(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 187 190 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
31.05.2023 Bulletin 2023/22

(21) Application number: **21845993.1**

(22) Date of filing: **24.06.2021**

(51) International Patent Classification (IPC):
F28F 9/02 *(2006.01)* ***F28D 1/053*** *(2006.01)*
F25B 39/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F25B 39/00; F28D 1/053; F28F 9/02

(86) International application number:
PCT/CN2021/102076

(87) International publication number:
WO 2022/017117 (27.01.2022 Gazette 2022/04)

(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

(30) Priority: **22.07.2020 CN 202010713874**
22.07.2020 CN 202021462968 U

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(54) HEAT EXCHANGER

(57) Disclosed in the embodiments of the present invention is a heat exchanger. The heat exchanger comprises: a header, comprising a first end and a second end which are opposite each other, and further comprising an inner cavity; a plurality of heat exchange tubes arranged in an axial direction of the header, with ends of the plurality of heat exchange tubes being connected to the header; and a connecting tube, the connecting tube comprising a connecting part and a supply part which is connected to the connecting part and also connected to the first end of the header, the supply part being configured such that a flow direction of a heat exchange medium supplied to a predetermined number of heat exchange tubes through the inner cavity of the header is not parallel to an axis of the header, the predetermined number of heat exchange tubes being a predetermined number of heat exchange tubes counted from the first end of the header. By using the heat exchanger according to the embodiments of the present invention, heat exchanger performance can be improved.

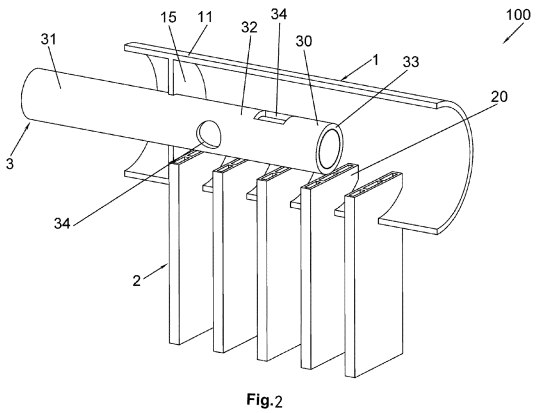

Fig.2

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Description

Technical Field

[0001] The embodiments of the present invention relate to a heat exchanger.

Background

[0002] A heat exchanger comprises a header, heat exchange tubes and a connecting tube. When the heat exchanger acts as an evaporator of a heat pump unit, the connecting tube generally acts as an outlet tube of the heat exchanger. When the heat exchanger acts as a condenser, the connecting tube acts as an inlet tube of the heat exchanger.

Summary of the Invention

[0003] An objective of the embodiments of the present invention is to provide a heat exchanger which, for example, enables an improvement in heat exchanger performance.

[0004] The embodiments of the present invention provide a heat exchanger, which comprises: a header, comprising a first end and a second end which are opposite each other, and further comprising an inner cavity; a plurality of heat exchange tubes arranged in an axial direction of the header, with ends of the plurality of heat exchange tubes being connected to the header; and a connecting tube, the connecting tube comprising a connecting part and a supply part which is connected to the connecting part and also connected to the first end of the header, the supply part being configured such that a flow direction of a heat exchange medium supplied to a predetermined number of heat exchange tubes through the inner cavity of the header is not parallel to an axis of the header, the predetermined number of heat exchange tubes being a predetermined number of heat exchange tubes counted from the first end of the header.

[0005] According to an embodiment of the present invention, at least a portion of the supply part is inserted in the first end of the header; and an end face of an end of the supply part that is remote from the connecting part is located at one side of a first heat exchange tube in the predetermined number of heat exchange tubes, said side being remote from the second end of the header, in the axial direction of the header.

[0006] According to an embodiment of the present invention, the supply part is inserted in the first end of the header; and an end face of an end of the supply part that is remote from the connecting part is located between a first heat exchange tube in the predetermined number of heat exchange tubes and a final heat exchange tube in the predetermined number of heat exchange tubes, in the axial direction of the header.

[0007] According to an embodiment of the present invention, the supply part of the connecting tube comprises an opening penetrating a tube wall, and/or an opening at the end of the supply part that is remote from the connecting part.

[0008] According to an embodiment of the present invention, a cross section of the opening is parallel or inclined relative to the axis of the header.

[0009] According to an embodiment of the present invention, an axis of the supply part of the connecting tube is parallel to the axis of the header, or an axis of the supply part of the connecting tube is inclined relative to the axis of the header.

[0010] According to an embodiment of the present invention, the end of the supply part of the connecting tube that is remote from the connecting part is closed, or a cross-sectional area of the end of the supply part of the connecting tube that is remote from the connecting part is smaller than a cross-sectional area of another portion of the supply part of the connecting tube.

[0011] According to an embodiment of the present invention, the end face of the end of the supply part is inclined relative to the axis of the header.

[0012] According to an embodiment of the present invention, the end face of the end of the supply part that is remote from the connecting part faces toward the ends of the predetermined number of heat exchange tubes inserted in the header.

[0013] According to an embodiment of the present invention, the axis of the supply part of the connecting tube is inclined relative to the axis of the header.

[0014] According to an embodiment of the present invention, in a direction from the first end to the second end of the header, an axis of the supply part of the connecting tube is inclined toward the ends of the predetermined number of heat exchange tubes inserted in the header, relative to the axis of the header.

[0015] According to an embodiment of the present invention, an end face of an end of the supply part that is remote from the connecting part is inclined relative to an axis of the supply part.

[0016] According to an embodiment of the present invention, an end of the supply part of the connecting tube that is remote from the connecting part is bent relative to another portion of the supply part.

[0017] According to an embodiment of the present invention, an end of the supply part of the connecting tube that is remote from the connecting part is bent toward the ends of the predetermined number of heat exchange tubes inserted in the header, relative to another portion of the supply part.

[0018] According to an embodiment of the present invention, the heat exchanger further comprises: a baffle disposed in the header, the baffle being disposed at one side of the end of the supply part, said side being remote from the connecting part, and the baffle allowing some of the heat exchange medium supplied by the connecting tube to flow along the header to the side of the baffle that is remote from the supply part.

[0019] According to an embodiment of the present in-

vention, a cross-sectional area of the supply part of the connecting tube gradually increases in a direction from the first end to the second end of the header.

[0020] According to an embodiment of the present invention, in the direction from the first end to the second end of the header, an axis of the supply part of the connecting tube is inclined toward the ends of the predetermined number of heat exchange tubes inserted in the header, relative to the axis of the header.

[0021] According to an embodiment of the present invention, if the heat exchanger is acting as a condenser, the connecting tube is an inlet tube of the heat exchanger, for inputting the heat exchange medium to the heat exchanger.

[0022] According to an embodiment of the present invention, the predetermined number is less than or equal to 10, or the supply part comprises a tube segment in the header, the tube segment having a length in the axial direction of the header, and the number of heat exchange tubes within the range of this length being less than or equal to 10.

[0023] According to an embodiment of the present invention, the header also has an end cap disposed at the first end of the header, and the supply part of the connecting tube is connected to the end cap or inserted in the header through an opening in the end cap.

[0024] According to an embodiment of the present invention, a ratio of the length, in the axial direction of the header, of a part of the connecting tube that is inserted in the inner cavity of the header to the length of the inner cavity of the header in the axial direction of the header is less than 1/5.

[0025] By using the heat exchanger according to the embodiments of the present invention, heat exchanger performance can be improved for example.

Brief Description of the Drawings

[0026]

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

Fig. 2 is a partially cut-open schematic perspective view of a heat exchanger according to an embodiment of the present invention.

Fig. 3 is a partially cut-open schematic perspective view of a heat exchanger according to another embodiment of the present invention.

Fig. 4 is a partially cut-open schematic perspective view of a heat exchanger according to another embodiment of the present invention.

Fig. 5 is a partially cut-open schematic perspective view of a heat exchanger according to another embodiment of the present invention.

Detailed Description of the Invention

[0027] The present invention is explained further below in conjunction with the accompanying drawings and specific implementations.

[0028] Referring to Figs 1 - 5, a heat exchanger 100 according to embodiments of the present invention comprises: a header 1, the header 1 comprising a first end 11 and a second end 12 which are opposite each other, and further comprising an inner cavity; a plurality of heat exchange tubes 2 arranged in the axial direction of the header 1, with ends 20 of the plurality of heat exchange tubes 2 being connected to the header 1; and a connecting tube 3, the connecting tube 3 comprising a connecting part 31 and a supply part 32 which is connected to the connecting part 31 and also connected to the first end 11 of the header 1, the supply part 32 being configured such that a flow direction of a heat exchange medium supplied to a predetermined number of heat exchange tubes 2 through the inner cavity of the header 1 is not parallel to the axis of the header 1, the predetermined number of heat exchange tubes 2 being a predetermined number of heat exchange tubes 2 counted from the first end 11 of the header 1. For example, the supply part 32 is configured such that the flow direction of the heat exchange medium supplied to the predetermined number of heat exchange tubes 2 forms an angle greater than 30 degrees relative to the axis of the header 1. In the embodiments shown in Figs. 1-5, the predetermined number of heat exchange tubes 2 is a predetermined number of heat exchange tubes 2 counted from the left end of the header 1. The heat exchanger 100 may further comprise fins arranged alternately with the heat exchange tubes 2. The predetermined number is less than or equal to 10, or the supply part 32 comprises a tube segment in the header 1, the tube segment having a length in the axial direction of the header 1, and the number of heat exchange tubes 2 within the range of this length being less than or equal to 10. In addition, the predetermined number may be selected according to particular circumstances, for example, may be 3, 4, 5, 6, 7, 8 or more.

[0029] In some embodiments of the present invention, the ratio of the length, in the axial direction of the header 1, of a part of the connecting tube 3 that is inserted in the inner cavity of the header 1 to the length of the inner cavity of the header 1 in the axial direction of the header 1 is less than 1/5. In the embodiments shown in the figures, there is no partition plate in the header 1; therefore, the length of the inner cavity of the header 1 in the axial direction of the header 1 is the length of the header 1 between two end caps, i.e. the length of the entire inner cavity. If a partition plate is provided in the header 1, the length of the inner cavity of the header 1 in the axial direction of the header 1 is the length between an end cap 15 at the first end and the partition plate (if one partition plate is provided), or is the length between the end cap 15 at the first end and the partition plate closest to the

end cap 15 at the first end (if a plurality of partition plates are provided).

[0030] In some embodiments of the present invention, if the heat exchanger 100 is acting as a condenser, the connecting tube 3 is an inlet tube of the heat exchanger, for inputting the heat exchange medium to the heat exchanger.

[0031] Referring to Figs. 1 and 5, in some embodiments of the present invention, at least a portion of the supply part 32 is inserted in the first end 11 of the header 1; and an end face 33 of an end 30 of the supply part 32 that is remote from the connecting part 31 is located at one side of a first heat exchange tube 2 in the predetermined number of heat exchange tubes 2, said side being remote from the second end 12 of the header 1, in the axial direction of the header 1, or is located at one side of the first heat exchange tube 2 in the predetermined number of heat exchange tubes 2, said side facing the first end 11 of the header 1, in the axial direction of the header 1. For example, the header 1 also has an end cap 15 disposed at the first end 11 of the header 1, and the supply part 32 of the connecting tube 3 is connected to the end cap 15 or inserted in the header 1 through an opening in the end cap 15. For example, the supply part 32 is inserted in the first end 11 of the header 1 through the opening in the end cap 15 of the header 1. The first heat exchange tube 2 is the leftmost heat exchange tube 2 in the figures.

[0032] Referring to Figs. 2 - 5, in some embodiments of the present invention, the supply part 32 is inserted in the first end 11 of the header 1; and the end face 33 of the end 30 of the supply part 32 that is remote from the connecting part 31 is located between the first heat exchange tube 2 in the predetermined number of heat exchange tubes 2 and a final heat exchange tube 2 in the predetermined number of heat exchange tubes 2, in the axial direction of the header 1. For example, the supply part 32 of the connecting tube 3 comprises an opening 34 penetrating a tube wall, and/or an opening at the end of the supply part 32 that is remote from the connecting part. A cross section of the opening is parallel or inclined relative to the axis of the header 1. The opening 34 may face in any radial direction of the connecting tube 3, and the opening 34 may have any suitable shape. According to some examples of the present invention, the end 30 of the supply part 32 of the connecting tube 3 that is remote from the connecting part 31 is closed, or the cross-sectional area of the end 30 of the supply part 32 of the connecting tube 3 that is remote from the connecting part 31 is smaller than the cross-sectional area of another portion of the supply part 32 of the connecting tube 3. In this way, the amount of heat exchange medium distributed to the predetermined number of heat exchange tubes 2 can be increased. The final heat exchange tube 2 is the rightmost heat exchange tube 2 shown in the figure in the predetermined number of heat exchange tubes 2.

[0033] Referring to Fig. 2, in some embodiments of the present invention, the axis of the supply part 32 of the connecting tube 3 is parallel to the axis of the header 1.

[0034] Referring to Figs. 3 and 4, in some embodiments of the present invention, the end face 33 of the end 30 of the supply part 32 that is remote from the connecting part 31 faces toward the ends 20 of the predetermined number of heat exchange tubes 2 inserted in the header 1, and the end face 33 of the end 20 of the supply part 32 is inclined relative to the axis of the header 1. Optionally, the end face 33 of the end 30 of the supply part 32 that is remote from the connecting part 31 may also not face toward the ends 20 of the predetermined number of heat exchange tubes 2 inserted in the header 1. For example, the end face 33 of the end 30 of the supply part 32 that is remote from the connecting part 31 is inclined relative to the axis of the supply part 32.

[0035] Referring to Figs. 1, 3 and 5, in some embodiments of the present invention, the axis of the supply part 32 of the connecting tube 3 is inclined relative to the axis of the header 1. For example, in the direction from the first end 11 to the second end 12 of the header 1, the axis of the supply part 32 of the connecting tube 3 is inclined toward the ends 20 of the predetermined number of heat exchange tubes 2 inserted in the header 1, relative to the axis of the header 1.

[0036] Referring to Fig. 4, in some embodiments of the present invention, the end 30 of the supply part 32 of the connecting tube 3 that is remote from the connecting part 31 is bent relative to another portion of the supply part 32. For example, the end 30 of the supply part 32 of the connecting tube 3 that is remote from the connecting part 31 is bent, relative to another portion of the supply part 32, toward the ends 20 of the predetermined number of heat exchange tubes 2 inserted in the header 1.

[0037] Referring to Fig. 4, in some embodiments of the present invention, the heat exchanger 100 further comprises a baffle 4 disposed in the header 1. The baffle 4 is disposed at one side of the end 30 of the supply part 32, said side being remote from the connecting part 31, and the baffle 4 may be spaced apart from the end 30 of the supply part 32. The baffle 4 allows some of the heat exchange medium supplied by the connecting tube 3 to flow along the header 1 to the side of the baffle 4 that is remote from the supply part 32. In this way, the amount of heat exchange medium distributed to the predetermined number of heat exchange tubes 2 can be increased.

[0038] Referring to Fig. 5, in some embodiments of the present invention, the cross-sectional area of the supply part 32 of the connecting tube 3 gradually increases in the direction from the first end 11 to the second end 12 of the header 1. For example, in the direction from the first end 11 to the second end 12 of the header 1, the axis of the supply part 32 of the connecting tube 3 is inclined toward the ends 20 of the predetermined number of heat exchange tubes 2 inserted in the header 1, relative to the axis of the header 1.

[0039] By using the heat exchanger according to the

embodiments of the present invention, heat exchanger performance can be improved.

[0040] For example, when a heat exchanger such as a micro-channel heat exchanger is used in an external machine of a heat pump unit, frost will form on the surface in winter (at this time the heat exchanger is an evaporator); once a certain amount of frost has formed, the unit will operate in reverse to perform defrosting, and the heat exchanger will become a condenser. When defrosting is being performed, high-temperature refrigerant enters the upper header 1 from the connecting tube 3, then flows along the heat exchange tubes 2 such as flat tubes to the lower header, while removing the frost on the heat exchange tubes 2.

[0041] When the refrigerant enters the upper header 2 from the connecting tube 3, a vortex low-pressure zone will form at the inlet of the header 2, and this might result in a low flow rate of refrigerant in the heat exchange tubes 2 at corresponding positions (the heat exchange tubes that are closest to the edge of the heat exchanger), in turn resulting in incomplete removal of the frost on these heat exchange tubes.

[0042] According to an embodiment of the present invention, when the heat exchanger is in a defrosting state (at which time it is a condenser), the flow direction of outlet fluid at the end of the connecting tube is changed, eliminating the vortex low-pressure zone in the fluid at the inlet of the header, increasing the amount of high-temperature gaseous refrigerant in the heat exchange tubes in the inlet region, and speeding up defrosting.

[0043] Although the above embodiments have been described, certain features in the above embodiments can be combined to form new embodiments.

Claims

1. A heat exchanger, comprising:

a header, comprising a first end and a second end which are opposite each other, and further comprising an inner cavity;
a plurality of heat exchange tubes arranged in an axial direction of the header, with ends of the plurality of heat exchange tubes being connected to the header; and
a connecting tube, the connecting tube comprising a connecting part and a supply part which is connected to the connecting part and also connected to the first end of the header, the supply part being configured such that a flow direction of a heat exchange medium supplied to a predetermined number of heat exchange tubes through the inner cavity of the header is not parallel to an axis of the header, the predetermined number of heat exchange tubes being a predetermined number of heat exchange tubes counted from the first end of the header.

2. The heat exchanger as claimed in claim 1, wherein: at least a portion of the supply part is inserted in the first end of the header; and an end face of an end of the supply part that is remote from the connecting part is located at one side of a first heat exchange tube in the predetermined number of heat exchange tubes, said side being remote from the second end of the header, in the axial direction of the header.

3. The heat exchanger as claimed in claim 1, wherein: the supply part is inserted in the first end of the header; and an end face of an end of the supply part that is remote from the connecting part is located between a first heat exchange tube in the predetermined number of heat exchange tubes and a final heat exchange tube in the predetermined number of heat exchange tubes, in the axial direction of the header.

4. The heat exchanger as claimed in claim 3, wherein: the supply part of the connecting tube comprises an opening penetrating a tube wall, and/or an opening at the end of the supply part that is remote from the connecting part.

5. The heat exchanger as claimed in claim 4, wherein: a cross section of the opening is parallel or inclined relative to the axis of the header.

6. The heat exchanger as claimed in any one of claims 1-3, wherein:
an axis of the supply part of the connecting tube is parallel to the axis of the header, or an axis of the supply part of the connecting tube is inclined relative to the axis of the header.

7. The heat exchanger as claimed in claim 4, wherein: the end of the supply part of the connecting tube that is remote from the connecting part is closed, or a cross-sectional area of the end of the supply part of the connecting tube that is remote from the connecting part is smaller than a cross-sectional area of another portion of the supply part of the connecting tube.

8. The heat exchanger as claimed in any one of claims 1-3, wherein:
the end face of the end of the supply part is inclined relative to the axis of the header.

9. The heat exchanger as claimed in claim 8, wherein: the end face of the end of the supply part that is remote from the connecting part faces toward the ends of the predetermined number of heat exchange tubes inserted in the header.

10. The heat exchanger as claimed in any one of claims 1-3, wherein:

in a direction from the first end to the second end of the header, an axis of the supply part of the connecting tube is inclined toward the ends of the predetermined number of heat exchange tubes inserted in the header, relative to the axis of the header.

11. The heat exchanger as claimed in any one of claims 1-3, wherein:
an end face of an end of the supply part that is remote from the connecting part is inclined relative to an axis of the supply part.

12. The heat exchanger as claimed in any one of claims 1-3, wherein:
an end of the supply part of the connecting tube that is remote from the connecting part is bent relative to another portion of the supply part.

13. The heat exchanger as claimed in any one of claims 1-3, wherein:
an end of the supply part of the connecting tube that is remote from the connecting part is bent toward the ends of the predetermined number of heat exchange tubes inserted in the header, relative to another portion of the supply part.

14. The heat exchanger as claimed in any one of claims 1-3, further comprising:
a baffle disposed in the header, the baffle being disposed at one side of the end of the supply part, said side being remote from the connecting part, and the baffle allowing some of the heat exchange medium supplied by the connecting tube to flow along the header to the side of the baffle that is remote from the supply part.

15. The heat exchanger as claimed in any one of claims 1-3, wherein:
a cross-sectional area of the supply part of the connecting tube gradually increases in a direction from the first end to the second end of the header.

16. The heat exchanger as claimed in claim 15, wherein:
in the direction from the first end to the second end of the header, an axis of the supply part of the connecting tube is inclined toward the ends of the predetermined number of heat exchange tubes inserted in the header, relative to the axis of the header.

17. The heat exchanger as claimed in claim 1, wherein:
if the heat exchanger is acting as a condenser, the connecting tube is an inlet tube of the heat exchanger, for inputting the heat exchange medium to the heat exchanger.

18. The heat exchanger as claimed in claim 1, wherein:
the predetermined number is less than or equal to 10, or the supply part comprises a tube segment in the header, the tube segment having a length in the axial direction of the header, and the number of heat exchange tubes within the range of this length being less than or equal to 10.

19. The heat exchanger as claimed in claim 1, wherein:
the supply part is configured such that the flow direction of the heat exchange medium supplied to the predetermined number of heat exchange tubes forms an angle greater than 30 degrees relative to the axis of the header.

20. The heat exchanger as claimed in claim 1, wherein:
the header also has an end cap disposed at the first end of the header, and the supply part of the connecting tube is connected to the end cap or inserted in the header through an opening in the end cap.

21. The heat exchanger as claimed in claim 1, wherein:
a ratio of the length, in the axial direction of the header, of a part of the connecting tube that is inserted in the inner cavity of the header to the length of the inner cavity of the header in the axial direction of the header is less than 1/5.

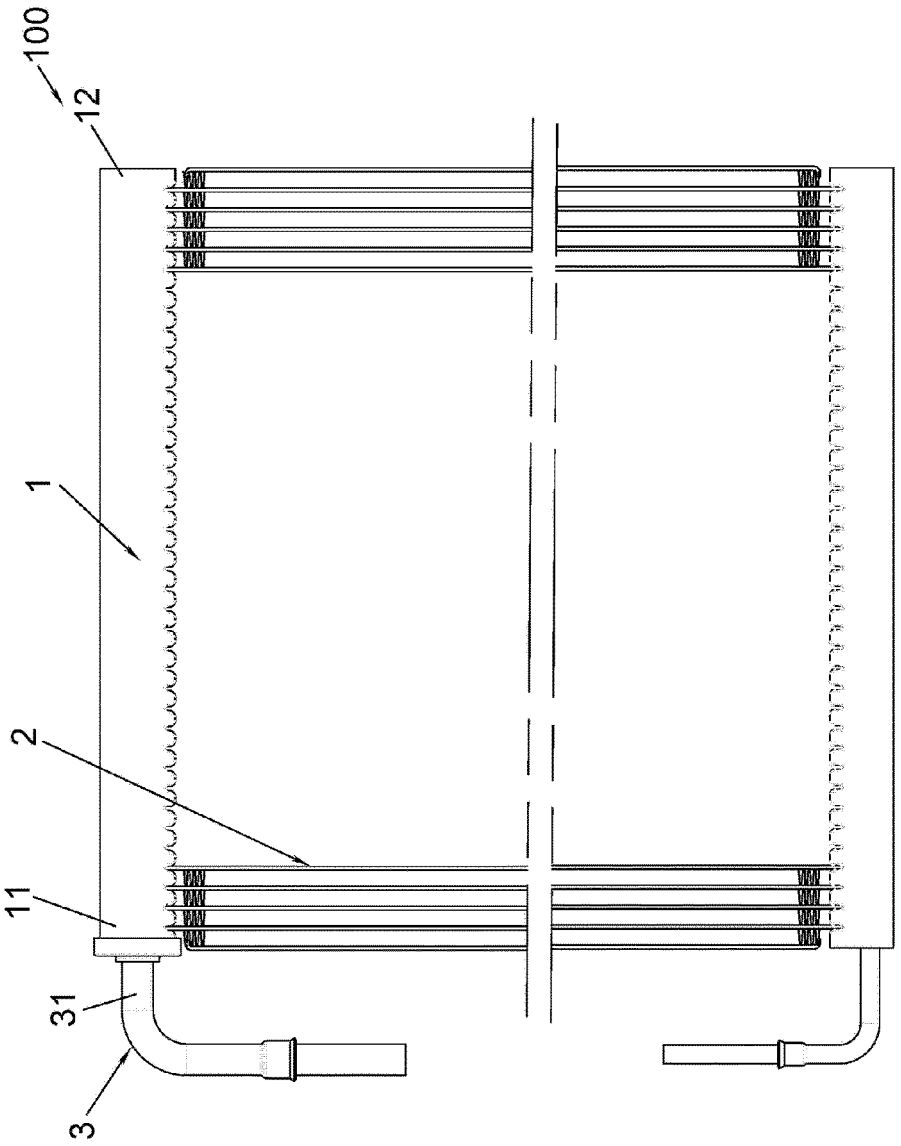

Fig.1

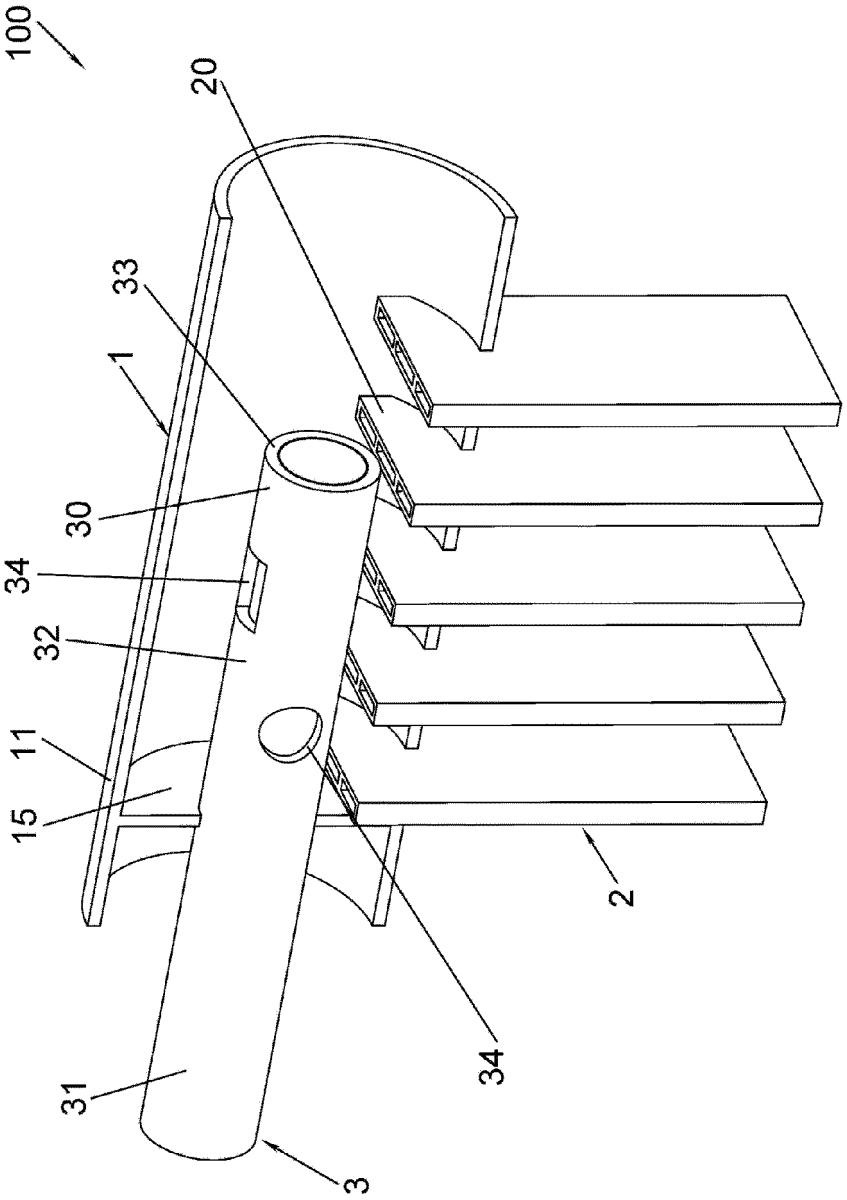

Fig.2

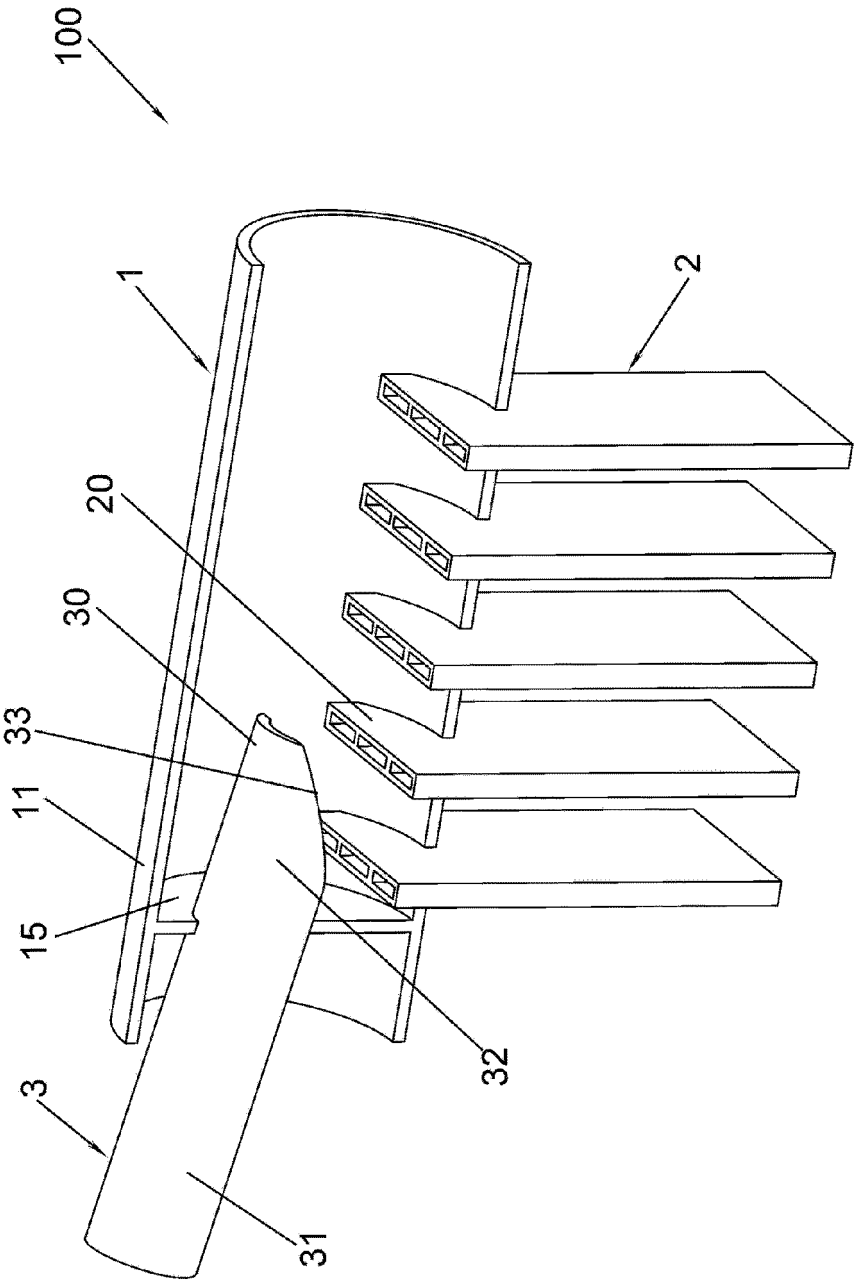

Fig.3

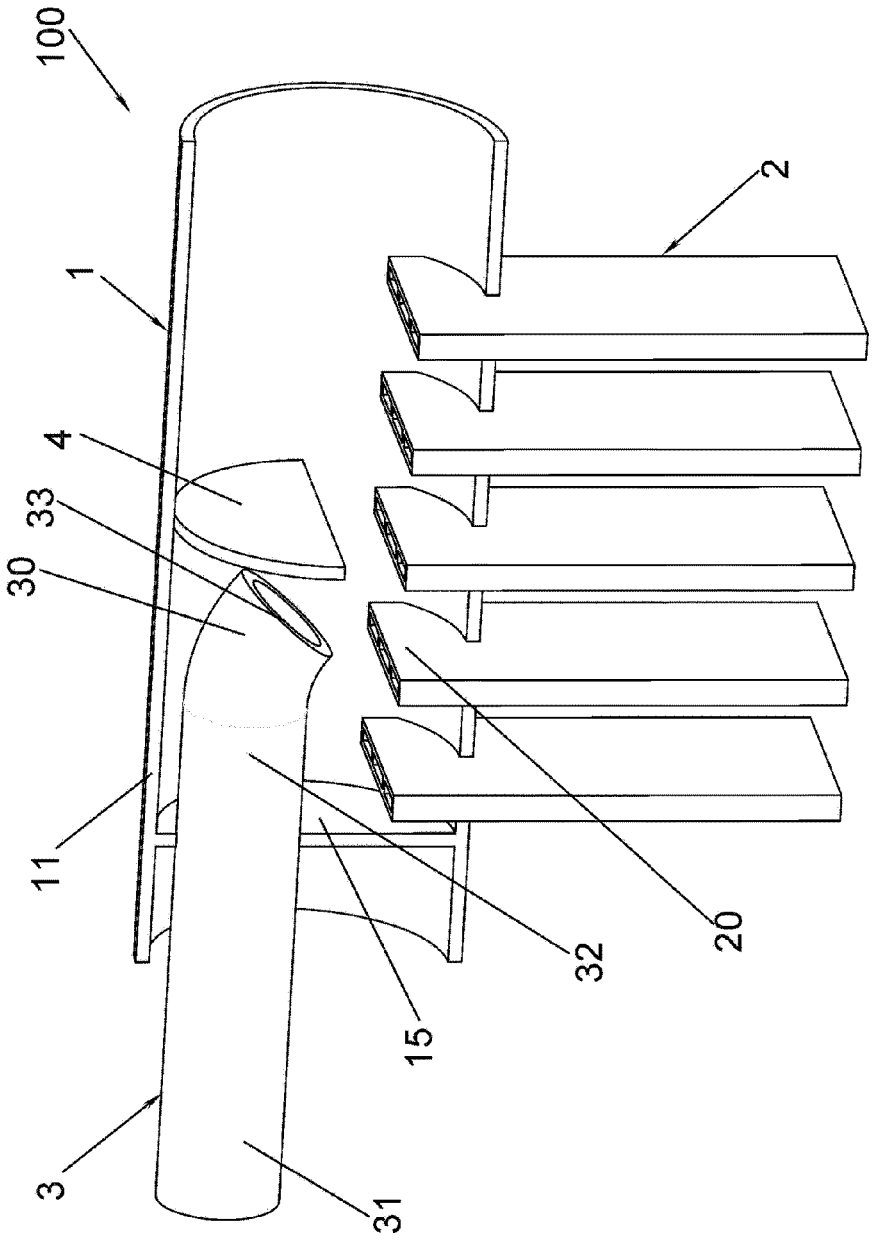

Fig.4

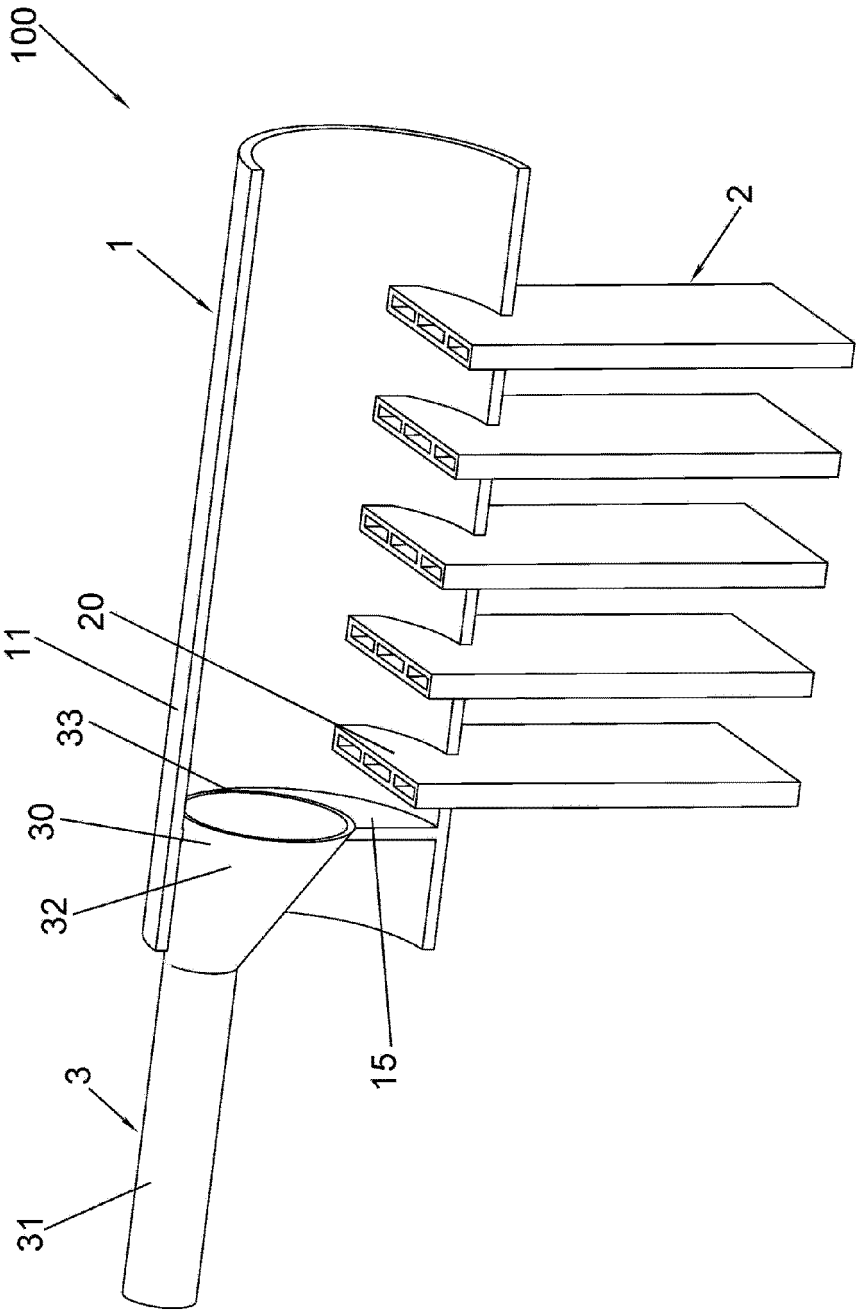

Fig.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/102076

A. CLASSIFICATION OF SUBJECT MATTER

F28F 9/02(2006.01)i; F28D 1/053(2006.01)i; F25B 39/00(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)

F28F 9;F28D 1;F25B 39

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, CNKI, VEN: 丹佛斯, 集管, 集流管, 集液管, 集箱, 集液箱, 集流箱, 分配, 分布, 倾斜, 弯曲, 角度, 弧形, header?, manifold?, collect+, distribut+, angle, tilt, slope, incline?, bend, bent, expand+, enlarge?, broaden

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 212566983 U (DANFOSS AS) 19 February 2021 (2021-02-19) claims 1-21	1-21
X	JP 06159983 A (SHOWA ALUMINUM CORP) 07 June 1994 (1994-06-07) description paragraphs [0024] and [0025], figures 3, 4	1, 3-7, 17-21
Y	JP 06159983 A (SHOWA ALUMINUM CORP) 07 June 1994 (1994-06-07) description paragraphs [0024] and [0025], figures 3, 4	14
Y	CN 204165423 U (ZHEJIANG DUN'AN ARTIFICIAL ENVIRONMENT CO., LTD.) 18 February 2015 (2015-02-18) description, paragraphs [0032]-[0053], and figures 1-5	14
X	WO 2013184522 A1 (MODINE MFG CO.) 12 December 2013 (2013-12-12) description, paragraphs [0020]-[0039], and figures 1-5	1, 3-7, 17-21
X	CN 103822406 A (DELPHI TECHNOLOGIES INC.) 28 May 2014 (2014-05-28) description, paragraphs [0024]-[0039], and figures 1-3	1, 3-7, 17-21
A	JP 2011185549 A (FUJI ELECTRIC CO., LTD. et al.) 22 September 2011 (2011-09-22) entire document	1-21

☑ 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	Date of mailing of the international search report
24 August 2021	**30 August 2021**

Name and mailing address of the ISA/CN	Authorized officer
China National Intellectual Property Administration (ISA/CN) **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088** **China**	
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Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/102076

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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