



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**06.07.2022 Bulletin 2022/27**

(51) International Patent Classification (IPC):  
**F28F 3/02 (2006.01)**

(21) Application number: **20461609.8**

(52) Cooperative Patent Classification (CPC):  
**F28D 7/1684; F28F 1/128; F28F 1/40; F28F 3/027; F28D 2021/0082; F28D 2021/0091; F28F 2215/08**

(22) Date of filing: **29.12.2020**

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

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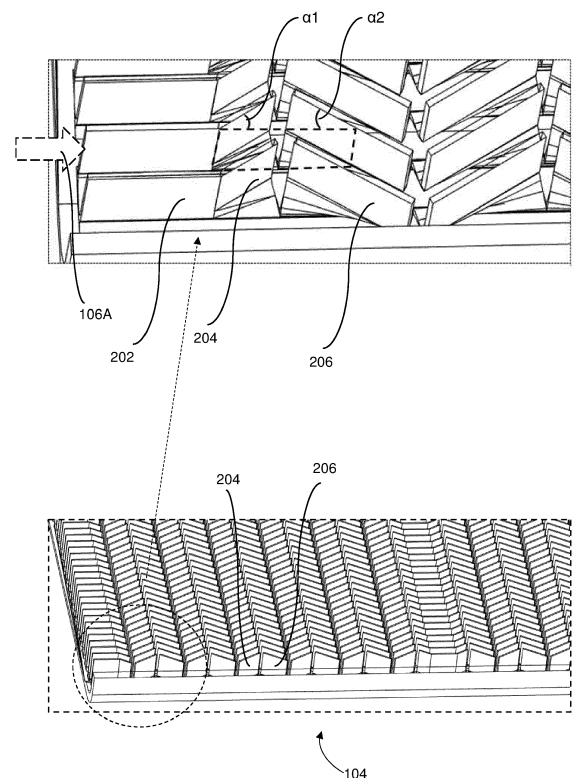
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(54) **HEAT EXCHANGER**

(57) The present invention discloses a heat exchanger for heat exchange between a first fluid and a second fluid. The heat exchanger includes a pair of manifolds, heat exchange tubes and a fin section. The heat exchange tubes are axially extending and providing a fluidal communication between the pair of manifolds for the first fluid. Further, the first fluid flows between the pair of manifolds in the first fluid direction and the second fluid flows between the heat exchange tubes in the second fluid direction perpendicular to the first fluid direction. The fin section includes a first louver section aligned at a first louver angle and a second louver section aligned at the second louver angle. Further, the first and second louver angles are being measured with respect to the intended first fluid flow direction and the second louver angle is different from the first louver angle.



**FIG. 4**

## Description

**[0001]** The present invention relates to a heat exchanger. In particular, the invention relates to the heat exchanger fins having louvers aligned at different angles.

**[0002]** Conventionally, the heat exchanger may comprise two fluid circuits configured to be in a heat exchange configuration. Further, one fluid circuit may be adapted for airflow, and other fluid circuit may be adapted for a coolant. Further, fins are provided in the airflow fluid circuit of the heat exchanger, and in contact with heat exchange tubes to increase heat exchange between the airflow and the coolant. The fins may increase pressure drop of airflow across the heat exchange tubes and the fins are adapted to force the airflow remain in turbulent regime, thereby, increasing heat exchange surface between the air flowing in the airflow fluid circuit and the coolant flowing in another fluid circuit. Further, the fins are provided with louvers to further increase pressure drop across the airflow fluid circuit. The louvers may be formed in a form of small cuts defined on the fins. The louver may be bended along their length to increase air pressure drop across the airflow fluid circuit.

**[0003]** Further, the louvers formed in fins may be in same length and the louvers are angled at same angle throughout the fins, so the pressure drop of the airflow across the core of the heat exchanger is homogenous. Such fins with the homogenous louvers may increase the pressure drop of the airflow at some areas of the heat exchange tubes and may reduce the pressure drop of the airflow at some areas of the heat exchange tubes. As a result, the heat exchange between the airflow and the coolant affected at some areas, thereby causing thermal shock at the heat exchange tubes. For example, the pressure drop of airflow at the inlet area of airflow fluid is more than the rest of area of the tubes. In such case, the heat exchange between the air and the coolant is higher at the inlet area of the airflow fluid circuit than of the outlet area of the airflow fluid circuit. As a result, the heat exchange tubes may undergo high stress and thermal shock due to non-uniform heat exchange between the two fluids and temperature gradient between the inlet area and outlet area of the airflow fluid circuit, thereby causing cracks on the heat exchange tubes and reduce service life of the heat exchanger.

**[0004]** Accordingly, there remains a need for a heat exchanger provided with non-uniform louvers in fins to achieve homogenous pressure drop across the core of the heat exchanger. Further, there remains another need for at least two different louver sections strategically defined on the fins of the heat exchanger that creates heterogeneous pressure drop across the core of the heat exchanger to reach uniform heat exchange between the two fluids across the core and optimize thermal performance of the heat exchanger.

**[0005]** In the present description, some elements or parameters may be indexed, such as a first element and a second element. In this case, unless stated otherwise,

this indexation is only meant to differentiate and name elements which are similar but not identical. No idea of priority should be inferred from such indexation, as these terms may be switched without betraying the invention. Additionally, this indexation does not imply any order in mounting or use of the elements of the invention.

**[0006]** In view of forgoing, the present invention discloses a heat exchanger for heat exchange between a first fluid and a second fluid. The heat exchanger includes a first manifold, a second manifold, and a plurality of heat exchange tubes. The plurality of heat exchange tubes is axially extending and providing a fluidal communication between the first manifold and the second manifold for the first fluid. Further, the first fluid flows from the first manifold to the second manifold in the first fluid direction and the second fluid flows between the heat exchange tubes in the second fluid direction perpendicular to the first fluid direction. The heat exchanger further includes a fin section provided in contact with the heat exchange tubes for facilitating heat exchange between the first fluid and the second fluid. The fin section further comprises at least one first louver section aligned at a first louver angle and at least one second louver section aligned at the second louver angle. Further, the first and second louver angles are being measured with respect to the intended first fluid flow direction and the second louver angle is different from the first louver angle.

**[0007]** In one embodiment, the first louver angle is greater than of the second louver angle.

**[0008]** In another embodiment, first louver angle is smaller than of the second louver angle.

**[0009]** In one example, the first louver section and the second louver section are alternatively formed on the fin section in the direction of the first fluid intended to flow there-through.

**[0010]** In another example, the second louver section is arranged downstream with respect to the first louver section in the direction of the first fluid intended to flow there-through.

**[0011]** Further, the first louver section and the second louver section include louver sets sloping alternately away and towards the fin section in the direction of the first fluid intended to flow there-through.

**[0012]** In one aspect, the heat exchanger includes a plurality of first louver sections and a plurality of second louver sections arranged alternately in the fin section.

**[0013]** Further, the length and width of the first louver section and the second louver section are the same.

**[0014]** In one embodiment, the fin section is provided within at least one heat exchange tube. In such case, the heat exchanger is configured for operation as a water charge air cooler, the first fluid being air and the second fluid being a liquid coolant.

**[0015]** In another embodiment, the fin section is interlaced between adjacent heat exchange tubes. In such case, the heat exchanger is configured for operation as a radiator, the first fluid being a liquid coolant and the second fluid being air.

**[0016]** Other characteristics, details and advantages of the invention can be inferred from the description of the invention hereunder. A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying figures, wherein:

Fig. 1 illustrates a perspective view of a heat exchanger, in accordance with an embodiment of the present invention;

Fig. 2 illustrates a schematic view of the heat exchanger of Fig. 1 without a housing, and showing heat exchange tubes;

Fig. 3 illustrates a cross-sectional view of a standalone heat exchange tube of the heat exchanger of Fig. 2 perpendicularly cut along the longitudinal axis of the heat exchange tube, and depicting the fin section having first and second louver sections aligned at different angles;

Fig. 4 illustrates another cross-sectional view of the heat exchange tube cut along the longitudinal direction of heat exchange tube; and

Figs. 5 and 6 illustrate different cross-sectional views of a standalone heat exchange tube of Fig. 2, in which the first louver sections of the fin section is parallelly aligned with respect to the first fluid flow direction, in accordance with another embodiment of the present invention.

**[0017]** It must be noted that the figures disclose the invention in a detailed enough way to be implemented, said figures helping to better define the invention if needs be. The invention should however not be limited to the embodiment disclosed in the description.

**[0018]** The present invention discloses a heat exchanger provided with specific fin and louvers pattern to achieve uniform heat exchange between two fluid flowing there through. Conventional heat exchanger may include a fin section that is in contact to heat exchange tubes and louvers formed on the fin section. As the louvers formed on the fin section are of same length and angled at same angle throughout the fin section, airflow and pressure drop across the heat exchange tubes are uniform. As temperature of the airflow at an inlet area and an outlet area of the air flow circuit is different and pressure drop across the heat exchange tubes is uniform, heat exchange between two fluids flowing therein is non-uniform. Such non-uniform heat exchange between two fluids can leads to thermal shock on the heat exchange tubes. To overcome such problems, at least two sets of louver sections are formed on the fin section and such set of louver sections are angled at different angles with

respect to the fin section of a heat exchanger, particularly, one set of louvers are aligned at one angle while the other set of louvers are aligned at the another angle. The heat exchanger includes a plurality of heat exchange elements extended between a pair of manifolds, and a fin section in contact with the heat exchange elements. Further, a first fluid flow is defined in between the pair of manifolds, and a second fluid flow is defined in a direction perpendicular to the first fluid flow. In an aspect, the heat exchanger can be configured for operation as a water charge air cooler. In such case, the first fluid is air and second fluid is a liquid coolant. In another aspect, the heat exchanger can be configured for operation as a radiator. In such case, the first fluid is a liquid coolant and the second fluid is air.

**[0019]** Figs. 1 and 2 illustrate schematic views of a heat exchanger 100, in accordance with an embodiment of the present invention. In the present example, Fig. 1 is a perspective view of the heat exchanger 100, and Fig. 2 is a perspective view of the heat exchanger 100 without a housing 102. The heat exchanger 100 includes a first manifold 102A, a second manifold 102B spaced apart from the first manifold 102A and a plurality of heat exchange elements 104. Further, the plurality of heat exchange elements 104 can be heat exchange tubes. The plurality of heat exchange elements 104, hereinafter referred to as heat exchange tubes are axially extending between the first manifold 102A and the second manifold 102B and is providing a fluidic communication between the first manifold 102A and the second manifold 102B. The heat exchanger 100 further includes a housing 102, in which the heat exchange tubes 104 are disposed. In other words, the heat exchange tubes 104 are at least partially enclosed by the housing 102. Further, at least two fluid flows are defined in the housing 102 and are in heat exchange configuration with each other, particularly, a first fluid flow and a second fluid fluidically isolated from the first fluid flow, but thermally coupled with the second fluid flow. Further, the first fluid flow may be defined in a first fluid circuit and the second fluid flow may be defined in a second fluid circuit.

**[0020]** In the present example, the first fluid flows from the first manifold 102A to the second manifold 102B through the heat exchange tubes 104 in the first fluid direction 106A. Further, the first fluid circuit is formed through the heat exchange tubes 104 in such a way the first fluid flows from the first manifold 102A to the second manifold 102B in the first fluid direction 106A. In other example, the first fluid circuit can be formed through the heat exchange tubes 104 in such a way the first fluid flows from the second manifold 102B to the first manifold 102A. The second fluid flows between the heat exchange tubes 104 in the second fluid direction 106B and the second fluid direction 106B is perpendicular to the first fluid direction 106A. Further, the housing 102 defines a path for the second fluid between the heat exchange tubes 104. Further, an inlet and outlet may be connected to housing 102 to introduce and receive the second fluid

to/from the heat exchanger 100.

**[0021]** The heat exchanger 100 further comprises a fin section 202 defined in contact with the heat exchange tubes 104. The fin section 202 having fins is provided in contact with the heat exchange tubes 104 in such a way that the fin section 202 facilitates heat exchange between the first fluid and the second fluid. The fin section 202 is provided in the heat exchanger 100 to increase pressure drop of the airflow flowing there through, so that the thermal performance of the heat exchanger 100 may be increased. In case the heat exchanger 100 is adapted for an operation as charged air coolers, the fin section 202 is disposed within the heat exchange tubes 104. In such case, the first fluid is air and the second fluid a liquid coolant. In case the heat exchanger 100 is adapted for an operation as radiators, the fin section 202 can be interlaced between adjacent heat exchange tubes 104. In such case, the first fluid is a liquid coolant and the second fluid is air.

**[0022]** A term "fin section" may be interpreted as an individual fin. Alternatively, term "fin section" may be interpreted as plurality of identical fins arranged in sequence.

**[0023]** The fin section 202 can be corrugated fins or flat fins. In another example, the fin section 202 can be formed as a weave shaped plate. Further, the fin section 202 includes at least two louver sections. The louver sections can comprise at least one first louver section and at least one second louver section. Further, louvers in the first louver section and the second louver section are different in size and are aligned at different angles. In one example, louvers in the first louver section is aligned at a first angle and louvers in the second louver section aligned at a second angle with respect to the intended first fluid flow direction 106A. The first and second louver sections are not shown in Figs. 1 and 2, and will be discussed with respect to the forthcoming figures. Usually, the fin section 202 is provided with a plurality of first louver sections and a plurality of second louver section to improve heat exchange efficiency thereof.

**[0024]** Figs. 3 and 4 illustrate different cross-section views of a standalone heat exchange tube 104 of the heat exchanger 100 of Fig. 2, in accordance with an embodiment of the present invention. In this example, Fig. 3 illustrates a cross-sectional view of the heat exchange tube 104 perpendicularly cut along the longitudinal axis of the heat exchange tube of Fig. 2, and depicting the first and second louver sections 204, 206 aligned at different angles and Fig. 4 illustrates another cross-sectional view of the heat exchange tube 104 cut along the longitudinal direction of heat exchange tube 104. As discussed above, the fin section 202 includes the at least one first louver section 204 and the at least one second louver section 206. Usually, the fin section 202 may include the plurality of first and second louver sections 204, 206 arranged alternatively in the fin section 202. Further, the first louver sections 204 and the second louver sections 206 include louvers strategically placed in the fin

section 202.

**[0025]** The first louver sections 204 are aligned at a first angle  $\alpha_1$  and the second louver sections 206 are aligned at a second angle  $\alpha_2$  with respect to the intended first fluid flow direction 106A. More specifically, the louvers in the first louver sections 204 are aligned at the first angle  $\alpha_1$  and the louvers in the second louver sections 206 are aligned at the second angle  $\alpha_2$ . In other words, the first louver sections 204 are aligned at a first angle  $\alpha_1$  and the second louver sections 206 are aligned at a second angle  $\alpha_2$  with respect to general axis of extension of the first and second louver sections 204, 206. Further, the first angle  $\alpha_1$  and the second angle  $\alpha_2$  are measured with respect to the first fluid flow direction 106A. The fin section 202 may thus comprise at least one first louver section 204 aligned at a first louver angle  $\alpha_1$  and at least one second louver section 206 aligned at the second louver angle  $\alpha_2$ , wherein the first and second louver angles  $\alpha_1$ ,  $\alpha_2$  are measured with respect to the intended first fluid flow direction 106A, wherein the second louver angle  $\alpha_2$  is different than the first louver angle  $\alpha_1$ , wherein the first and second louver angles  $\alpha_1$ ,  $\alpha_2$  are measured with respect to the intended first fluid flow direction 106A, the first louver angle  $\alpha_1$  corresponding to the first louver section 204 being located earlier within the fluid flow in which the fin section 204 is intended to be located than the second angle  $\alpha_2$  corresponding to the second louver section 206 being located. In one embodiment, the second louver angle  $\alpha_2$  of the second louver sections 206 is different from the first louver angle  $\alpha_1$  of the first louver sections 204. For example, the louvers in the first louver sections 204 may be aligned at angle ranging of 0 to 45 degree with respect to the fin section 202 and the louvers in the second louver sections 206 may be angled at range of 10 to 45 degree with the fin section 202. In this embodiment, the fin section 202 is corrugated fins having lateral walls extending along the heat exchange tubes 104. The first louver sections 204 and second louver sections 206 are formed on both the lateral walls of the fin section 202.

**[0026]** In the preferred embodiment, the first louver angle  $\alpha_1$  of the first louver section 204 is smaller than the second louver angle  $\alpha_2$  of the second louver section 206, wherein the first and second louver angles  $\alpha_1$ ,  $\alpha_2$  are measured with respect to the intended first fluid flow direction 106A, the first louver angle  $\alpha_1$  corresponding to the first louver section 204 being located earlier within the fluid flow in which the fin section 204 is intended to be located than the second angle  $\alpha_2$  corresponding to the second louver section 206 being located later within the fluid flow in which the fin section 204 is intended to be located. As shown in Fig. 4, the first louver angle  $\alpha_1$  and the second louver angle  $\alpha_2$  are measured with respect to the first fluid flow direction 106A. Also it is evident from Fig. 4, the first louver angle  $\alpha_1$  of the first louver sections 204 is smaller than the second louver angle  $\alpha_2$  of the second louver sections 206. Alternatively, the first louver angle  $\alpha_1$  of the first louver sections 204 can be

equal to the second louver angle  $\alpha_2$  of the second louver sections 206. Alternatively, the first louver angle  $\alpha_1$  of the first louver sections 204 can be greater than the second louver angle  $\alpha_2$  of the second louver sections 206. Therefore, pressure drop of the first fluid across the heat exchange tubes 104 may be non-uniform, thereby increasing heat exchange surface between the first fluid and the second fluid.

**[0027]** In a preferred embodiment, the first louver sections 204 and the second louver sections 206 are alternatively formed on the fin section 202 in the first fluid flow direction 106A. In another embodiment, the second louver sections 206 is arranged downstream with respect to the first louver sections 204 in the first fluid flow direction 106A. Here the first fluid flow direction 106A is a direction in which the first fluid intended to flow there-through.

**[0028]** Figs. 5 and 6 illustrate different cross-sectional views of the standalone heat exchange tube 104 of Fig. 1, in which the first louver sections 204 of the fin section 202 is parallelly aligned with respect to the first fluid flow direction 106A, in accordance with another embodiment of the present invention. In this embodiment, the first louver sections 102 are aligned along the longitudinal direction the fin section 202. In other words, the first louver angle  $\alpha_1$  of the first louver sections 204 is approximately 0 degree with respect to the longitudinal axis of the heat exchange tube 104. Further, the second louver sections 206 are angled at the second louver angle  $\alpha_2$  throughout the fin section 202. In the preferred embodiment, the louvers in the first louver sections 204 and the second louver sections 206 are formed as rectangular angled slats sloping in a direction along the first fluid flow and in a direction opposite to the first fluid flow.

**[0029]** As shown in Fig. 4, the first louver sections 204 include louver sets sloping away and towards the fin section 202 in the direction of the first fluid flow direction 106A. In one example, the first louver sections 204 are sloping in a direction of the first fluid flow 106A and the second louver sections 206 are sloping in a direction opposite to the first fluid flow 106A. In another example, the first louver sections 204 are sloping in a direction opposite to the first fluid flow 106A and the second louver sections 206 are sloping in a direction of the first fluid flow 106A. In yet another example, both the first and second louver sections 204, 206 are either sloping in a direction of the first fluid flow 106A or sloping in a direction opposite to the first fluid flow 106A. In a preferred embodiment, a set of louvers in the first louver section 204 may be sloped in a direction of the first fluid flow 106A and another set of louvers in the first louver sections 204 may be sloped in a direction opposite to the first fluid flow 106A. Similarly, a set of louvers in the second louver sections 206 may be sloped in a direction of the first fluid flow 106A and another set of louvers in the in the second louver sections 206 may be sloped in a direction opposite to the first fluid flow 106A. Alternatively, the first louver sections 204 formed on a lateral wall of the fin section 204 is sloping

in a direction of the first fluid flow 106A and the first louver sections 204 formed on the other lateral wall of the fin section 202 is sloping in a direction opposite to the first fluid flow 106A.

**[0030]** Further, the louvers in the first louver sections 204 and the second louver sections 206 are of different sizes, particularly, the length of louvers in the first louver sections 204 is different from the length of louvers in the second louver sections 206. In the preferred embodiment, the louver length of the first louver sections 204 is equal to the louver length of the second louver sections 206, when the length is measure along the general axis "P1" of extension of the first louver sections 204 and the second louver sections 206. Alternatively, the louver length of the first louver sections 204 can be smaller than of the louver length of the second louver sections 206 when the length is measured along the general axis "P1" of extension of the first louver sections 204 and the second louver sections 206. Alternatively, the louver length of the first louver sections 204 can be bigger than of the louver length of the second louver sections 206 when the length is measured along the general axis "P1" of extension of the first louver sections 204 and the second louver sections 206.

**[0031]** In a preferred embodiment, the number of louvers in the first louver sections 204 is equal to the number of louvers in the second louver sections 206. Alternatively, the number of louvers in the first louver sections 204 is greater than the number of louvers in the second louver sections 206. Alternatively, the number of louvers in the first louver sections 204 is smaller than the number of louvers in the second louver sections 206.

**[0032]** Further, the louvers in the first louver sections 204 and the second louver sections 206 are of different sizes, particularly, the width of louvers the first louver sections 204 is different from the width of louvers in the second louver sections 206. The width of the louver may be measured in substantially perpendicular direction with respect to the elongation direction of the louver. In the preferred embodiment, the width of louvers in the first louver sections 204 is equal to the width of louvers in the second louver sections 206. Alternatively, the width of louvers in the first louver sections 204 can be smaller than of the width of louvers in the second louver sections 206. Alternatively, the width of louvers in the first louver sections 204 can be bigger than of the width of louvers in the second louver sections 206.

**[0033]** As the first and second louver sections 204, 206 are aligned at different angles, the pressure drop across the heat exchange tubes 104 are uniform, thereby the heat exchange between the first fluid and the second fluid are uniform. As a result, the thermal performance of the heat exchanger 100 is increased and eliminating damages of the heat exchange tubes 104 due to high stress and thermal shock experiencing on the heat exchange tubes 104.

**[0034]** In any case, the invention cannot and should not be limited to the embodiments specifically described

in this document, as other embodiments might exist. The invention shall spread to any equivalent means and any technically operating combination of means.

## Claims

1. A heat exchanger (100) for heat exchange between a first fluid and a second fluid, comprising:

a first manifold (102A) and a second manifold (102B);

a plurality of heat exchange tubes (104) axially extending and providing a fluidal communication between the first manifold (102A) and the second manifold (102B) for the first fluid, wherein the first fluid flows from the first manifold (102A) to the second manifold (102B) in the first fluid direction (106A) and the second fluid flows between the heat exchange tubes (104) in the second fluid direction (106B) substantially perpendicular to the first fluid direction (106A); and a fin section (202) in contact with the heat exchange tubes (104) for facilitating heat exchange between the first fluid and the second fluid, **characterized in that** the fin section (202) further comprises:

at least one first louver section (204) aligned at a first louver angle ( $\alpha_1$ ) and at least one second louver section (206) aligned at the second louver angle ( $\alpha_2$ ), wherein the first and second louver angles ( $\alpha_1$ ,  $\alpha_2$ ) are measured with respect to the intended first fluid flow direction (106A), wherein the second louver angle ( $\alpha_2$ ) is different than the first louver angle ( $\alpha_1$ ).

2. The heat exchanger (100) as claimed in claim 1, wherein the first louver angle ( $\alpha_1$ ) is greater than the second louver angle ( $\alpha_2$ ), wherein the first and second louver angles ( $\alpha_1$ ,  $\alpha_2$ ) are measured with respect to the intended first fluid flow direction (106A), the first louver angle ( $\alpha_1$ ) corresponding to the first louver section (204) being located earlier within the fluid flow in which the fin section (204) is intended to be located than the second angle ( $\alpha_2$ ) corresponding to the second louver section (206) being located later within the fluid flow in which the fin section (204) is intended to be located.

3. The heat exchanger (100) as claimed in claim 1, wherein the first louver angle ( $\alpha_1$ ) is smaller than of the second louver angle ( $\alpha_2$ ), wherein the first and second louver angles ( $\alpha_1$ ,  $\alpha_2$ ) are measured with respect to the intended first fluid flow direction (106A), the first louver angle ( $\alpha_1$ ) corresponding to the first louver section (204) being located earlier within the fluid flow in which the fin section (204) is intended to be located than the second angle ( $\alpha_2$ )

corresponding to the second louver section (206) being located later within the fluid flow in which the fin section (204) is intended to be located.

4. The heat exchanger (100) as claimed in claim 3, wherein the first louver angle ( $\alpha_1$ ) of the first louver section (204) is selected, so that at least one individual louver within the first louver section (204) is parallel to the intended fluid flow direction.

5. The heat exchanger (100) as claimed in any of the preceding claims, wherein the first louver section (204) and the second louver section (206) are alternately formed on the fin section (202) in the direction of the first fluid intended to flow there-through.

6. The heat exchanger (100) as claimed in any of the claims 1 to 5, wherein the second louver section (204) is arranged downstream with respect to the first louver section (204) in the direction of the first fluid intended to flow there-through.

7. The heat exchanger (100) as claimed in any of the preceding claims, wherein the first louver section (204) and the second louver section (206) comprise louver sets sloping alternately in substantially opposite directions.

8. The heat exchanger (100) as claimed in any of the preceding claims, wherein a length and a width of the first louver section (204) and the second louver section (206) are the same.

9. The heat exchanger (100) according to any preceding claim, wherein the fin section (202) is provided within at least one heat exchange tube (104).

10. The heat exchanger (100) according to claim 9, wherein the heat exchanger (100) is configured for operation as a water charge air cooler, the first fluid being air and the second fluid being a liquid coolant.

11. The heat exchanger (100) according to any of claims 1-9, wherein the fin section (202) is interlaced between adjacent heat exchange tubes (104).

12. The heat exchanger (100) according to claim 11, wherein the heat exchanger (100) is configured for operation as a radiator, the first fluid being a liquid coolant and the second fluid being air.

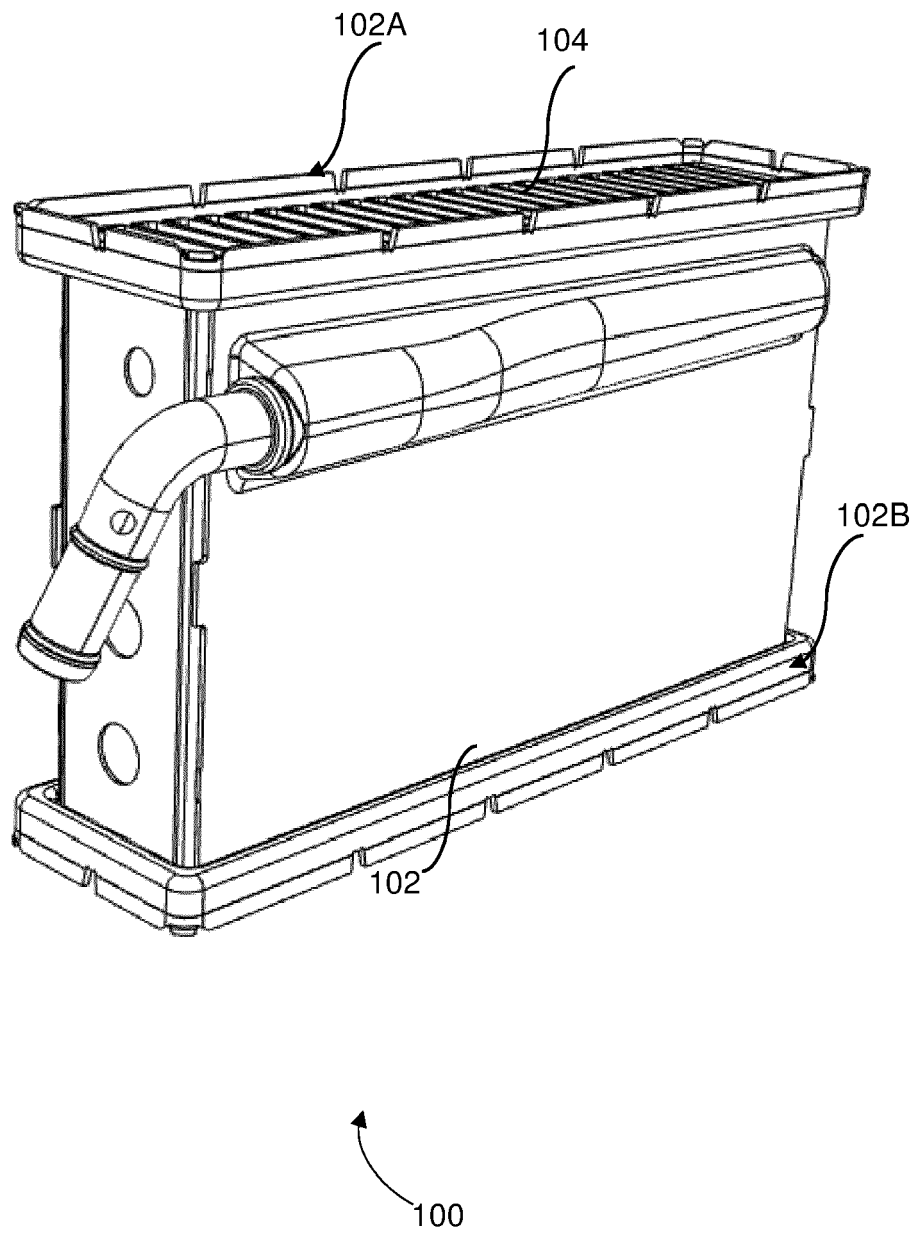


FIG. 1

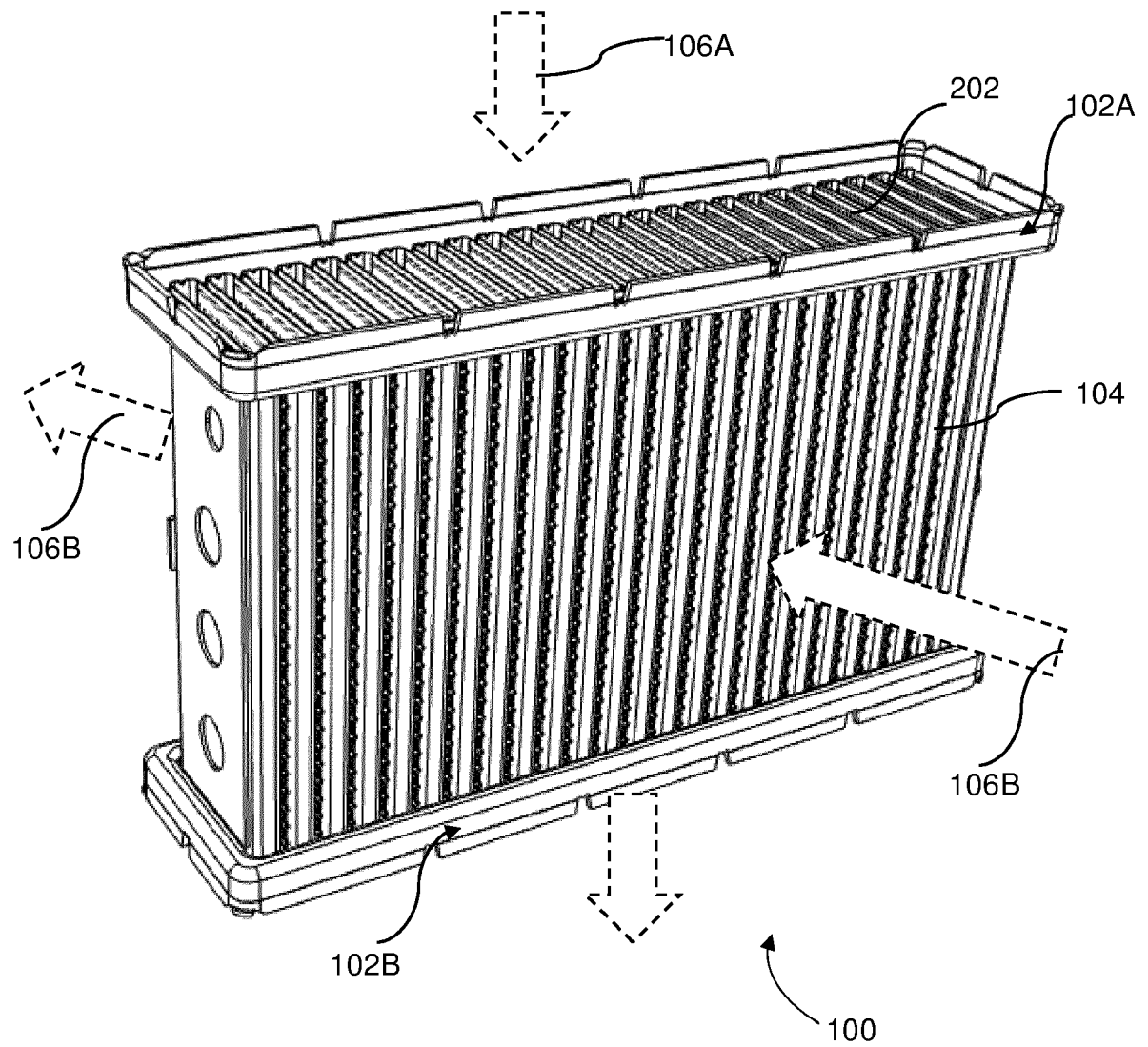


FIG. 2

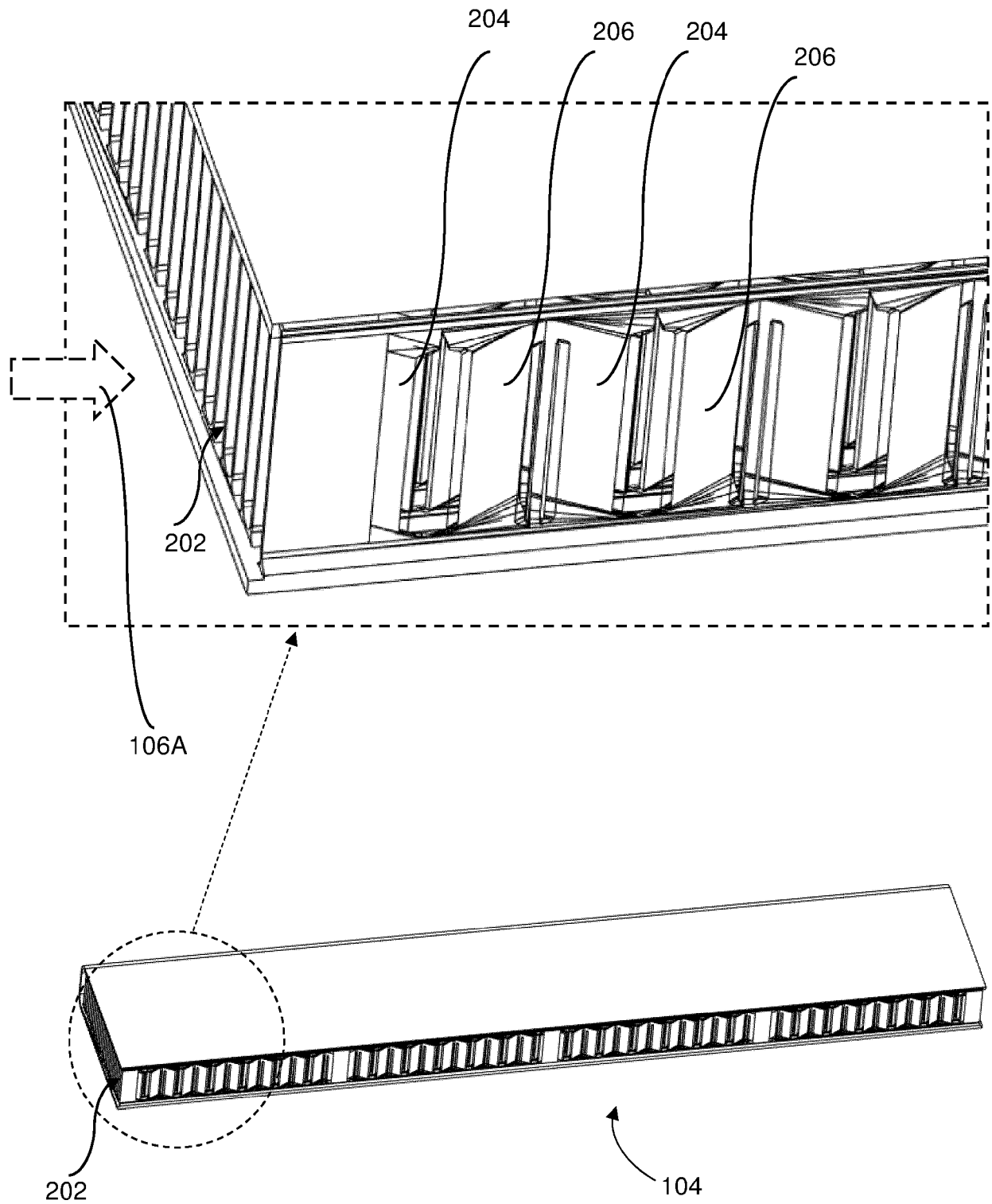


FIG. 3

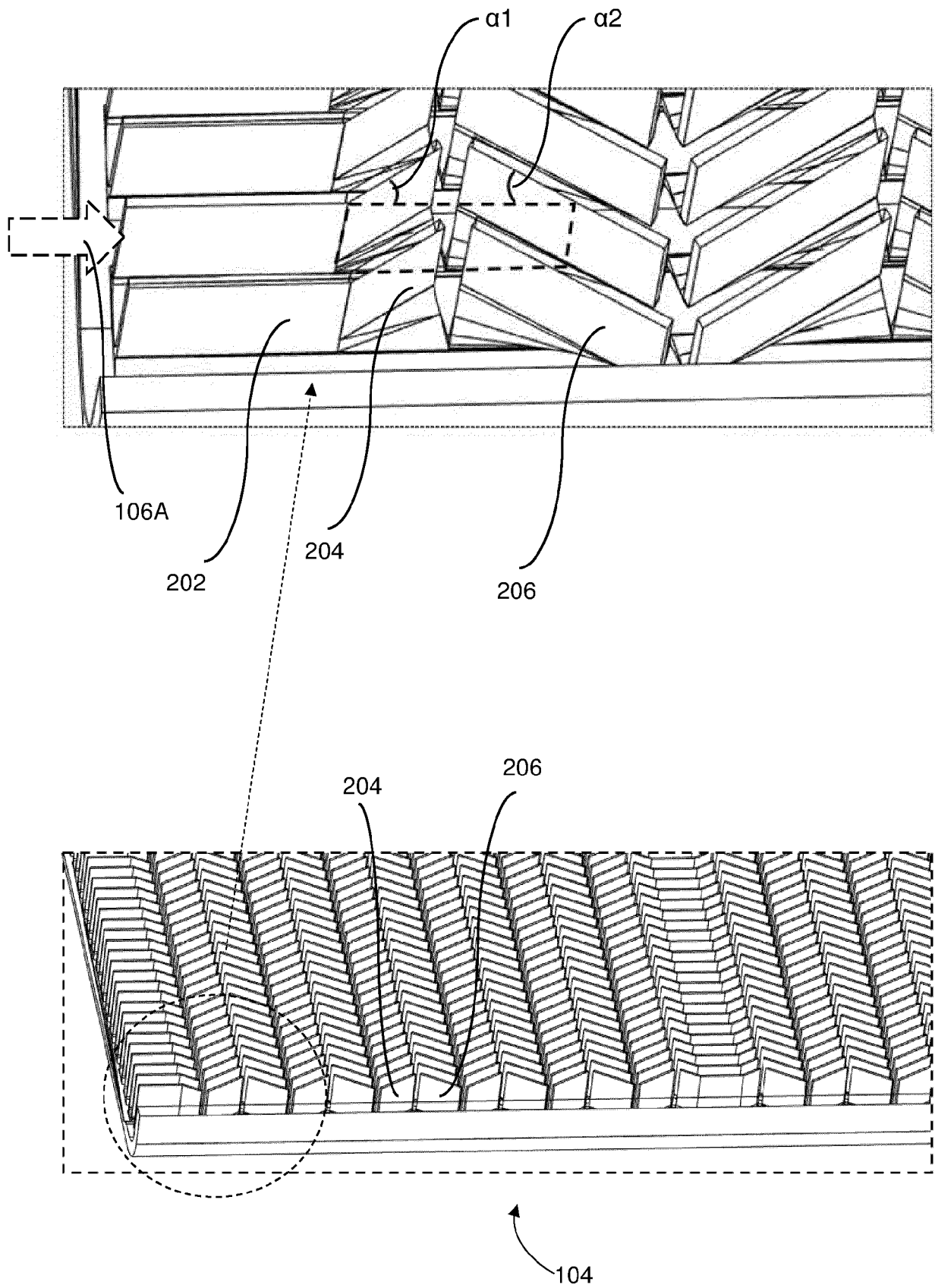


FIG. 4

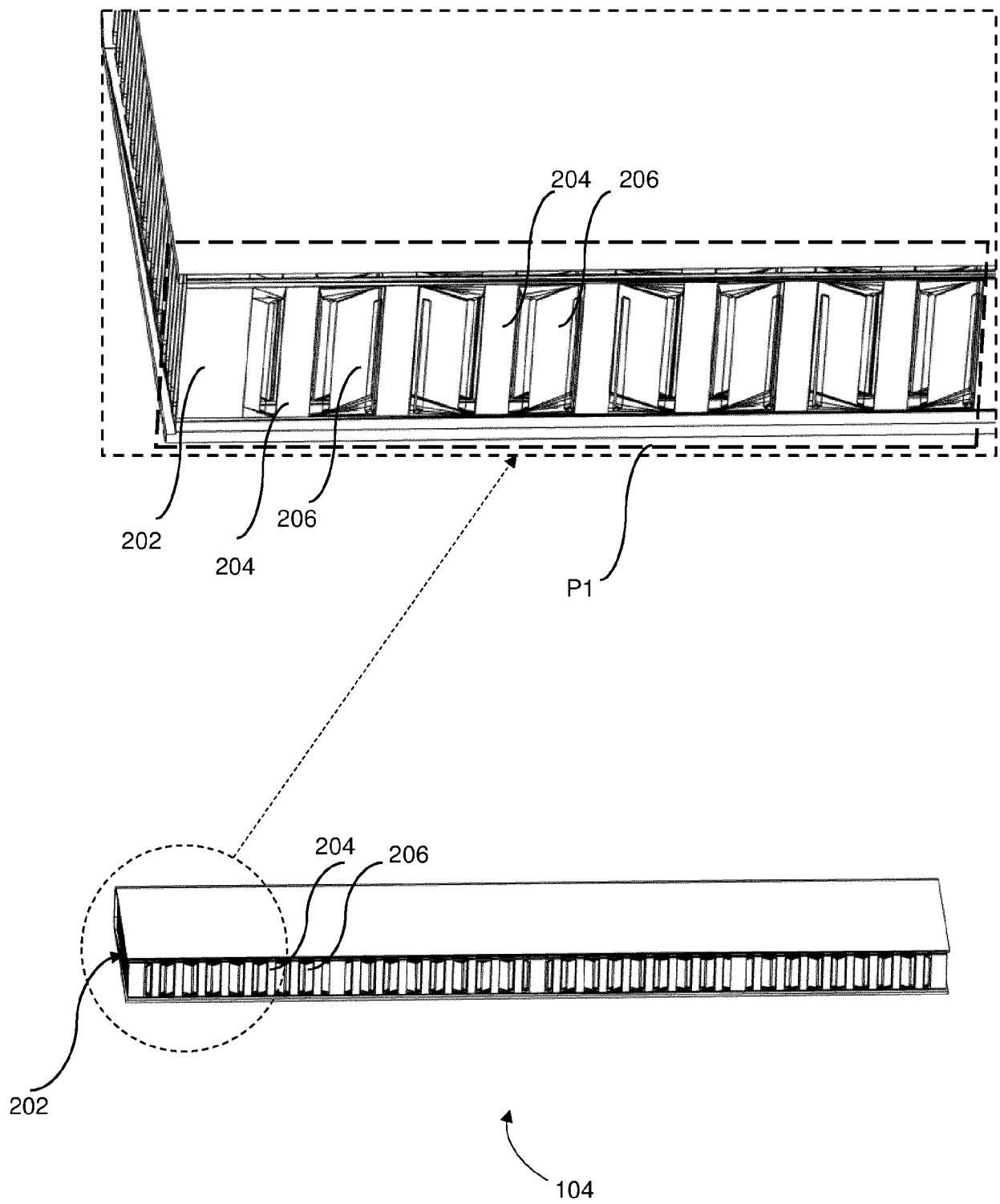


FIG. 5

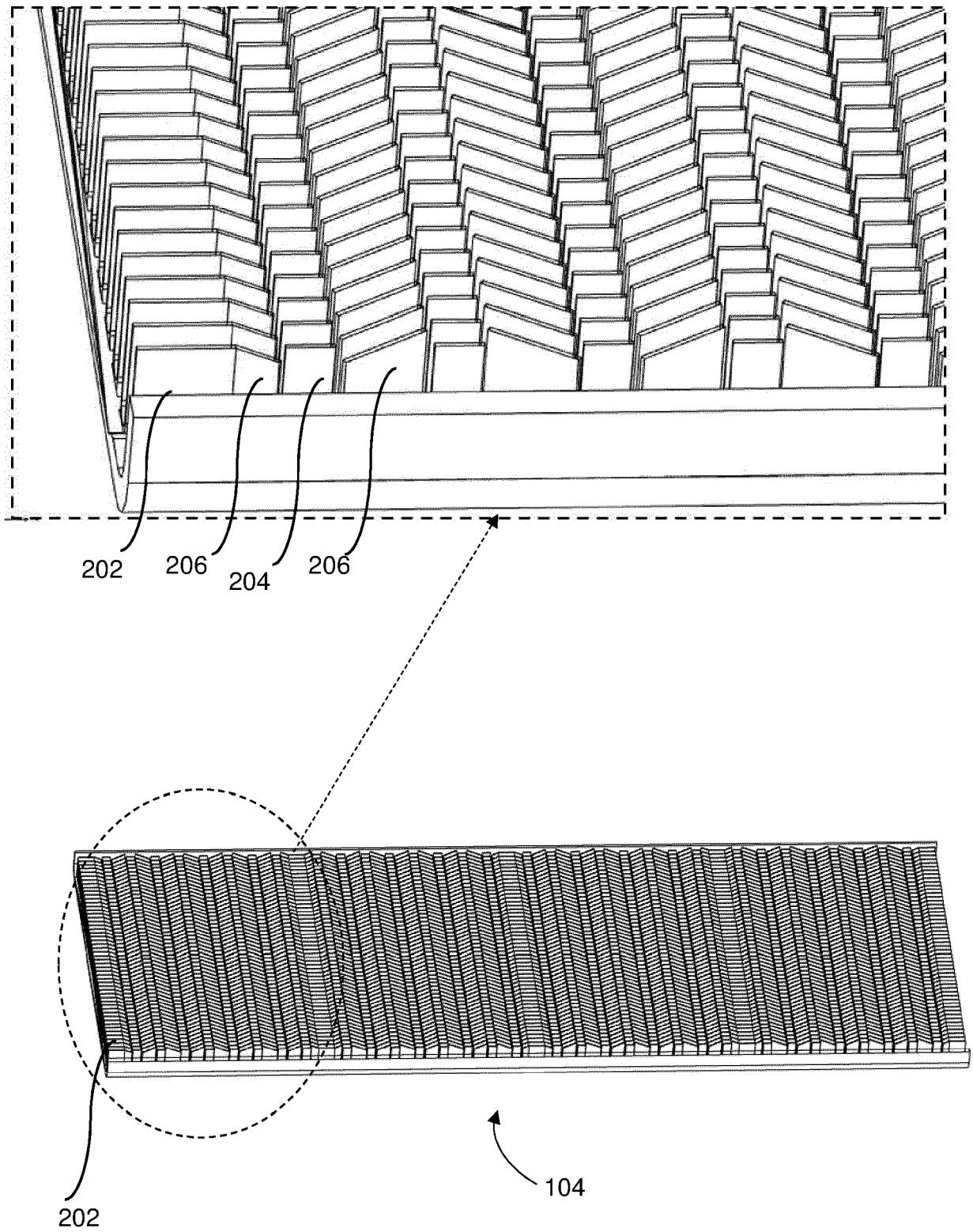


FIG. 6



## EUROPEAN SEARCH REPORT

Application Number  
EP 20 46 1609

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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                             |                                                          |                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-----------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Citation of document with indication, where appropriate, of relevant passages                                               | Relevant to claim                                        | CLASSIFICATION OF THE APPLICATION (IPC) |
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