preferred embodiment of the method according to the invention comprises the step of removing material from the sheet elements and/or the central area to create openings into the fixed end portions of the sheet elements and/or the central area. This is also a step to further improve the heat spread capability of the heat dissipation structure.

With reference to the attached claims it is noted that all possible combinations of features mentioned in the claims are part of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

A detailed description of the invention is provided below. The description is provided by way of non-limiting examples to be read with reference to the drawings in which:

Fig. 1 schematically shows in a perspective top view a first embodiment of the heat dissipation structure according to the invention;

Fig. 2 schematically shows in a perspective bottom view the first embodiment of the heat dissipation structure according to the invention;

Fig. 3 schematically shows in a perspective top view a second embodiment of the heat dissipation structure according to the invention;

Fig. 4 schematically shows in a perspective top view a first embodiment of the heat dissipation device according to the invention;

Fig. 5 schematically shows in a top view an example of a single piece of heat-conducting sheet material;

Fig. 6 schematically shows in a perspective top view the result obtained after performing a step of an embodiment of the method according to the invention;

Fig. 7 schematically shows in a perspective top view the result obtained after performing another step of the embodiment of the method according to the invention;

Fig. 8 schematically shows in a perspective top view the result obtained after performing another step of the embodiment of the method according to the invention;

Fig. 9 schematically shows in a perspective top view the result obtained after performing another step of the embodiment of the method according to the invention;

Fig. 10 schematically shows in a perspective top view the result obtained after performing another step of the embodiment of the method according to the invention; and

Fig. 11 schematically shows in an exploded view an embodiment of the lighting device according to the invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

It is expressly noted that the disclosed embodiments are schematically depicted. The embodiments only represent examples. The same reference numerals have been used in the several embodiments for the same or corresponding elements and parts and the like, however not all the elements and parts and the like have been indicated in the several embodiments.

The heat dissipation structure 1, depicted in Figs. 1 and 2, is configured for dissipating heat from a light source, particularly provided with one or more LEDs. Generally, the depicted position corresponds to the use position of the heat dissipation structure. The heat dissipation structure 1 is provided with a plate-like central area 3, which has a circumferential edge 5. The structure 1 is further provided with several of cooling segments 7, which are arranged along the circumferential edge 5 and surround the central area 3. The cooling segments 7 are perpendicularly oriented with regard to the plate-like central area 3. The central area 3 and the cooling segments 7 are formed from one single piece of heat-conducting sheet material. In Fig.5 an example of such a piece of heat-conducting sheet material 9 is shown. The shown sheet is made of aluminum. The cooling segments 7 each have a fixed end portion 25 which forms an integral connection 13 with the central area 3. The cooling segments 7 extent in an axial direction A with regard to the central area 3, i.e. an axial direction away from an inner face 3a of the central area 3, wherein the plurality of cooling segments 7 defines an interior space 15. Each cooling segment 7 is provided with a central portion 17 which extends in the axial direction A and extends accordingly to the circumferential edge 5, i.e. parallel or substantially parallel to a local portion 5a of the circumferential edge 5. Each cooling segment 7 is further provided with two side portions 19a and 19b which each extend in the axial direction A and in an inward direction I oriented towards said interior space 15. Each cooling segment 7 has a first end portion 21 provided with a first opening 23. Each cooling segment 7

further has a second end portion 25 located oppositely to the first end portion 21, seen in the axial direction A, and provided with an aperture 27 located adjacent to the circumferential edge 5 of the central area 3. The first end portions 21 are remote from the central area 3, while the second end portions 25 are located near to the central area 3. The central portion 17 and the two side portions 19a and 19b of each cooling segment 7 form, during use of the heat dissipation structure, a chimney 29 which extends from the aperture 27 to the first opening 23 of each cooling segment 7. In the present embodiment nine cooling segments 7 put together around the circumferential edge 5 are applied, wherein the cooling segments 7 substantially cover the entire circumferential edge 5. This means that during use nine adjacent chimneys 29 allow cooling air currents through the heat dissipation structure 1, resulting into an efficient cooling of the heat dissipation structure 1.

In the heat dissipation structure 1, depicted in Figs. 1 and 2, the central portion 17 of each cooling segment 7 is provided with one or more open windows 31. By way of example, several possible window shapes have been shown. A preferred window has a tapered shape, which is smaller towards the first end portion 21 of the cooling segment 7 and is larger towards the second end portion 25 of the cooling segment. Alternatives for this window shape are e.g. a rectangular shape, a triangular shape, a round shape, a trapezium shape and a louver shape, and combinations of two or more of these shapes. By way of example, different window shapes have been applied into the embodiment of Figs. 1 and 2. For efficiency reasons it is preferred to provide the fixed end portion 25 of at least a number of the cooling segments 7 with a second opening 33. For the same reasons the second opening 33 preferably extends at least partly into the central area 3. The circumferential edge 5 of the plate-like central area 3 of the dissipation structure 1 shown in Figs. 1 and 2 is a substantially circular edge, even although there are straight edge portions near to the cooling segments 7.

The heat dissipation structure 1 depicted in Fig. 3 resembles the dissipation structure of Figs. 1 and 2, and for this reason only distinctive features will be discussed. The heat dissipation structure 1 of Fig. 3 has cooling segments 7 provided with side portions 19a and 19b having wings 20a and 20b, respectively. These wings 20a and 20b are perpendicularly oriented with respect to the side portions 19a and 19b, in such a way that the wings 20a and 20b of each cooling segment 7 face each other. As is depicted, a pair of wings 20a and 20b of a cooling segment 7 runs parallel to the central portion 17 of the relevant cooling segment 7. The wings

increase the surface area of the cooling segments for, during use, further improving the degree of cooling.

The heat dissipation device 35 depicted in Fig. 4 comprises a heat dissipation structure 1, e.g. the embodiment as shown in Figs. 1 and 2, or Fig. 3, or a similar embodiment. The heat dissipation device 35 further comprises a further heat dissipation structure 37 being a structure similar to the embodiment as shown in Figs. 1 and 2, or Fig. 3. The heat dissipation structure 37 is accommodated into the interior space 15 of the heat dissipation structure 1, i.e. both heat dissipation structures are coaxially arranged. In an alternative embodiment of the heat dissipation device 35 both heat dissipation structures 1 and 37 are arranged in an axially rotated position with respect to each other, i.e. that the heat dissipation structure 37 is somewhat, e.g. 20 degrees, rotated around the longitudinal axis of the device 35, which axis coincides in Fig. 4 with the line indicating the direction A, with regard to the heat dissipation structure 1.

An embodiment of the method according to the invention will now be elucidated with reference to Figs. 5 to 10. In this embodiment the method of manufacturing a heat dissipation structure 1 or 37 or a similar structure, comprises a first step of providing a single piece of heat-conducting sheet material 9, such as aluminum or tin, as is shown in Fig. 5.

In a second step, see Fig. 6, material is removed from the single piece of sheet material 9 for creating a plate-like central area 3 provided with a circumferential edge 5 and comprising a plurality of outwardly extending sheet elements 7a. In this example nine sheet elements 7a are formed. The material may be removed by conventional processes, like stamping, cutting or punching. Each formed sheet element 7a is provided with an aperture 27 and has a fixed end portion 25, which forms an integral connection 13 with the central area 3, a free end portion 21 and a central portion 17. The central portion 17 extends between the fixed end portion 25 and the free end portion 21 and is bordered by two side portions 19aa and 19bb.

In a third step, see Fig. 7, the two side portions 19aa and 19bb of each sheet element 7a are bent towards one and the same side S with respect to the plate-like central area 3, i.e. bent away from the central area 3. Each side portion 19aa and 19bb is bent around a first fold line 45 located between the central portion 17 and the relevant side portion 19aa or 19bb and

extending from the free end portion 21 of the sheet element 7a towards the central area 3 for creating two opposite side portions 19a and 19b.

In a fourth step, see Figs. 8 and 9, the sheet elements 7a are bent towards the one and same side S. Each sheet element 7a is bent around at least one second fold line 47 located in or near the fixed end portion 25 and extending perpendicular to the first fold lines 45 for creating a plurality of cooling segments 7, see Fig. 10. After bending, the cooling segments 7 extent in an axial direction A with regard to the central area 3, wherein all cooling segments 7 define and enclose an interior space 15. The cooling segments 7 are provided with the central portion 17 which extend in the axial direction A and extend accordingly to the circumferential edge 5. The cooling segments 7 are further provided two side portions 19a and 19b which extend in the axial direction A and extend in inward directions (I) oriented towards the interior space 15. Any conventional bending or folding method may be applied for bending portions of the sheet material.

In a preferred step, see Figs. 6 and 7, material from the sheet elements 7a is removed for creating one or more open windows 31 into the central portion 17 of each of the sheet elements 7a.

In another preferred step, see Figs. 6 and 7, material is removed from the sheet elements 7a and/or the central area 3 to create openings 33 into the fixed end portions 25 of the sheet elements 7a and/or the central area 3.

With reference to Fig. 11 an embodiment of the lighting device according to the invention will now be discussed. The lighting device 39 depicted in Fig. 11 comprises the heat dissipation device 35 of Fig. 4, which dissipation device 39 is provided with the heat dissipation structures 1 and 37. Alternatively, the lighting device 39 may comprise a variant of the dissipation device 35 or may comprise the heat dissipation structure as disclosed in Fig. 1 and 2, or Fig. 3, or a variant thereof. The lighting device 39 further comprises one or more light emitting diodes (LEDs), not shown in the figure. The one or more LEDs may be mounted into a reflector 6. The reflector 6, as well as a printed circuit board 8, is mounted on an outer face 41 of the central area 3 of the heat dissipation structure 1. The reflector 6 is covered by a diffuser 10. An electronic driver unit 4, which is placed into a two-piece housing

12a and 12b, is at least partially accommodated into the interior space 15 of the heat dissipation structure 37.

Summarizing, the invention relates to a heat dissipation structure for dissipating heat from a light source. The structure, which is formed from one single piece of sheet material, has a central area surrounded by axially extending cooling segments. The cooling segments have fixed end portions. Such a cooling element is at least provided with 1) a central portion axially extending and extending accordingly the circumferential edge, 2) two side portions axially extending and extending in an inward direction, 3) a first end portion provided with a first opening, and 4) a fixed second end portion located oppositely to the first end portion and provided with an aperture adjacent to the circumferential edge. The central portion and the two side portions of such a cooling segment form a chimney from the aperture to the first opening allowing a cooling air stream through the relevant cooling segment from the aperture to the first opening.

It will be clear to a person skilled in the art that the scope of the present invention is not limited to the examples discussed in the foregoing. Several amendments and modifications of the discussed examples are possible without deviating from the scope of the present invention as defined in the claims. While the present invention has been illustrated and described in detail in the figures and the description, such illustrations and descriptions are to be considered illustrative or exemplary only, and not restrictive. The present invention is not limited to the disclosed embodiments. Any variation to and combination of the described and/or depicted embodiments which can be understood and effected by a person skilled in the art of practicing the claimed invention, from a study of the figures, the description and the attached claims, is part of the invention. In the claims, the word “comprise” and conjugations thereof do not exclude other steps or elements, and the indefinite article “a” or “an” does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope of the present invention.

CLAIMS

1. A heat dissipation structure (1) for dissipating heat from a light source, which structure is provided with

a plate-like central area (3) having a circumferential edge (5) and

a plurality of cooling segments (7) arranged along the circumferential edge of the central area,

wherein the central area and the cooling segments are substantially formed from one single piece of heat-conducting sheet material (9), which cooling segments at least substantially extent in an axial direction (A) with regard to the central area, wherein the cooling segments each have a first end portion (21) and a fixed second end portion (25) located oppositely to the first end portion, seen in said axial direction, and forming an integral connection (13) with the central area, wherein the plurality of cooling segments defines an interior space (15), which cooling segments each are provided with

a central portion (17) at least substantially extending in said axial direction and extending accordingly to said circumferential edge,

two side portions (19a,19b) each at least substantially extending in said axial direction and in an inward direction (I) oriented towards said interior space, wherein

the first end portion (21) is provided with a first opening (23), and

the second end portion (25) is provided with at least one aperture (27) adjacent to the circumferential edge of the central area,

wherein the central portion and the two side portions of each cooling segment form a chimney (29) from the at least one aperture to the first opening of each cooling segment.

2. The heat dissipation structure as claimed in claim 1, wherein the central portion (17) of at least a number of the cooling segments (7) is provided with at least one open window (31).

3. The heat dissipation structure as claimed in claim 1, wherein the circumferential edge (5) of the plate-like central area (3) is a substantially circular edge.

4. The heat dissipation structure as claimed in claim 1, wherein the cooling segments (7) are substantially perpendicularly oriented with regard to the plate-like central area (3).

5. The heat dissipation structure as claimed in claim 2, wherein the at least one open window (31) has a rectangular shape, a triangular shape, a round shape, a trapezium shape or a louver shape, or a combination of two or more of these shapes.

6. The heat dissipation structure as claimed in claim 2, wherein the at least one open window (31) has a tapered shape, which is larger towards the first end portion (21) of the cooling segment (7) and is smaller towards the second end portion (25) of the cooling segment.

7. The heat dissipation structure as claimed in claim 2, wherein at least a number of the cooling segments (7) is provided with more than one open window (31).

8. The heat dissipation structure as claimed in claim 1, wherein at least a number of the cooling segments (7) has a second opening (33) provided into the fixed second end portion (25).

9. The heat dissipation structure as claimed in claim 8, wherein the second opening (33) partly extends into the central area (3).

10. A heat dissipation device (35), wherein a further heat dissipation structure (37) is accommodated into the interior space (15) of the heat dissipation structure (1) as claimed in any one of the previous claims, which further heat dissipation structure has the characteristics of the heat dissipation structure as claimed in any one of the previous claims.

11. The heat dissipation device as claimed in claim 10, wherein both heat dissipation structures (1,37) are arranged in an axially rotated position with respect to each other.

12. A lighting device (39), comprising the heat dissipation structure (1) as claimed in any one of the preceding claims 1 to 9 or the heat dissipation device (35) as claimed in the claim 10 or 11, and comprising an electronic driver unit (4) at least partially accommodated into said heat dissipation structure or heat dissipation device, wherein the lighting device is configured for comprising one or more solid state light emitters (2) provided on an outer face (41) of the central area (3) of said heat dissipation structure.

13. A method of manufacturing a heat dissipation structure (1,37), comprising the following steps

- providing a single piece of heat-conducting sheet material (9);

- removing material from said single piece of sheet material to create a plate-like central area (3) with a circumferential edge (5) provided with a plurality of outwardly extending sheet elements (7a), each sheet element being provided with an aperture (27) adjacent the circumferential edge and having a free first end portion (21), a fixed second end portion (25) forming an integral connection (13) with the central area (3), and a central portion (17) extending between the fixed end portion (25) and the free end portion (21), wherein the central portion is bordered by two side portions (19aa,19bb);

- bending the two side portions of each sheet element towards one and the same side (S), wherein each side portion is bent around a first fold line (45) located between the central portion and the relevant side portion and extending from the free end portion of the sheet element towards the central area to create two opposite side portions (19a, 19b);

- bending the sheet elements towards said one and the same side, wherein each sheet element is bent around at least one second fold line (47) located in or near the fixed end portion and extending substantially perpendicular to the first fold lines to create a plurality of cooling segments (7), which cooling segments at least substantially extent in an axial direction (A) with regard to the central area, wherein the plurality of cooling segments define an interior space (15), which cooling segments each are provided with:

said central portion at least substantially extending in said axial direction and extending accordingly to said circumferential edge, and

two side portions at least substantially extending in said axial direction and extending in an inward direction (I) oriented towards said interior space.

14. The method as claimed in claim 13, wherein the step of removing material comprises removing material from said sheet elements (7a) to create an open window (31) into the central portion (17) of at least a number of the plurality of outwardly extending sheet elements (7a).

15. The method as claimed in claim 13, comprising the step of removing material from the sheet elements (7a) and/or the central area (3) to create openings (33) into the fixed end portions (25) of the sheet elements and/or the central area.

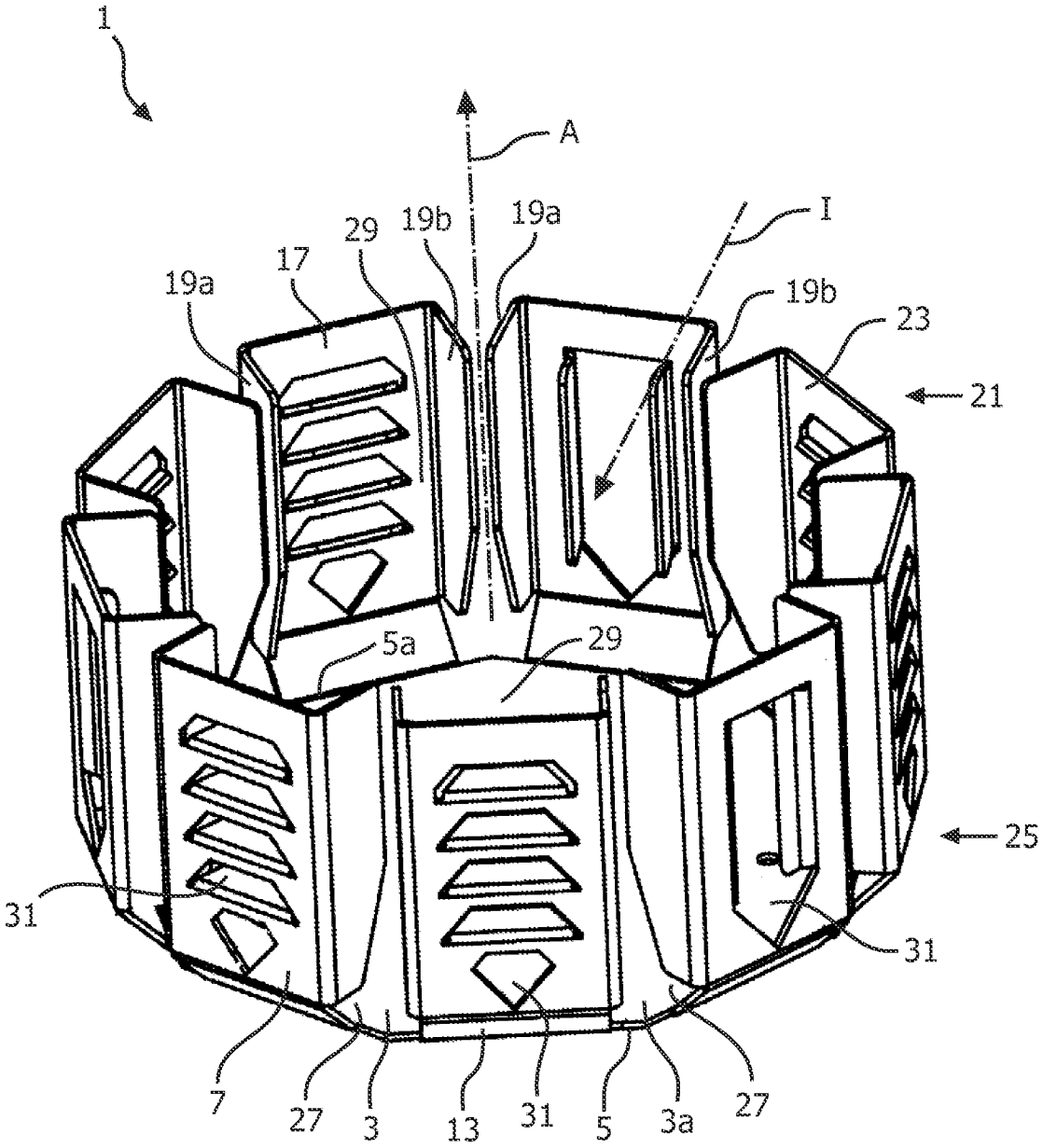


FIG. 1

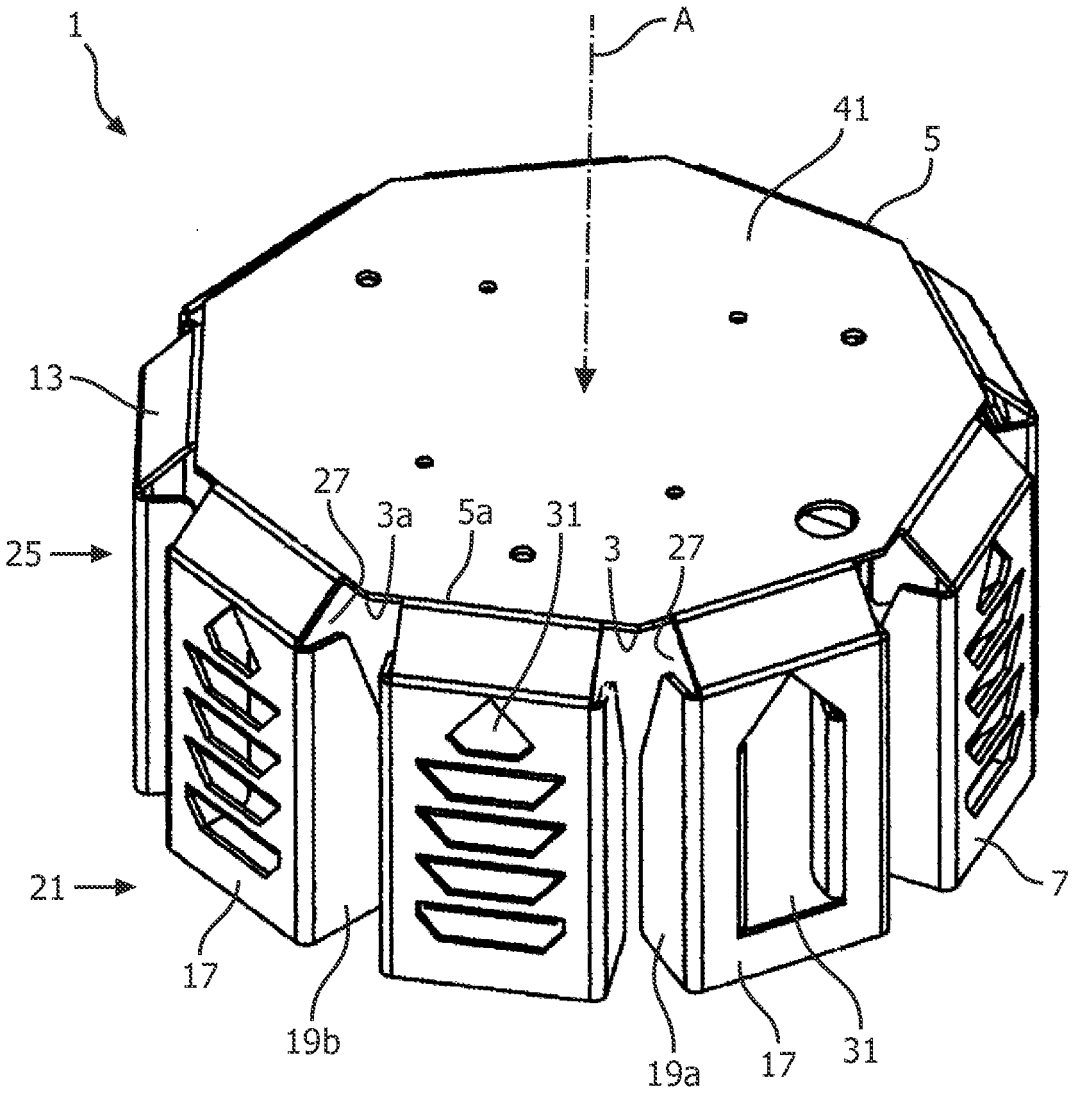


FIG. 2

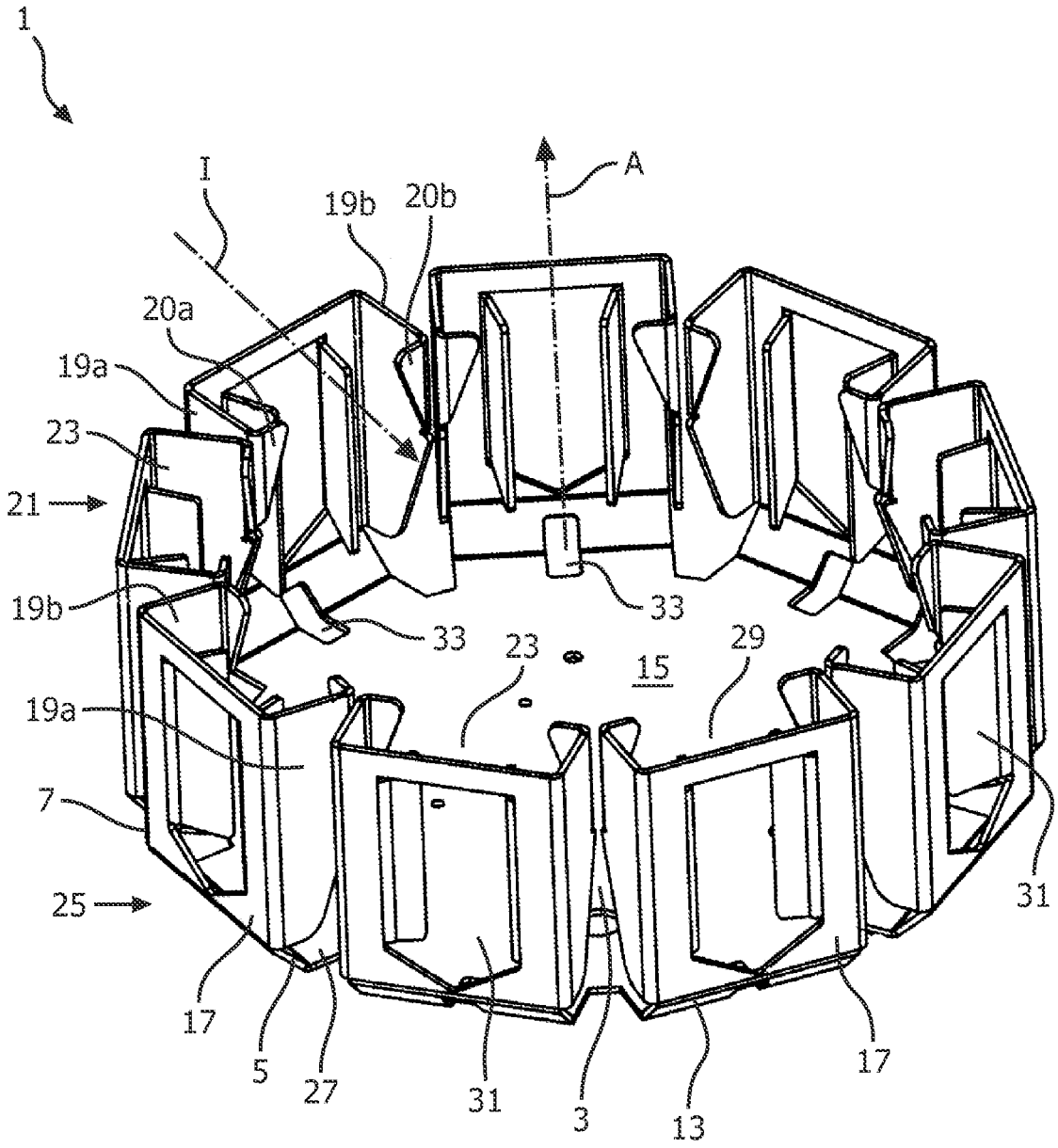

1
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19b
20b
20a
19a
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19b
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FIG. 3

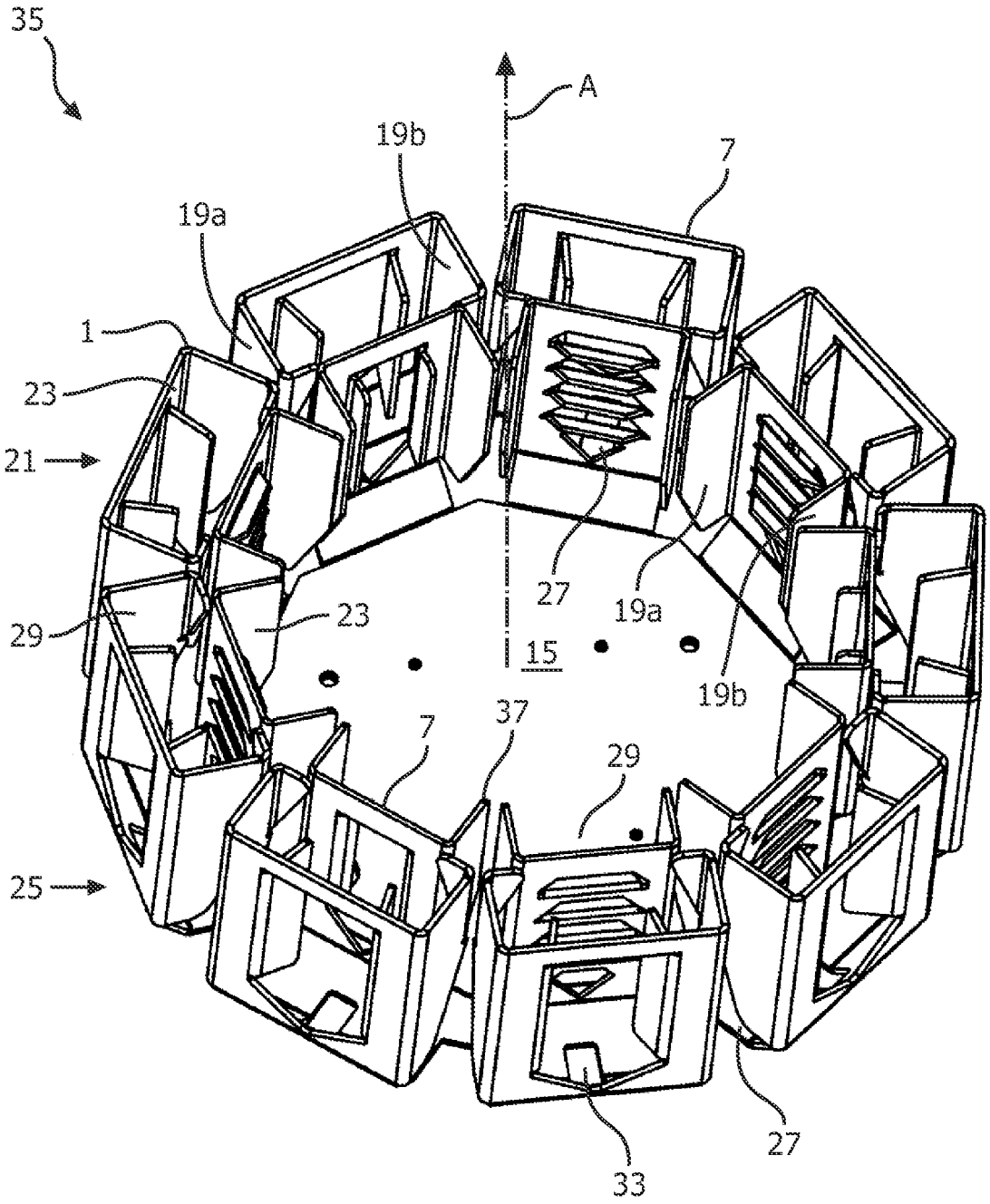


FIG. 4

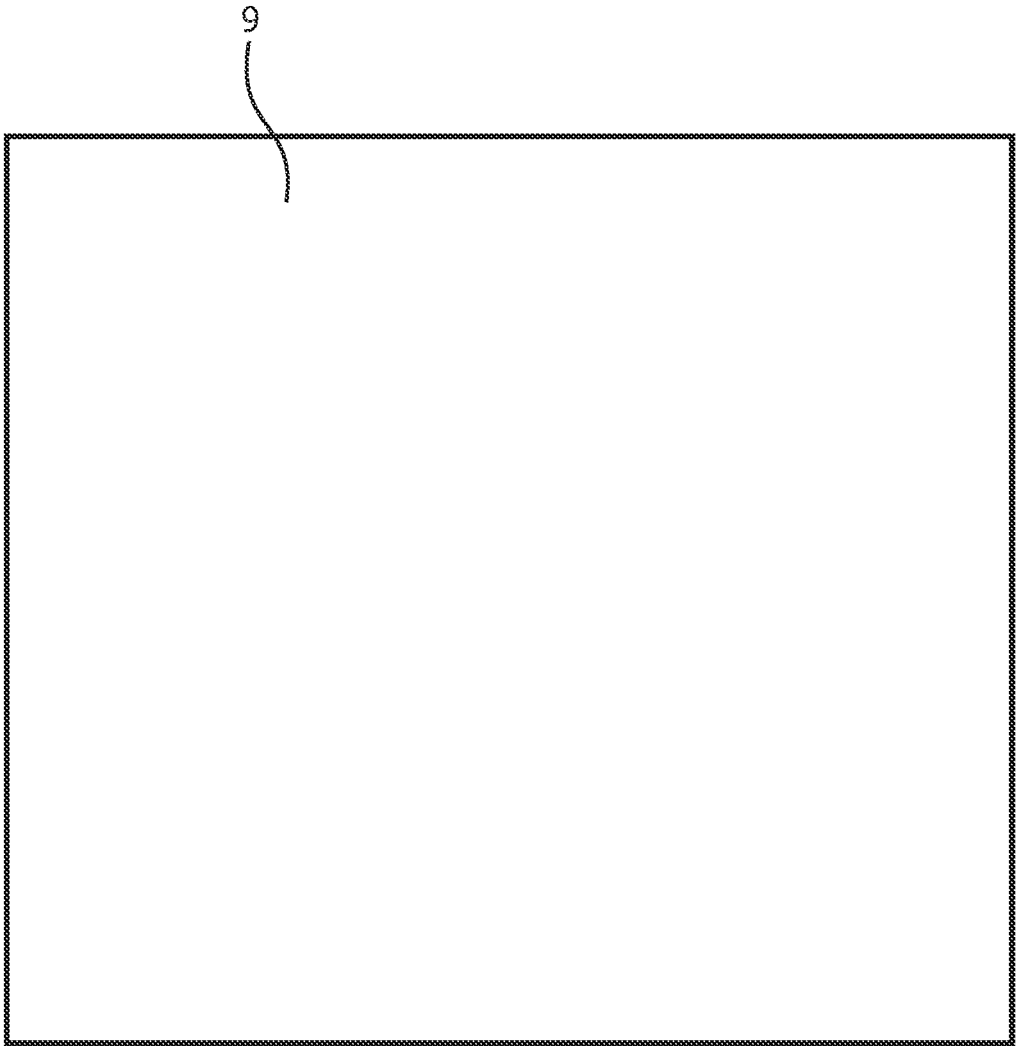


FIG. 5

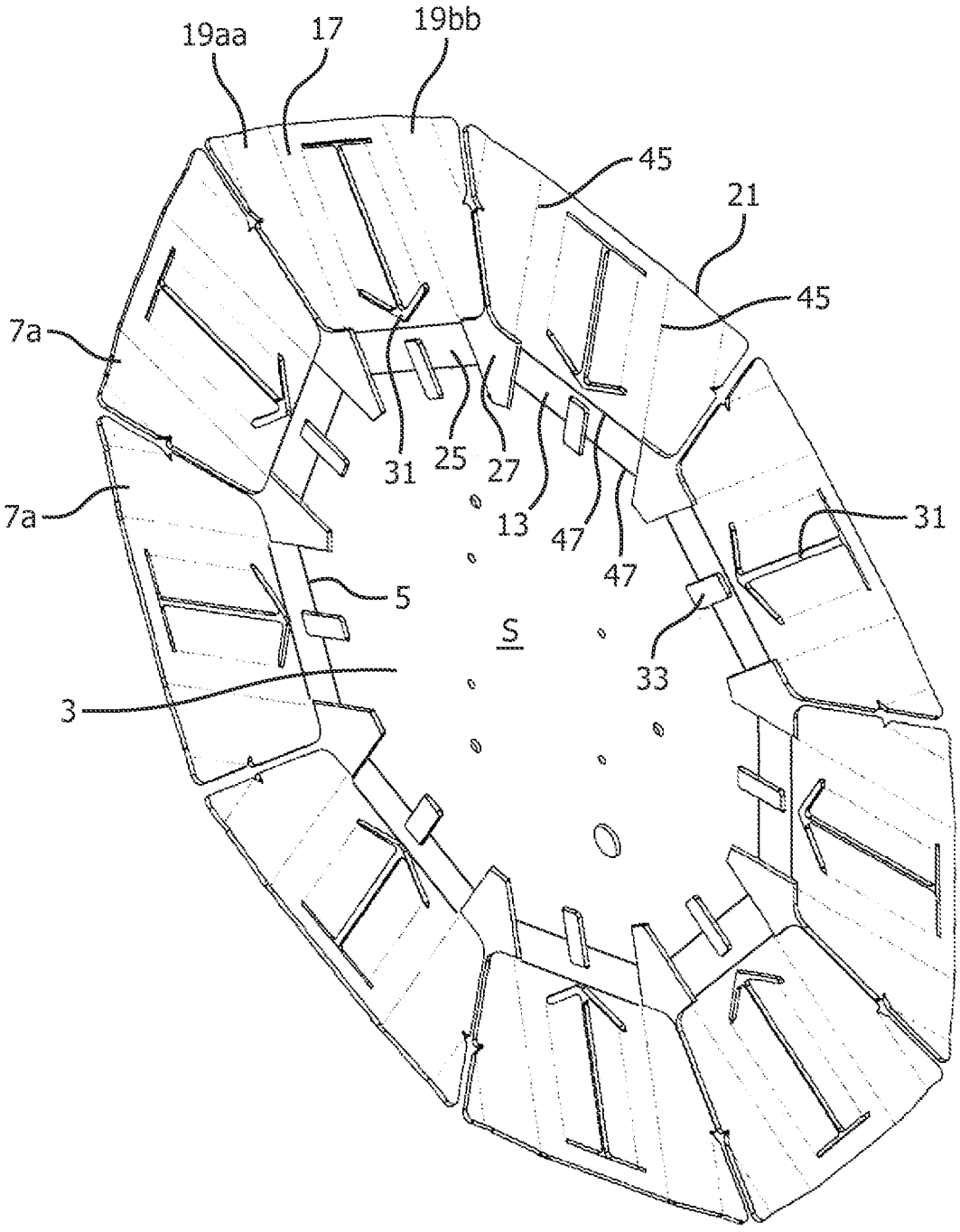


FIG. 6

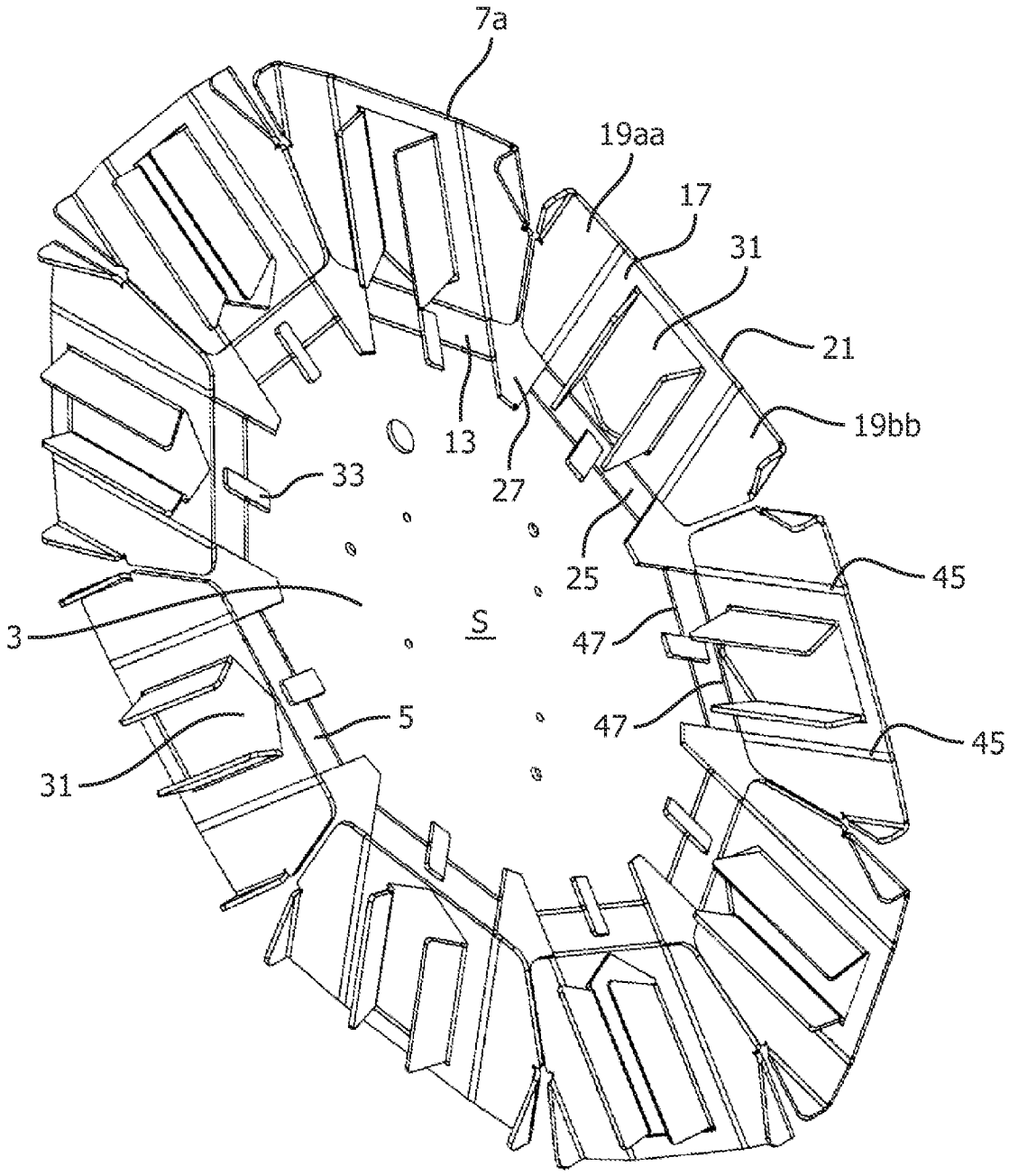


FIG. 7

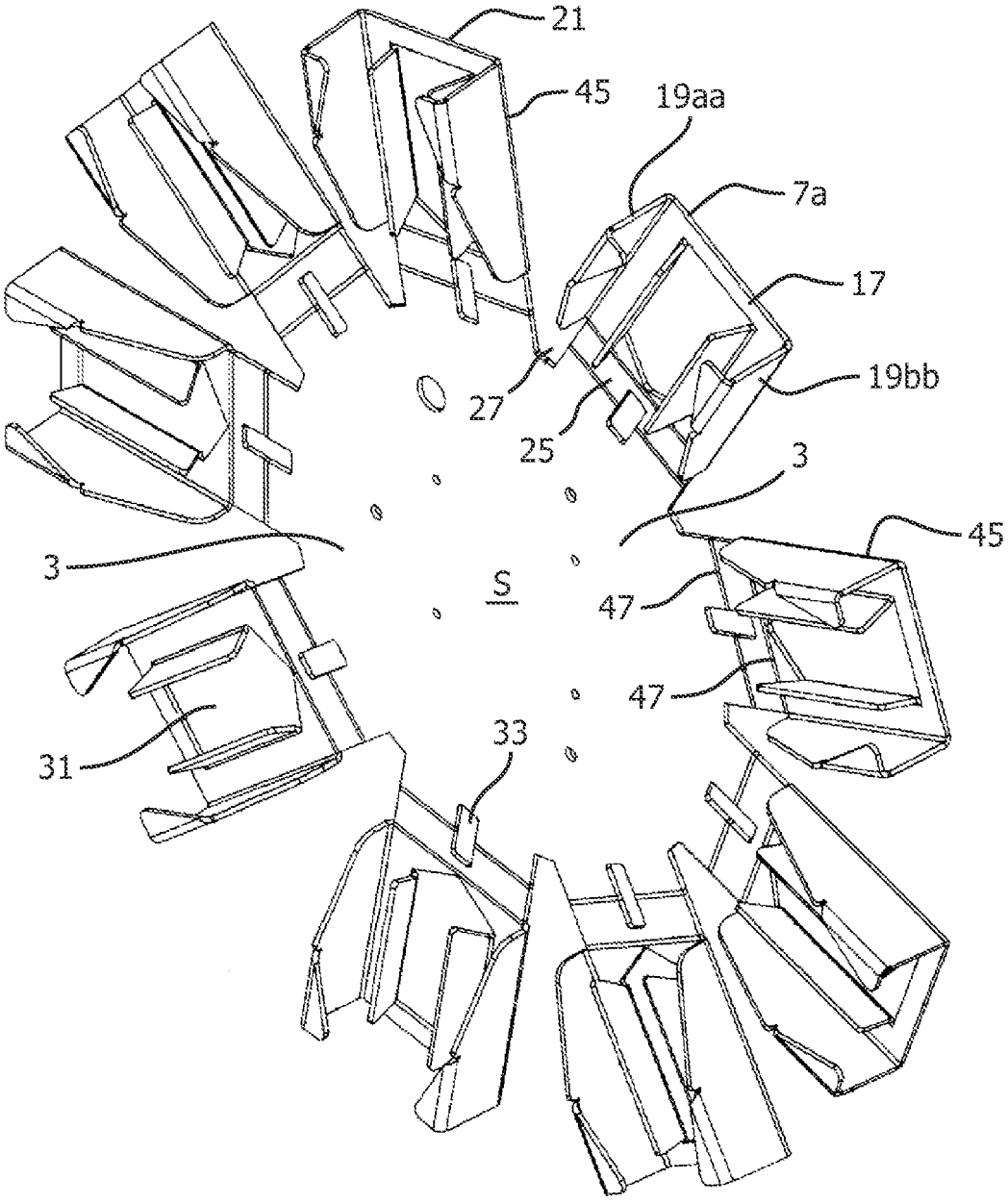


FIG. 8

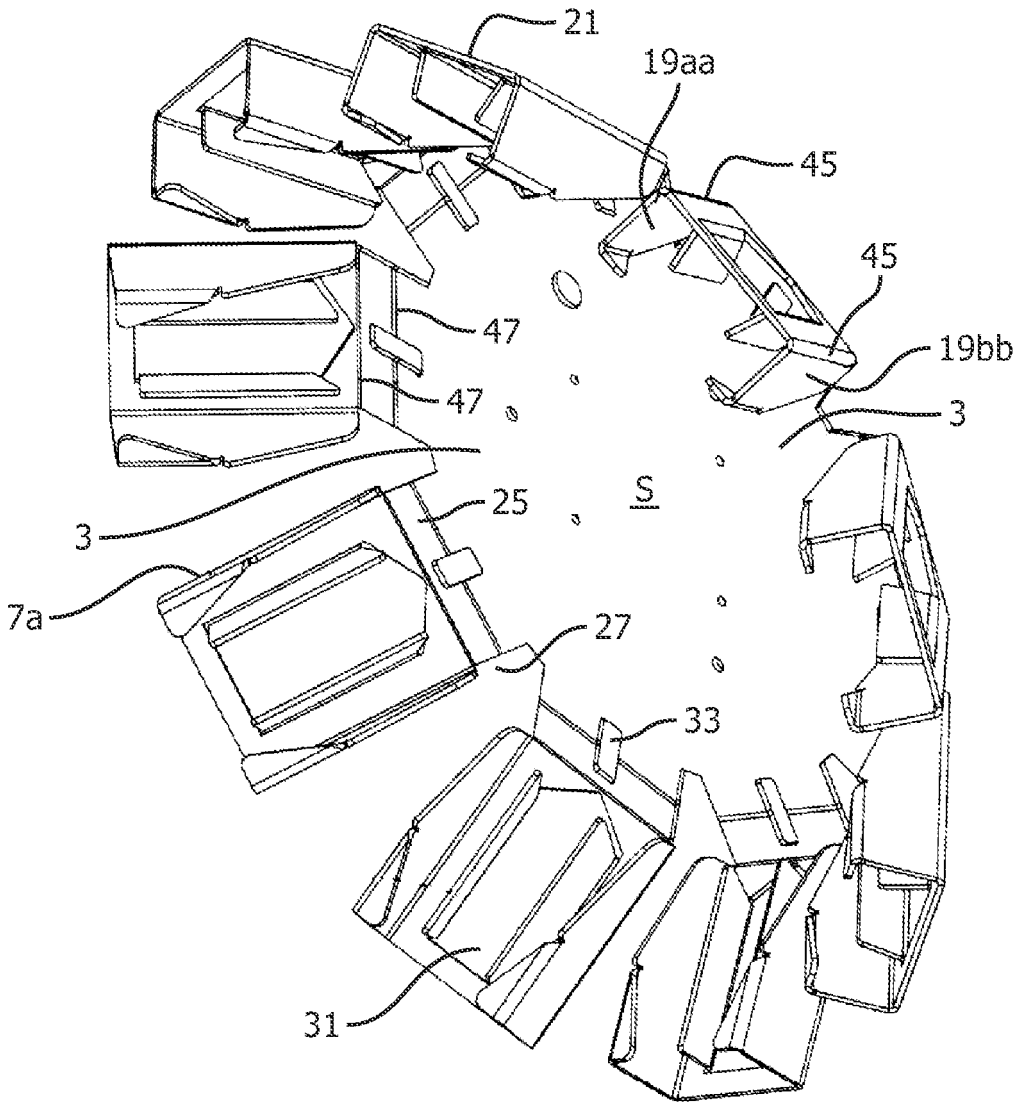


FIG. 9

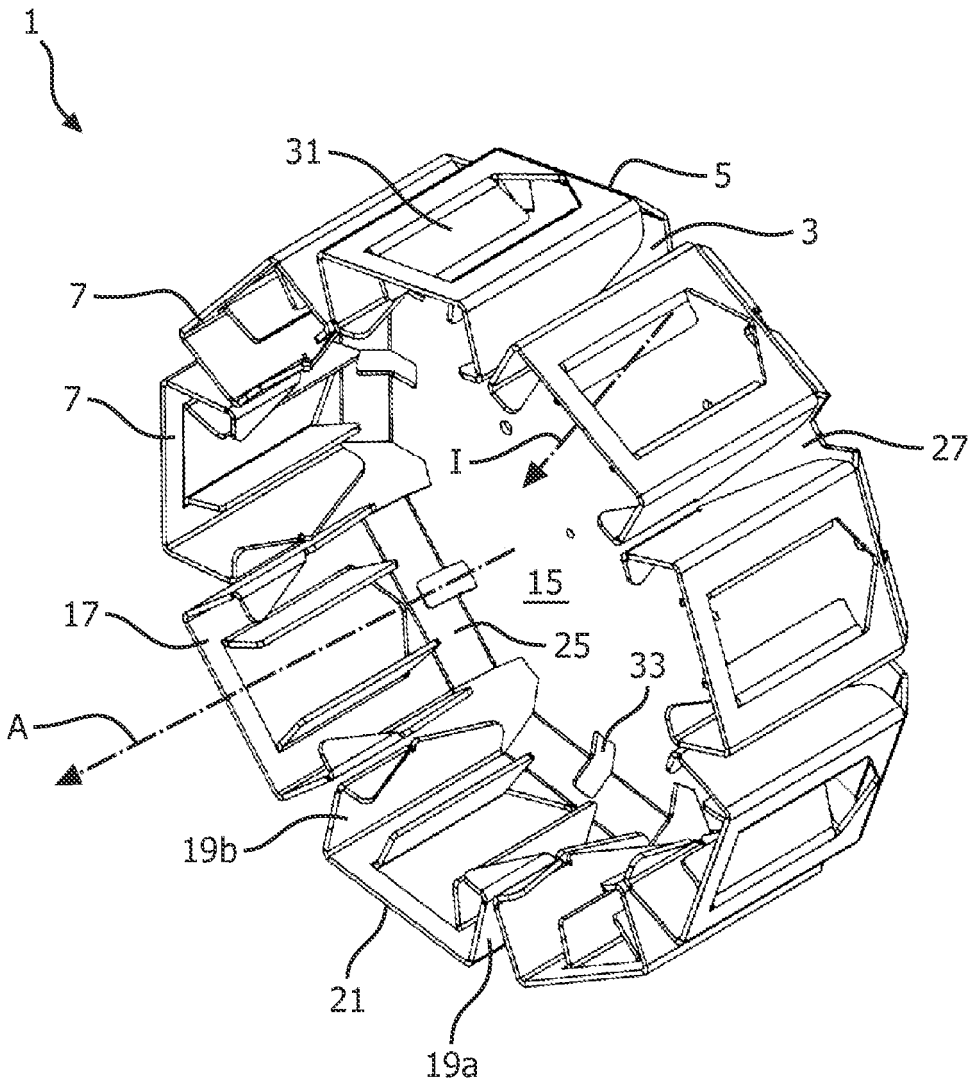


FIG. 10

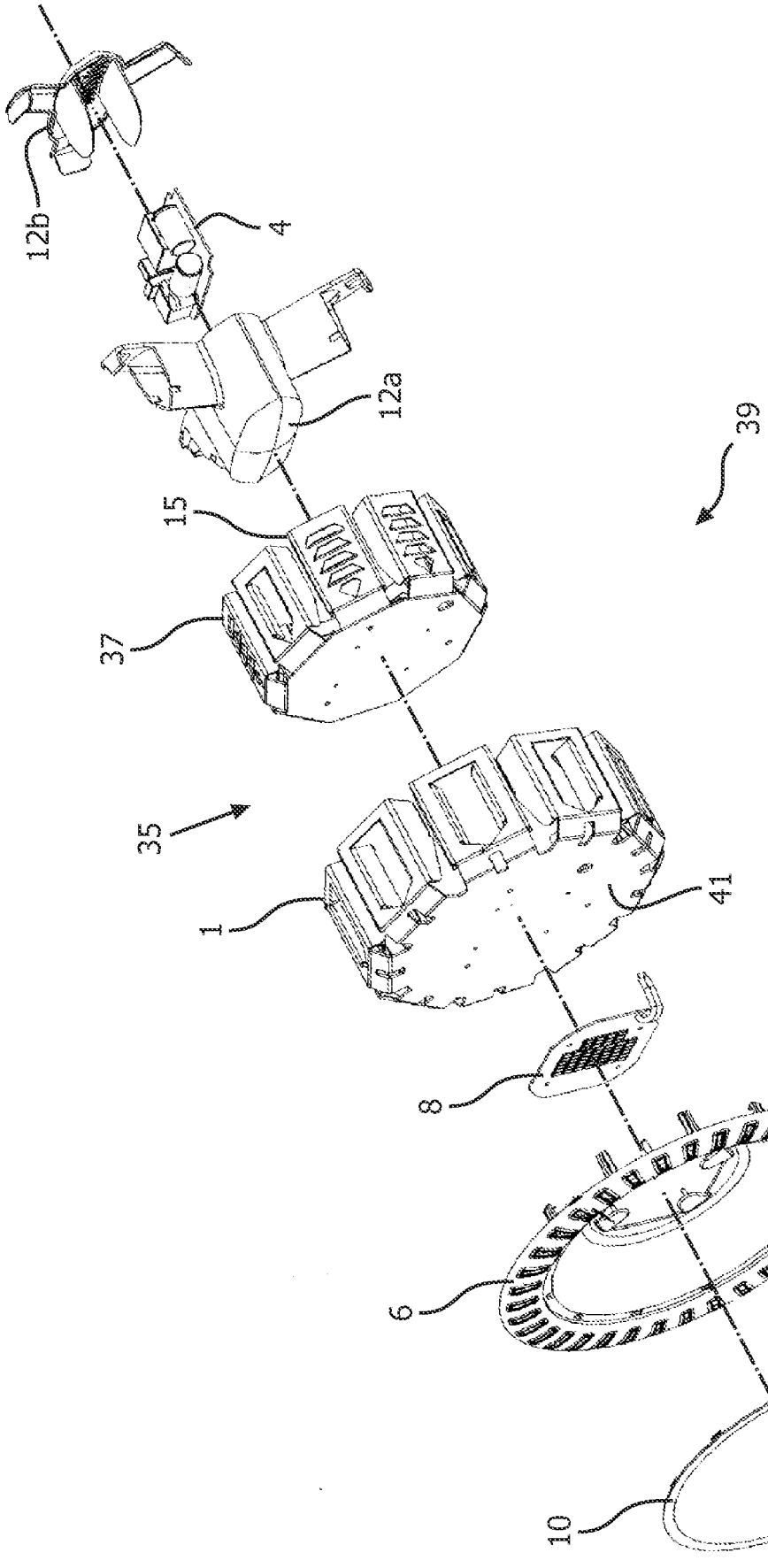


FIG. 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2013/056889

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21V29/00
ADD. F21V23/00 F21Y101/02

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)
F21V F21K F21Y

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.
Y	WO 2011/078507 A2 (CEDIC CO LTD [KR]; CHO JANG-HYUNG [KR]) 30 June 2011 (2011-06-30) figures 1-7 & US 2012/298346 A1 (CHO JANG-HYUNG [KR]) 29 November 2012 (2012-11-29) paragraphs [0036] - [0048], [0053] - [0055], [0063]	1-9, 12-15
Y	US 2010/277067 A1 (MAXIK FREDRIC S [US] ET AL) 4 November 2010 (2010-11-04) figures 1-10	1-9, 12-15
Y	US 2012/195043 A1 (WATANABE HIROYUKI [JP] ET AL) 2 August 2012 (2012-08-02) abstract; figures 6-9	1-9, 12-15

-/--

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

[X] See patent family annex.

* Special categories of cited documents :

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"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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"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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 February 2014	17/02/2014

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	von der Hardt, M

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2013/056889

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	WO 2011/124386 A1 (LEMNIS LIGHTING PATENT HOLDING B V [NL]; ENGELBERTS NORBERTUS [NL]; RO) 13 October 2011 (2011-10-13) cited in the application abstract; figures 1-6	1-15
A	WO 2011/029724 A1 (OSRAM GMBH [DE]; HOETZL GUENTER [DE]; REINGRUBER FABIAN [DE]) 17 March 2011 (2011-03-17) cited in the application abstract; figures 1-19, 13, 14	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2013/056889

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		WO 2011029724 A1	17-03-2011