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(54) **HEAT EXCHANGER**

(57) A heat exchanger (100), the heat exchanger (100) comprising: a plurality of heat exchange tubes (1) arranged in a first direction and extending in a second direction perpendicular to the first direction; and a plurality of fins (2) provided between every two adjacent heat exchange tubes (1) and in contact with one another, each fin (2) comprising a curved surface portion. The heat exchanger is able to increase the heat exchange area.

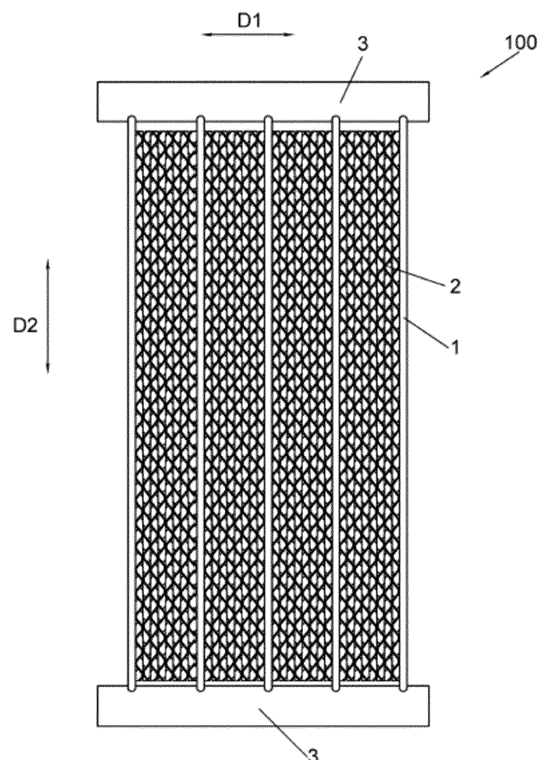


Fig. 1

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Description

Cross-reference to related application

[0001] The present application claims the rights and interests of Chinese patent application no. 201811632359.5 submitted to the Chinese Patent Office on December 28, 2018, the entire disclosed contents of which are incorporated herein by reference.

Technical Field

[0002] The embodiments of the present invention relate to a heat exchanger.

Background

[0003] In conventional heat exchangers, usually only one corrugated fin is arranged between two adjacent heat exchange tubes.

Summary of the Invention

[0004] The object of the embodiments of the present invention is to provide a heat exchanger, which can increase the heat exchange area, for example.

[0005] According to an embodiment of the present invention, a heat exchanger is provided, comprising: a plurality of heat exchange tubes arranged in a first direction and extending in a second direction perpendicular to the first direction; and a plurality of fins arranged between two adjacent heat exchange tubes and in contact with each other, the fin comprising a curved-surface portion.

[0006] According to an embodiment of the present invention, the second direction and a third direction perpendicular to the first direction and the second direction define a reference plane; in at least one of two mutually perpendicular cross sections perpendicular to the reference plane, the curved-surface portion has a curved-line shape.

[0007] According to an embodiment of the present invention, the curved-surface portion is formed by a plurality of planar portions.

[0008] According to an embodiment of the present invention, the curved-surface portion of the fin has a smaller curvature at one side in the third direction of the heat exchanger than at the other side in the third direction of the heat exchanger; and/or the curved-surface portion of the fin has a smaller curvature at one side in the second direction of the heat exchanger than at the other side in the second direction of the heat exchanger.

[0009] According to an embodiment of the present invention, the curvature of the curved-surface portion of the fin gradually increases from one side in the third direction of the heat exchanger to the other side in the third direction of the heat exchanger; and/or the curvature of the curved-surface portion of the fin gradually increases from one side in the second direction of the heat exchanger

to the other side in the second direction of the heat exchanger.

[0010] According to an embodiment of the present invention, the curvature of the curved-surface portion of the fin is zero at said one side in the third direction of the heat exchanger; and/or the curvature of the curved-surface portion of the fin is zero at said one side in the second direction of the heat exchanger.

[0011] According to an embodiment of the present invention, the curved-surface portion of the fin has a corrugated shape and comprises alternately arranged strip-shaped ridges and troughs.

[0012] According to the embodiment of the present invention, mutually contacting ridges of the curved-surface portions of two adjacent fins cross over each other.

[0013] According to an embodiment of the present invention, when viewed in the first direction, mutually contacting ridges of the curved-surface portions of two adjacent fins are arranged symmetrically with respect to a plane defined by the first direction and the second direction.

[0014] According to an embodiment of the present invention, when viewed in the first direction, the curved-surface portion of the fin has an I-shape, a V-shape, a W-shape, a C-shape or an L-shape.

[0015] According to an embodiment of the present invention, the curved-surface portion of the fin has a bumpy shape and comprises multiple rows of discrete protrusions and multiple rows of discrete depressions.

[0016] According to an embodiment of the present invention, protrusions of the curved-surface portions of two adjacent fins are in contact with each other.

[0017] According to an embodiment of the present invention, adjacent fins between two adjacent heat exchange tubes are spaced apart at one side in the third direction of the heat exchanger; and/or adjacent fins between two adjacent heat exchange tubes are spaced apart at one side in the second direction of the heat exchanger.

[0018] The heat exchanger according to the embodiments of the present invention can increase the heat exchange area, for example.

Brief Description of the Drawings

[0019]

Fig. 1 is a schematic diagram of a heat exchanger according to an embodiment of the present invention;

Fig. 2 is a schematic three-dimensional view of a fin according to a first embodiment of the present invention;

Fig. 3 is a schematic three-dimensional view of a fin according to a second embodiment of the present invention;

Fig. 4 is a schematic three-dimensional view of a fin according to a third embodiment of the present invention.

vention;

Fig. 5 is a schematic partial enlarged three-dimensional view of a heat exchanger according to the third embodiment of the present invention;

Fig. 6 is a schematic three-dimensional view of a fin according to a fourth embodiment of the present invention; and

Fig. 7 is a schematic partial enlarged three-dimensional view of a heat exchanger according to the fourth embodiment of the present invention.

Detailed Description of the Invention

[0020] The present invention is explained further below in conjunction with the drawings and particular embodiments.

[0021] Referring to Figs. 1 to 7, a heat exchanger 100 according to an embodiment of the present invention comprises: a plurality of heat exchange tubes 1 arranged in a first direction D1 and extending in a second direction D2 perpendicular to the first direction D1; and a plurality of fins 2 arranged between two adjacent heat exchange tubes 1 and in contact with each other, the fin 2 comprising a curved-surface portion 20. The heat exchanger 100 further comprises headers 3; the heat exchange tubes 1 are connected between the two headers 3, and are in fluid communication with the two headers 3. The heat exchange tubes 1 may be flat tubes. The fins 2 extend in the second direction D2, and are parallel to the heat exchange tubes 1. The fins 2 have a plate-like shape. The entire fin 2 may be the curved-surface portion 20. The heat exchanger in an embodiment of the present invention can, for example, increase the heat exchange area, and can also increase the turbulence of the fluid (for example, wind) by disturbing flow, so as to enhance heat exchange.

[0022] Referring to Figs. 1 to 7, according to an embodiment of the present invention, the second direction D2 and a third direction D3 perpendicular to the first direction D1 and the second direction D2 define a reference plane, and in at least one of two mutually perpendicular cross sections perpendicular to the reference plane, the curved-surface portion 20 has a curved-line shape. The curved-surface portion 20 may be formed by a plurality of planar portions, for example, by a plurality of small planar portions.

[0023] Referring to Figs. 1 and 2, according to an embodiment of the present invention, the curved-surface portion 20 of the fin 2 has a smaller curvature at one side in the third direction D3 of the heat exchanger 100 than at the other side in the third direction D3 of the heat exchanger 100; and/or the curved-surface portion 20 of the fin 2 has a smaller curvature at one side in the second direction D2 of the heat exchanger 100 than at the other side in the second direction D2 of the heat exchanger 100. According to an example of the present invention, the curvature of the curved-surface portion 20 of the fin 2 gradually increases from one side in the third direction

D3 of the heat exchanger 100 to the other side in the third direction D3 of the heat exchanger 100; and/or the curvature of the curved-surface portion 20 of the fin 2 gradually increases from one side in the second direction D2 of the heat exchanger 100 to the other side in the second direction D2 of the heat exchanger 100. For example, the curvature of the curved-surface portion 20 of the fin 2 is zero at said one side in the third direction D3 of the heat exchanger 100; and/or the curvature of the curved-surface portion 20 of the fin 2 is zero at said one side in the second direction D2 of the heat exchanger 100.

[0024] Referring to Figs. 1 and 2, according to an embodiment of the present invention, adjacent fins 2 between two adjacent heat exchange tubes 1 are not connected to each other or are spaced apart at one side in the third direction D3 of the heat exchanger 100; and/or adjacent fins 2 between two adjacent heat exchange tubes 1 are not connected to each other or are spaced apart at one side in the second direction D2 of the heat exchanger 100.

[0025] Referring to Figs. 1 and 2, according to an embodiment of the present invention, a curved surface parameter of the fin 2 varies on a single fin 2, or varies among multiple fins 2; referring to Figs. 1 and 2, at one side in the third direction D3 of the heat exchanger 100, such as the windward side, the curvature of the fin 2 is small, and can be as small as 0, i.e. planar. From the windward side to the leeward side (the other side in the third direction D3 of the heat exchanger 100), the curvature increases. In this way, the windward side is not easily blocked by frost, so the defrost cycle is increased while facilitating water drainage. The windward sides of adjacent fins 2 may not be connected together, i.e. they may be spaced apart. When the heat exchange tubes 100 are placed approximately vertically (when the heat exchanger 100 is placed as shown in Fig. 1), the curvature at the bottom (one side in the second direction D2 of the heat exchanger 100) is small, and can be as small as 0, i.e. planar. This facilitates water drainage at the bottom. The bottoms of adjacent fins may not be connected to each other, that is, they may be spaced apart.

[0026] Referring to Figs. 2 to 5, according to an embodiment of the present invention, the curved-surface portion 20 of the fin 2 has a corrugated shape and comprises alternately arranged strip-shaped ridges 21 and troughs 22. A ridge 21 when viewed from one side in the first direction D1 of the fin 2 is a trough 22 when viewed from the other side in the first direction D1 of the fin 2.

[0027] Referring to Fig. 3, according to an embodiment of the present invention, the fin 2 is provided with an opening 25, which may be an opening formed by removing material, an opening with a flange, or a window-like opening, etc. By breaking the boundary layer when fluid is flowing, the thickness of the boundary layer is reduced, and the effect of improving heat exchange is achieved.

[0028] Referring to Figs. 4 and 5, according to an embodiment of the present invention, mutually contacting

ridges 21 of the curved-surface portions 20 of two adjacent fins 2 cross over each other. For example, when viewed in the first direction D1, the mutually contacting ridges 21 of the curved-surface portions 20 of two adjacent fins 2 are arranged symmetrically with respect to a plane defined by the first direction D1 and the second direction D2. When viewed in the first direction D1, the curved-surface portion 20 of the fin 2 may have an I-shape, a V-shape, a W-shape, a C-shape or an L-shape, etc.

[0029] Referring to Figs. 4 and 5, according to an embodiment of the present invention, the fins 2 may be connected to each other by means of protruding parts on the fins 2. For example, the fin 2 has a corrugated pattern comprising the ridges 21 and troughs 22. Adjacent fins 2 are connected, and the ridges 21 (or troughs 22) of two adjacent fins 2 cross over each other to form channels between the adjacent fins 2, so that wind can pass through the channels and exchange heat with the fins. When the heat exchanger 100 is placed as shown in Fig. 1, condensed water can be discharged from the bottom of the fins 2 along the channels. The curved-surface portion 20 of the fin 2 has a corrugated shape, wherein the waves are periodic. The ridge 21 and the trough 22 may both extend in one direction, or each ridge 21 and trough 22 is composed of a plurality of linear parts. The wave dimensions (period size, wave height, angle, etc.) on each wave can be different. On a single fin 20, the wave dimensions of two adjacent fins 20 may also be different. Relative to the third direction, mutually contacting ridges 21 (or troughs 22) of two adjacent fins 2 are symmetrically arranged.

[0030] Referring to Figs. 6 and 7, according to an embodiment of the present invention, the curved-surface portion 20 of the fin 2 has a bumpy shape and comprises multiple rows of discrete protrusions 23 and multiple rows of discrete depressions 24. Protrusions 23 of the curved-surface portions 20 of two adjacent fins 2 are in contact with each other. The protrusions 23 may comprise at least one of a drop-shaped protrusion, a crescent-shaped protrusion and a round protrusion. A protrusion 23 when viewed from one side in the first direction D1 of the fin 2 is a depression 24 when viewed from the other side in the first direction D1 of the fin 2. There can be a smooth transition between the tops of adjacent protrusions 23 and depressions 24; that is to say, transitional surfaces connecting the tops of the protrusions 23 and the tops of the depressions 24 can be smooth curved surfaces.

[0031] Referring to Figs. 6 and 7, according to an embodiment of the present invention, the protrusions 23 of the curved-surface portions 20 that are in contact with each other are arranged to be staggered or arranged in parallel. The protrusions 23 may be streamlined; for example, the protrusions 23 at the windward side are larger than the protrusions 23 at the leeward side. The dimensions of the protrusions 23 vary on a single fin 2, e.g. the height, size, density, etc. of the protrusions. The dimensions of the protrusions 23 on the plurality of fins 2 may

also vary.

[0032] The fin 2 can also be provided with another connecting member to connect the adjacent fin 2 or the heat exchange tube 1. In addition, a protruding curved-surface connecting member can be further formed on the fin 2. At least one side surface of at least a portion of the fins is provided with a connecting member for connecting the adjacent fin 2 or the heat exchange tube 1. The connecting member can be a protrusion further punched out on the fin 2, or a flange (L-shaped flange, O-shaped flange, etc.), a bridging piece, etc., or a combination thereof. The flange of the opening in Fig. 3 can also act as a connecting member.

Claims

1. A heat exchanger, comprising:

a plurality of heat exchange tubes arranged in a first direction and extending in a second direction perpendicular to the first direction; and
a plurality of fins arranged between two adjacent heat exchange tubes and in contact with each other, the fin comprising a curved-surface portion.

2. The heat exchanger as claimed in claim 1, wherein: the second direction and a third direction perpendicular to the first direction and the second direction define a reference plane; in at least one of two mutually perpendicular cross sections perpendicular to the reference plane, the curved-surface portion has a curved-line shape.

3. The heat exchanger as claimed in claim 1, wherein: the curved-surface portion is formed by a plurality of planar portions.

4. The heat exchanger as claimed in claim 2, wherein:

the curved-surface portion of the fin has a smaller curvature at one side in the third direction of the heat exchanger than at the other side in the third direction of the heat exchanger; and/or
the curved-surface portion of the fin has a smaller curvature at one side in the second direction of the heat exchanger than at the other side in the second direction of the heat exchanger.

5. The heat exchanger as claimed in claim 2, wherein:

the curvature of the curved-surface portion of the fin gradually increases from one side in the third direction of the heat exchanger to the other side in the third direction of the heat exchanger; and/or
the curvature of the curved-surface portion of

the fin gradually increases from one side in the second direction of the heat exchanger to the other side in the second direction of the heat exchanger.

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6. The heat exchanger as claimed in claim 4 or 5, wherein:

the curvature of the curved-surface portion of the fin is zero at said one side in the third direction of the heat exchanger; and/or
the curvature of the curved-surface portion of the fin is zero at said one side in the second direction of the heat exchanger.

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7. The heat exchanger as claimed in claim 1, wherein: the curved-surface portion of the fin has a corrugated shape and comprises alternately arranged strip-shaped ridges and troughs.

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8. The heat exchanger as claimed in claim 7, wherein: mutually contacting ridges of the curved-surface portions of two adjacent fins cross over each other.

9. The heat exchanger as claimed in claim 7, wherein: when viewed in the first direction, mutually contacting ridges of the curved-surface portions of two adjacent fins are arranged symmetrically with respect to a plane defined by the first direction and the second direction.

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10. The heat exchanger as claimed in claim 7, wherein: when viewed in the first direction, the curved-surface portion of the fin has an I-shape, a V-shape, a W-shape, a C-shape or an L-shape.

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11. The heat exchanger as claimed in claim 1, wherein: the curved-surface portion of the fin has a bumpy shape and comprises multiple rows of discrete protrusions and multiple rows of discrete depressions.

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12. The heat exchanger as claimed in claim 11, wherein: protrusions of the curved-surface portions of two adjacent fins are in contact with each other.

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13. The heat exchanger as claimed in any one of claims 1 to 5, wherein:

adjacent fins between two adjacent heat exchange tubes are spaced apart at one side in the third direction of the heat exchanger; and/or
adjacent fins between two adjacent heat exchange tubes are spaced apart at one side in the second direction of the heat exchanger.

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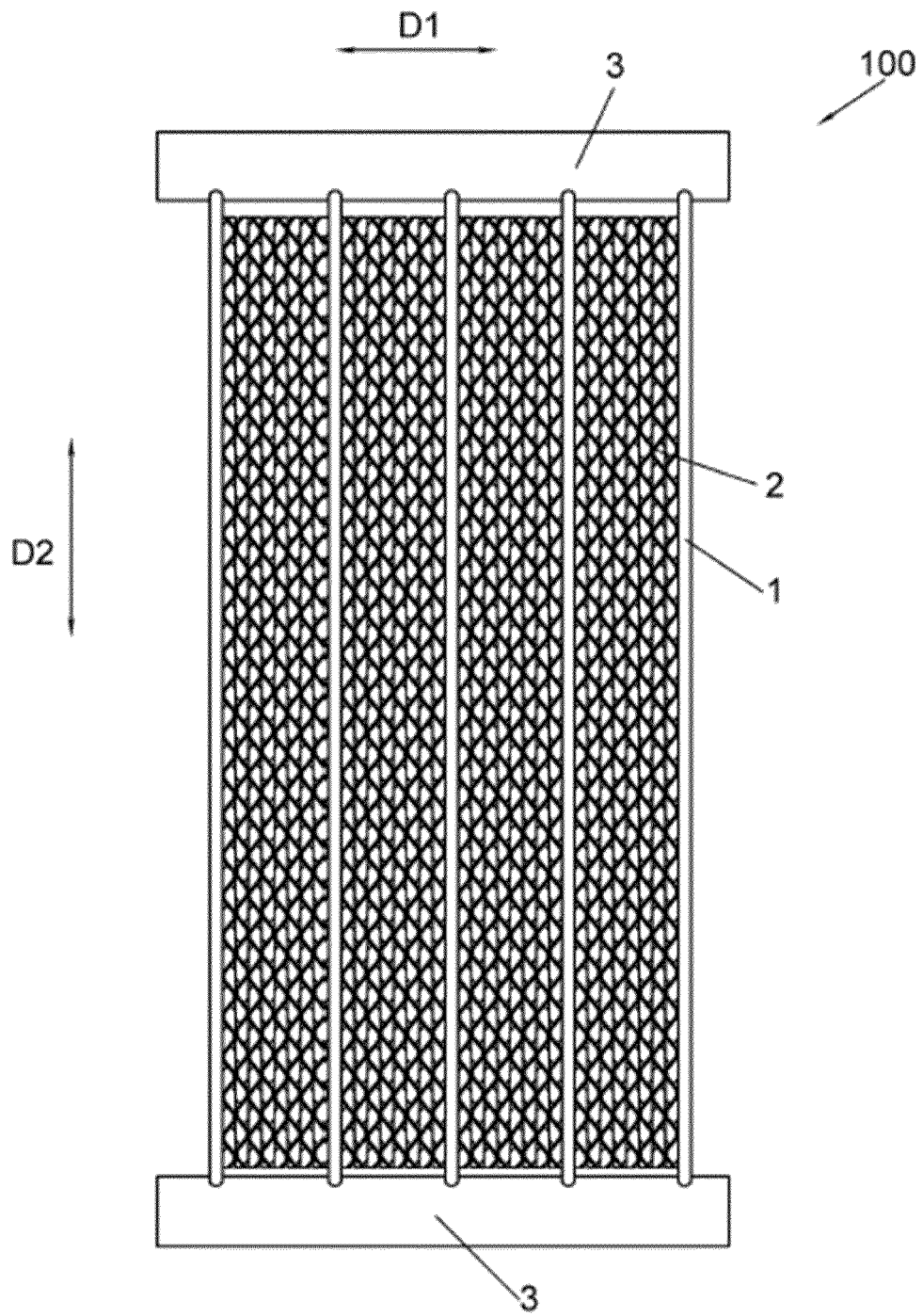


Fig. 1

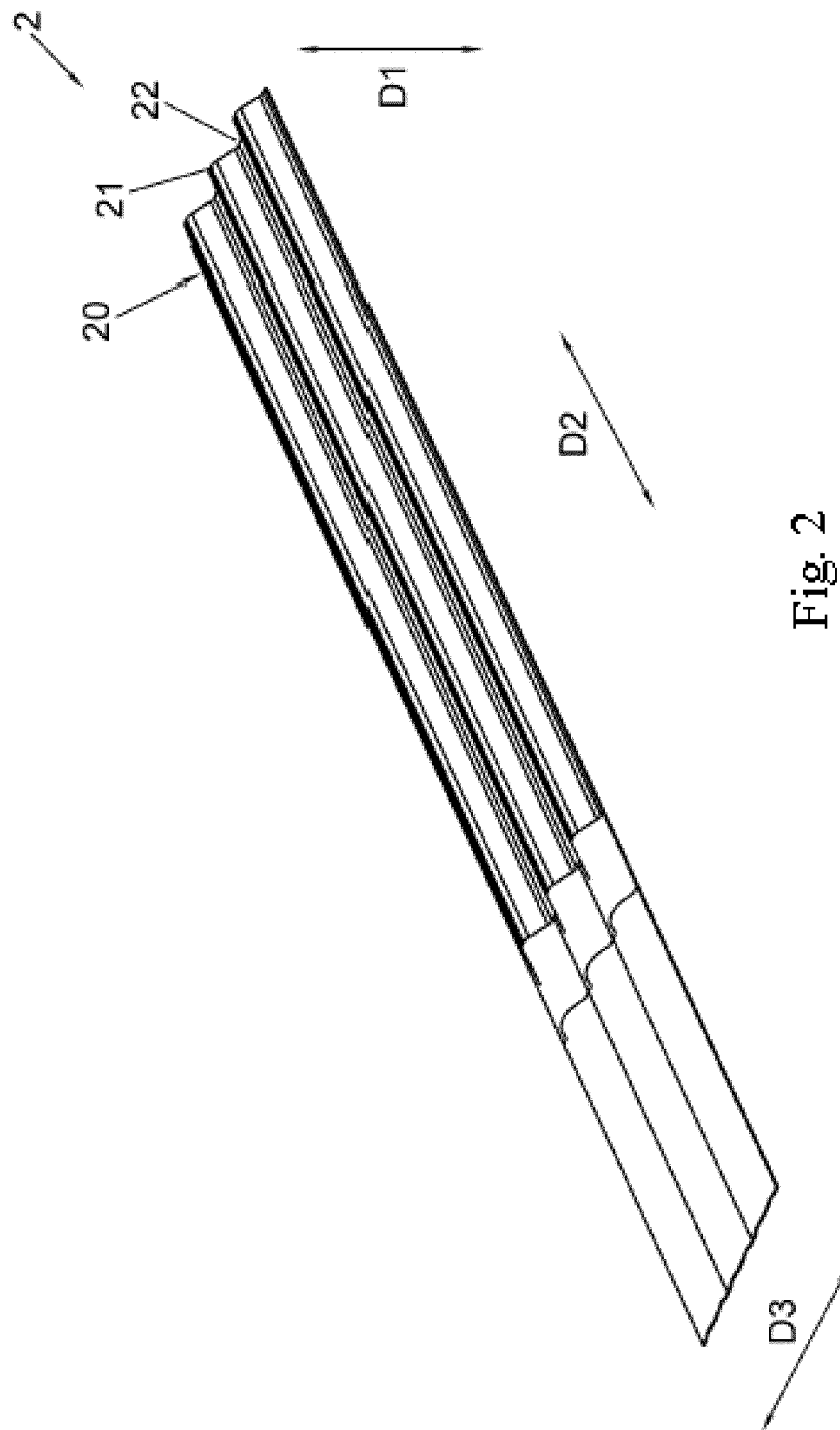


Fig. 2

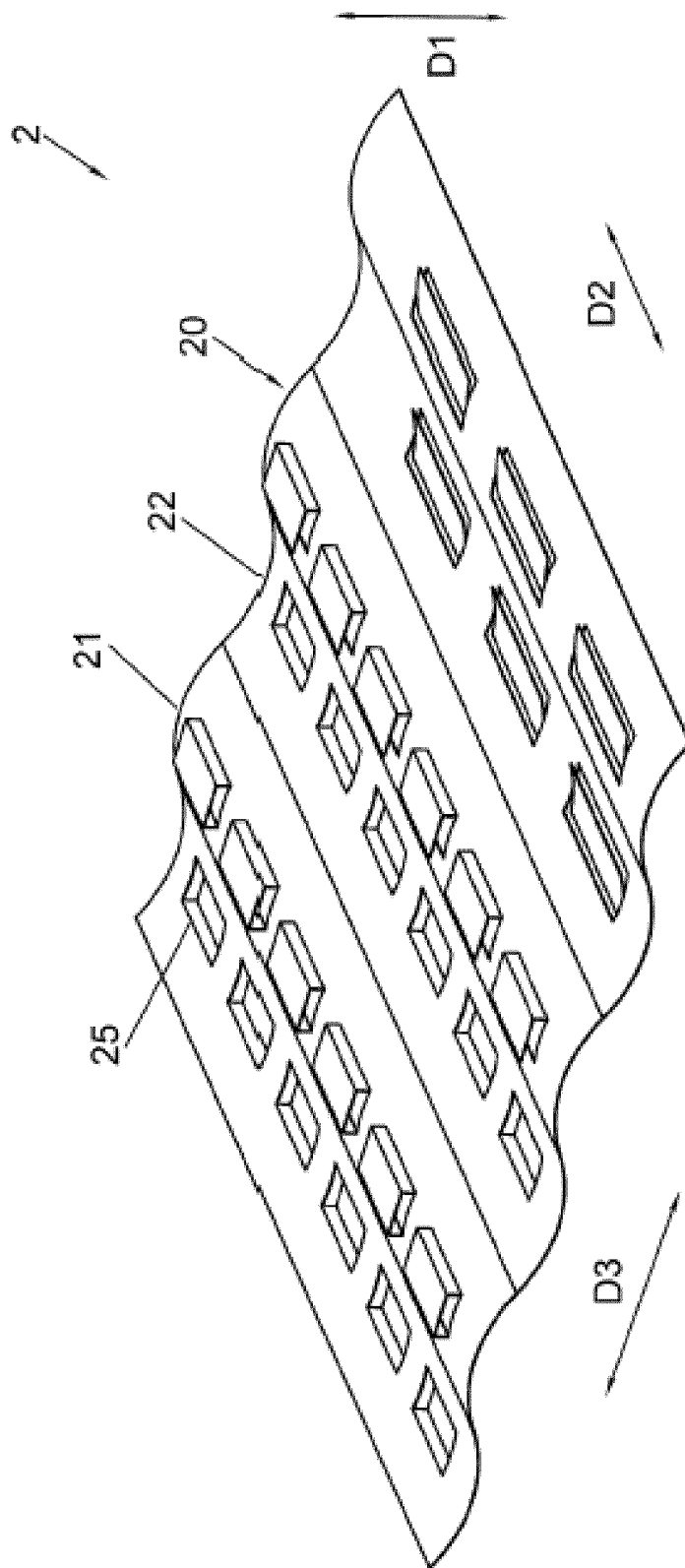


Fig. 3

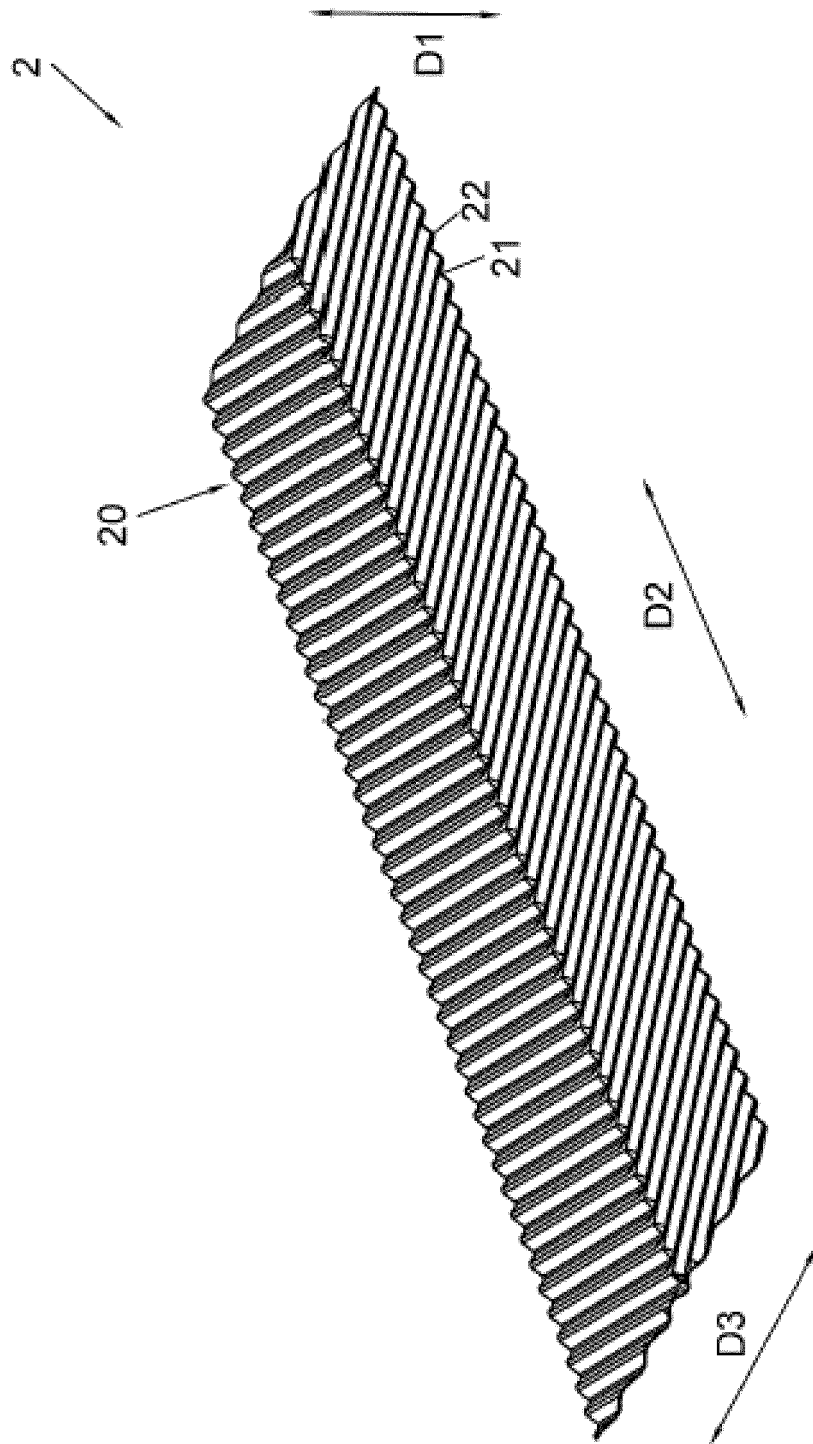


Fig. 4

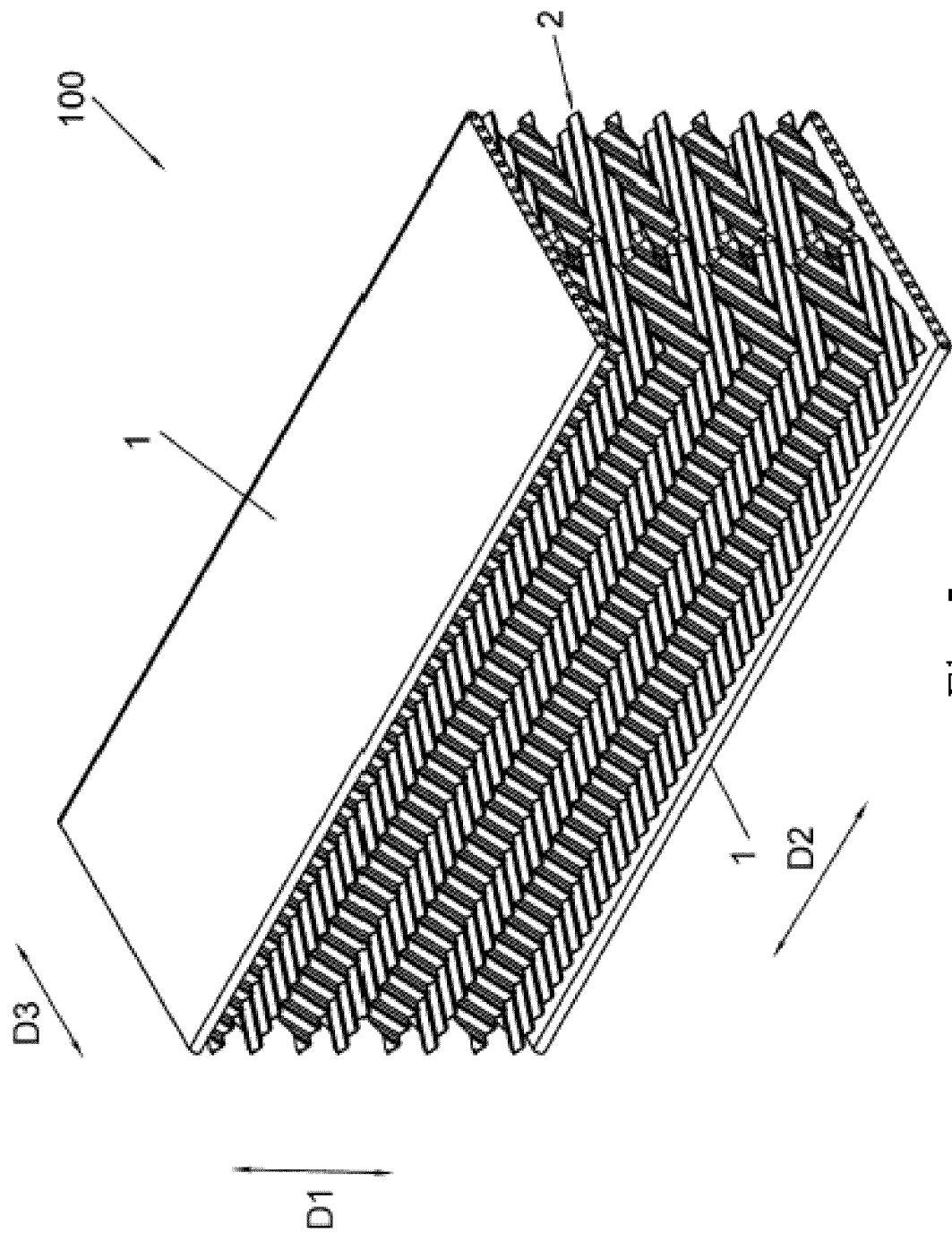


Fig. 5

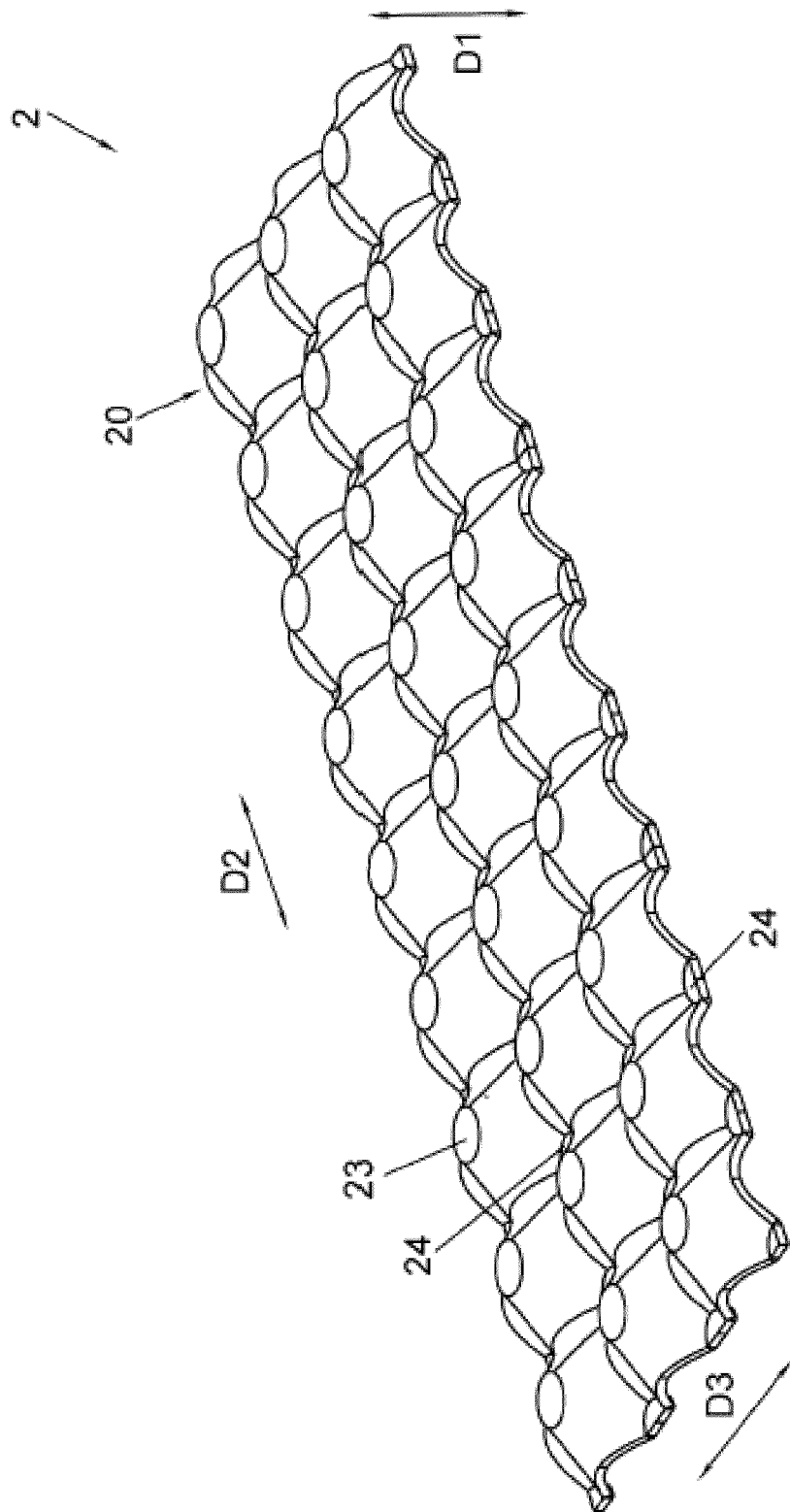


Fig. 6

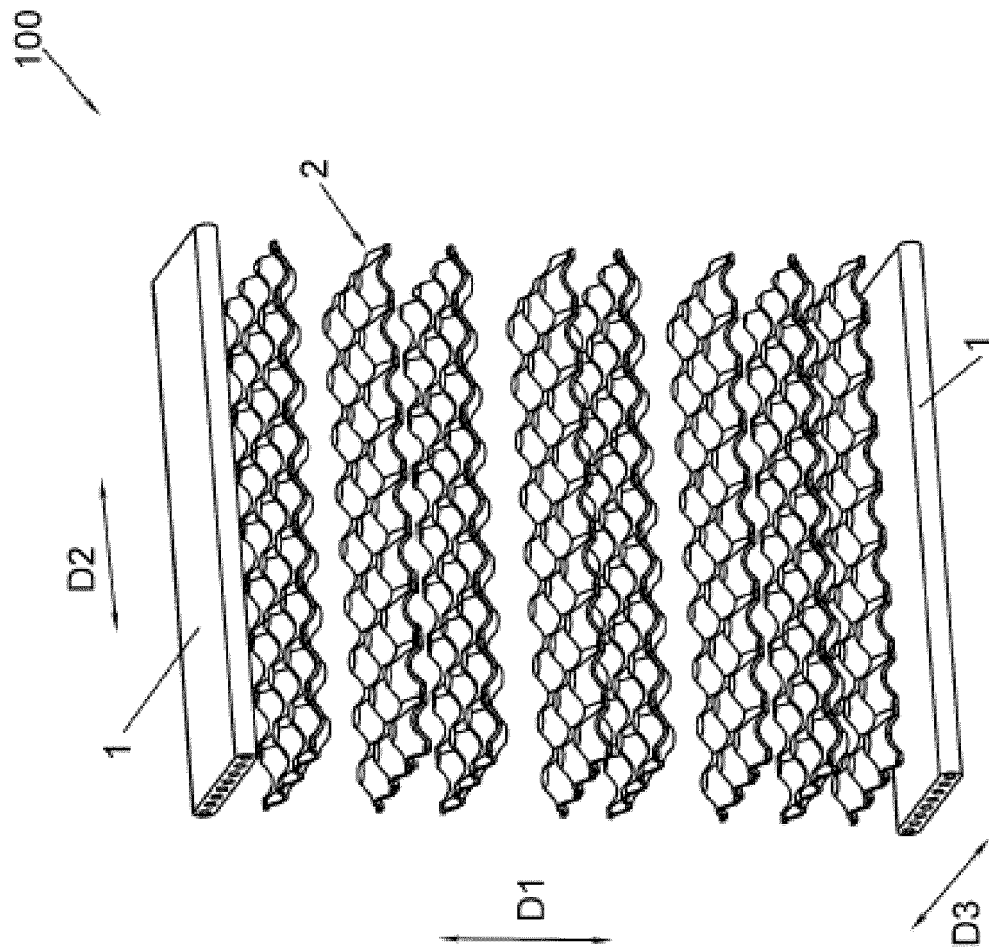


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/099626

A. CLASSIFICATION OF SUBJECT MATTER

F28D 1/04(2006.01)i; F28F 1/12(2006.01)i; F28D 1/053(2006.01)i; F28D 1/06(2006.01)i

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)

F28D; F28F

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)

CNABS, CNTXT, 中国期刊网全文数据库, CHINA JOURNAL FULL-TEXT DATABASE, DWPI, SIPOABS, EPTXT: 张锋 or 沈世杰 or 李艳星, 曲面, 波形, 波浪, 换热, 热交换, 翅片, 肋片, 集流管, 集管, 集箱, curv+, wav+, corrugat+, fin?, rib?, header?, collector?, manifold?.

C. 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	CN 101802539 A (SHARP CORPORATION) 11 August 2010 (2010-08-11) entire document	1-13

☐ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

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Date of the actual completion of the international search

28 October 2019

Date of mailing of the international search report

08 November 2019

Name and mailing address of the ISA/CN

China National Intellectual Property Administration
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Authorized officer

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Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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