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

(11) EP 4 036 507 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.08.2022 Bulletin 2022/31

(21) Application number: **21203587.7**

(22) Date of filing: **20.10.2021**

(51) International Patent Classification (IPC):
F28D 1/03 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F28D 1/0341; F28D 1/05358; F28F 1/025; F28F 9/0221; F28F 9/182; F28F 21/084;
F28D 2021/0068; F28F 2255/16

(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: **01.02.2021 JP 2021014067**

(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd.**
Osaka-shi, Osaka 540-6207 (JP)

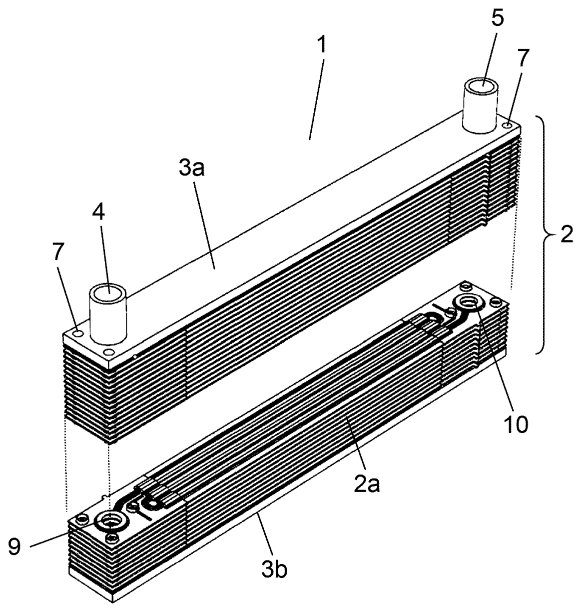
(72) Inventors:
- **NAGOSHI, Kenji**
  Osaka, 540-6207 (JP)
- **OKUMURA, Takuya**
  Osaka, 540-6207 (JP)
- **HASEGAWA, Hiroshi**
  Osaka, 540-6207 (JP)

(74) Representative: **Eisenführ Speiser**
Patentanwälte Rechtsanwälte PartGmbB
Arnulfstraße 27
80335 München (DE)

(54) **PLATE-FIN HEAT EXCHANGER AND REFRIGERATION SYSTEM USING SAME**

(57) A plate-fin heat exchanger according to the present disclosure is obtained by layering a plurality of plate fins (2a). Each of plate fins (2a) includes first header region (11a), second header region (11b), and flow channel region (12), wherein first and second header regions (11a, 11b) are each constituted by two joined plates (16a, 16b) each having a header flow channel opening, flow channel region (12) is constituted by single flow channel plate (18) in which heat transfer flow channel (8) is integrally formed, and first and second header regions (11a, 11b) are integrally joined to flow channel region (12).

FIG. 1



EP 4 036 507 A1

Description

BACKGROUND

1. Technical Field

[0001] The present disclosure relates to a plate-fin heat exchanger and a refrigeration system using the plate-fin heat exchanger.

2. Description of the Related Art

[0002] PTL 1 discloses a plate-fin heat exchanger. The plate-fin heat exchanger includes a plurality of plate fins layered with a gap therebetween. Each of the plate fins includes a first header flow channel, a second header flow channel, and a heat transfer flow channel. The plate fin includes a pair of plates which are brazed to face each other. The plate fin allows a first fluid such as a refrigerant to flow from the first header flow channel to the second header flow channel via the heat transfer flow channel, and promotes heat exchange between the first fluid flowing through the heat transfer flow channel and a second fluid such as air flowing through a gap between the plate fins.

Citation List

Patent Literature

[0003] PTL 1: Unexamined Japanese Patent Publication No. 2018-66532

SUMMARY

[0004] The present disclosure solves the problems caused by the conventional plate fin configuration, and provides a plate-fin heat exchanger that is lightweight and highly reliable and has high performance, and a refrigeration system using the plate-fin heat exchanger.

[0005] A plate-fin heat exchanger according to the present disclosure includes a plate fin including a first header flow channel, a second header flow channel, and a heat transfer flow channel connected between the first and second header flow channels, the plate fin including a first header region having the first header flow channel, a second header region having the second header flow channel, and a flow channel region having the heat transfer flow channel, wherein the first and second header regions are each constituted by two joined plates each having a header flow channel opening, the flow channel region is constituted by a single flow channel plate in which the heat transfer flow channel is integrally formed, and the first and second header regions are integrally joined to the flow channel region.

[0006] In the plate-fin heat exchanger according to the present disclosure, the flow channel region is constituted by a single plate in which the heat transfer flow channel is integrally formed due to the above configuration. The joining portions are located only in the first and second header regions, and thus, can be minimized. Therefore, the reliability of the heat exchanger is improved. In addition, the flow channel region constituted by a single plate has reduced weight and reduced thickness as compared with a flow channel region constituted by two joined plates. The reduction in thickness enables reduction in flow resistance of the second fluid flowing between the plate fins. As described above, a plate-fin heat exchanger which is highly reliable, is lightweight, and has high performance and a refrigeration system using the plate-fin heat exchanger are provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

FIG. 1 is an exploded perspective view illustrating an appearance of a plate-fin heat exchanger according to a first exemplary embodiment;
FIG. 2 is a perspective view illustrating a part of a plate-fin layered body of the plate-fin heat exchanger;
FIG. 3 is a perspective view illustrating an overall configuration of a plate fin of the plate-fin heat exchanger;
FIG. 4 is a developed perspective view illustrating header regions of the plate fin of the plate-fin heat exchanger;
FIG. 5 is an enlarged perspective view of a main part of the plate fin of the plate-fin heat exchanger;
FIG. 6 is a cross-sectional view taken along line A-A of FIG. 2;
FIG. 7 is an enlarged cross-sectional view of a main part of FIG. 6;
FIG. 8 is a cross-sectional view taken along line B-B of FIG. 2;
FIG. 9 is a perspective view illustrating a developed state, a completed state, and a layered state of plate fins in another exemplary embodiment;
FIG. 10 is a diagram illustrating a refrigeration cycle of an air conditioner illustrated as an example of a refrigeration system using the plate-fin heat exchanger; and
FIG. 11 is a cross-sectional view illustrating an indoor unit of the air conditioner.

DETAILED DESCRIPTION

(Underlying knowledge of the present disclosure)

[0008] As disclosed in PTL 1, each of plate fins of a plate-fin heat exchanger includes two plates brazed to face each other. Each plate includes a header flow channel opening and a recessed groove for a heat transfer flow channel. Such a plate fin is likely to cause a joining defect due to a large number of joining portions and the complexity of the flow channel configuration. Therefore, there is a problem that it is necessary to improve reliability by reducing joining defects. Further, since the plate fin includes two joined plates, the plate fin is large in thickness, so that a gap between the plate fins decreases. Therefore, there is also a problem that the flow resistance of a fluid flowing through the gap between the plate fins is increased to deteriorate heat exchange performance, and the weight of the entire heat exchanger increases.

[0009] The inventors of the present disclosure have found that there are problems as described above, and arrived at the subject matter of the present disclosure in order to solve the problems.

[0010] The present disclosure provides a plate-fin heat exchanger which is highly reliable, is lightweight, and has high performance and a refrigeration system using the plate-fin heat exchanger.

[0011] Exemplary embodiments will be described in detail below with reference to the drawings. However, detailed descriptions more than necessary may be omitted. For example, a detailed description of well-known matters, and a duplicate description of substantially identical configurations may not be provided. This is to avoid an unnecessarily redundant description below and to facilitate understanding of a person skilled in the art.

[0012] The accompanying drawings and the following description are provided to help those skilled in the art to fully understand the present disclosure and are not intended to limit the subject matter recited in the appended claims.

(First exemplary embodiment)

[0013] A first exemplary embodiment will now be described with reference to FIGS. 1 to 8.

[1-1. Configuration]

[0014] As illustrated in FIG. 1, heat exchanger 1 according to the present exemplary embodiment includes plate-fin layered body 2, end plate 3a joined to an upper surface of plate-fin layered body 2, and end plate 3b joined to a lower surface of plate-fin layered body 2. Plate-fin layered body 2 is joined to and integrated with end plates 3a and 3b. End plates 3a and 3b have substantially the same shape as plate-fin layered body 2 in planar view. Heat exchanger 1 has tube 4 and tube 5 that are connected to end plate 3a. Tube 4 serves as an inlet when heat exchanger 1 is used as a condenser and serves as an outlet when heat exchanger 1 is used as an evaporator. Conversely, tube 5 serves as an outlet when heat exchanger 1 is used as a condenser and serves as an inlet when heat exchanger 1 is used as an evaporator.

[0015] End plates 3a and 3b on both sides of plate-fin layered body 2 are joined to plate-fin layered body 2 by brazing while sandwiching plate-fin layered body 2. End plates 3a and 3b are connected to each other at both ends in the longitudinal direction of end plates 3a and 3b by fastening means 7 to maintain rigidity as a heat exchanger.

[0016] As illustrated in FIGS. 2 and 3, plate fin 2a has heat transfer flow channels 8 through which a first fluid (hereinafter referred to as a refrigerant) such as a refrigerant flows. In plate-fin layered body 2, a gap through which a second fluid (hereinafter referred to as air) such as air flows is formed between layered plate fins 2a. Plate-fin layered body 2 promotes heat exchange between the refrigerant flowing through heat transfer flow channels 8 provided in plate fins 2a and air flowing through a gap formed between layered plate fins 2a.

[0017] As illustrated in FIG. 4, plate fin 2a includes first header region 11a, second header region 11b, and flow channel region 12. First header region 11a has first header flow channel 9 connected to tube 4. Second header region 11b has second header flow channel 10 connected to tube 5. Flow channel region 12 has heat transfer flow channels 8 connecting first header flow channel 9 and second header flow channel 10. First and second header regions 11a and 11b are integrally joined to flow channel region 12.

[0018] First and second header regions 11a and 11b have substantially the same shape. First header region 11a will be described below. In order to avoid redundant description, the description of second header region 11b may be omitted. As illustrated in FIG. 5, first header region 11a includes first plate 16a and second plate 16b that are brazed to face each other. First plate 16a includes header flow channel opening 9a (10a), ring-shaped recessed groove 13 formed in an outer periphery of header flow channel opening 9a, communication-path recessed groove 14 extending from ring-shaped recessed groove 13, and flow channel cover 15 connected to communication-path recessed groove 14. Second plate 16b has header flow channel opening 9a (10a) and ring-shaped recessed groove 13 formed in an outer periphery of header flow channel opening 9a. In this example, first header region 11a includes connection member 17 that connects first plate 16a and second plate 16b. Connection member 17 is bent, so that first plate 16a faces second plate 16b.

[0019] On the other hand, flow channel region 12 is constituted by single flow channel plate 18. Flow channel plate 18 is provided with heat transfer flow channels 8 that are formed integrally with flow channel plate 18 by extrusion process in this example. The left end of flow channel plate 18 is held between first plate 16a and second plate 16b of first header region 11a, and is integrated with first header region 11a by brazing. Similarly, the right end of flow channel plate 18 is integrated with second header region 11b by brazing.

[0020] A connecting and joining configuration for connecting first header region 11a and flow channel region 12 will be described in more detail with reference to FIG. 5 as an example. Flow channel region 12 includes heat transfer flow channel formation portions 12a and fin portions 12b. Heat transfer flow channel formation portions 12a are seamless tubes or pipes, and heat transfer flow channels 8 are formed therein. Heat transfer flow channel formation portions 12a each have first end part 12ab protruding further to first header region 11a from fin portions 12b. First end part 12ab is sandwiched between flow channel cover 15 provided in first plate 16a of first header region 11a and a flat surface portion of second plate 16b, and is connected to first header region 11a by brazing. Second header region 11b is also connected to flow channel region 12 by basically the same connecting and joining configuration. As illustrated in FIG. 4, heat transfer flow channel formation portions 12a each have second end part 12ac opposite to first end part 12ab. Second end part 12ac is sandwiched between flow channel cover 15 provided in first plate 16a of second header region 11b and a flat surface portion of second plate 16b, and is connected to second header region 11b by brazing. With this configuration, a series of paths connecting first header flow channel 9 and second header flow channel 10 are formed by flow channel cover 15 of first plate 16a and first end parts 12ab of heat transfer flow channel formation portions 12a of flow channel plate 18.

[0021] First and second header regions 11a and 11b each have protruding ribs 22 on the flat surface portion. As illustrated in FIG. 7, when plate fins 2a are layered, protruding ribs 22 abut on flow channel cover 15 of adjacent plate fin 2a and press flow channel cover 15 against first end parts 12ab of heat transfer flow channel formation portions 12a.

[0022] In addition, as illustrated in FIG. 5, heat transfer flow channels 8 of flow channel region 12 are extruded as a pair of two rows in this example. As shown in FIG. 8, flow channel region 12 has protrusions 12c for allowing the air flowing through the gap between layered plate fins to meander on the back surfaces of fin portions 12b between heat transfer flow channel formation portions 12a.

[0023] Further, the plurality of heat transfer flow channels 8 arranged in parallel are connected by auxiliary communication flow paths 19 recessed in first and second header regions 11a and 11b, respectively, and turn back between first header flow channel 9 and second header flow channel 10.

[0024] End plates 3a and 3b and plate fins 2a are made of aluminum or an aluminum alloy.

[1-2. Operation]

[0025] Next, the operation and effect of the plate-fin heat exchanger configured as described above will be described by taking, as an example, a case where the plate-fin heat exchanger is used as a heat exchanger of an air conditioner.

[0026] When heat exchanger 1 according to the present exemplary embodiment is used, for example, under a condensation condition, a refrigerant in a gas phase state flows into first header flow channels 9 on an inlet side of plate-fin layered body 2 through tube 4. The gas-phase refrigerant flowing into first header flow channels 9 flows while turning back through heat transfer flow channels 8 of plate fins 2a, and flows out through tube 5 to a refrigerant circuit of a refrigeration system via second header flow channels 10 on the outlet side. The gas-phase refrigerant sequentially transitions into a liquid phase by heat exchange with air passing through the gaps between layered plate fins while flowing through heat transfer flow channels 8.

[0027] Here, first and second header regions 11a and 11b each include two plates which are first plate 16a and second plate 16b and which are joined by brazing. Flow channel region 12 includes single flow channel plate 18 having heat transfer flow channels 8 formed therein by extrusion process. Therefore, in heat exchanger 1, the joining portions by brazing are located only in first and second header regions 11a and 11b, and thus can be minimized. Accordingly, the reliability of heat exchanger 1 can be significantly enhanced.

[0028] On the other hand, flow channel region 12 of plate fin 2a is composed of single flow channel plate 18 having heat transfer flow channels 8 formed therein by extrusion process. The thickness of each fin portion 12b of flow channel region 12 is smaller than the total thickness of brazed first and second plates 16a and 16b of header region 11. As illustrated in FIG. 7, each of heat transfer flow channel formation portions 12a of flow channel region 12 has thickness t. First and second header regions 11a and 11b each are constituted by joined first and second plates 16a and 16b, and have thickness T in communication-path recessed groove 14. Thickness T corresponds to a thickness of a portion having a conventional heat transfer flow channel formed by joining two plates. Thickness t is smaller than thickness T.

[0029] Therefore, gap L, which is an air passage, between flow channel regions 12 of layered plate fins illustrated in FIG. 8 can be made wider as compared with a prior art. Thus, the flow resistance of air can be reduced, and the performance of heat exchanger 1 can be enhanced. In addition, heat exchanger 1 enables air to meander as indicated by dashed arrow Y by protrusions 12c protruding to gap L between flow channel regions 12 of layered plate fins, whereby the performance of heat exchanger 1 can be further enhanced.

[0030] Further, plate fin 2a is reduced in weight due to reduction in thickness of flow channel region 12. Therefore, the weight of entire heat exchanger 1 can be significantly reduced, whereby weight saving can be achieved.

[0031] As illustrated in FIG. 5, first header region 11a is connected to flow channel region 12 such that first end parts 12ab of heat transfer flow channel formation portions 12a are sandwiched between flow channel cover 15 provided in first plate 16a of first header region 11a and the flat surface portion of second plate 16b. Similarly, second header region 11b is connected to flow channel region 12. As a result, first and second header regions 11a and 11b can be easily connected to flow channel region 12, and connection by brazing can be ensured with joining defects being suppressed.

[0032] In the present exemplary embodiment, each of first and second header regions 11a and 11b has protruding ribs 22 on the flat surface portion of second plate 16b. When plate fins 2a are layered, protruding ribs 22 press flow channel cover 15 of adjacent plate fin 2a. The first fluid applies pressure (plate releasing pressure) in a direction of releasing first plate 16a from second plate 16b at the joint portion between flow channel cover 15 and first end parts 12ab of heat transfer flow channel formation portions 12a. Protruding ribs 22 can apply pressure against the plate releasing pressure to first plate 16a, so that first and second plates 16a and 16b are kept firmly joined to each other. As a result, the reliability can be further improved by enhancing the airtightness at the joint portion, between flow channel cover 15 and first end parts 12ab of heat transfer flow channel formation portions 12a, through which the first fluid flows.

[0033] Further, in each of first and second header regions 11a and 11b, first plate 16a and second plate 16b are connected by connection member 17. First plate 16a and second plate 16b are managed as one component, and thus, a number of components can be reduced, and parts management can be facilitated.

[0034] In the present exemplary embodiment, first header region 11a includes first header flow channel 9. Second header region 11b has second header flow channel 10. First header region 11a and second header region 11b are located at opposite ends of plate fin 2a, respectively. However, the configuration is not limited thereto, and as shown in FIG. 9, plate fin 2a may include header region 11, auxiliary flow channel region 21, and flow channel region 12 connected between header region 11 and auxiliary flow channel region 21. Header region 11 includes first header flow channel 9 and second header flow channel 10. Auxiliary flow channel region 21 has communication path 20 connecting heat transfer flow channels 8. As described above, first header flow channel 9 and second header flow channel 10 may be provided at one end of plate fin 2a.

[0035] The same effects as described above can also be obtained by the configuration described above in which first header flow channel 9 and second header flow channel 10 are provided at one end of plate fin 2a. In addition, first header flow channel 9 and second header flow channel 10 are disposed at one end of plate fin 2a, so that tubes of a refrigeration system can be connected to first header flow channel 9 and second header flow channel 10 at one place.

[1-3. Effects and others]

[0036] As described above, the plate-fin heat exchanger according to the present disclosure includes plate fin 2a including first header flow channel 9, second header flow channel 10, and heat transfer flow channel 8 connected between first and second header flow channels 9 and 10, plate fin 2a including first header region 11a having first header flow channel 9, second header region 11b having second header flow channel 10, and flow channel region 12 having heat transfer flow channel 8, wherein first and second header regions 11a and 11b are each constituted by two joined plates 16a and 16b each having a header flow channel opening, flow channel region 12 is constituted by single flow channel plate 18 in which heat transfer flow channel 8 is integrally formed, and first and second header regions 11a and 11b are integrally joined to flow channel region 12.

[0037] As a result, flow channel region 12 is constituted by single flow channel plate 18 in which heat transfer flow channel 8 is integrally formed. The joining portions are located only in first and second header regions 11a and 11b. That is, the joining portions by brazing or the like can be minimized. Therefore, the reliability of heat exchanger 1 can be enhanced. Flow channel region 12 constituted by single flow channel plate 18 can reduce the flow resistance of the second fluid due to reduced weight and reduced thickness as compared with a flow channel region constituted by two joined plates. As a result, it is possible to provide a plate-fin heat exchanger that is lightweight, has high performance, and is highly reliable.

[0038] Further, the plate-fin heat exchanger according to the present disclosure includes plate fin 2a including first header flow channel 9, second header flow channel 10, and a plurality of heat transfer flow channels 8 connected in series between first and second header flow channels 9 and 10, plate fin 2a including header region 11 having first and second header flow channels 9 and 10, flow channel region 12 having the plurality of heat transfer flow channels 8, and auxiliary flow channel region 21 having communication path 20 connecting the plurality of heat transfer flow channels 8, wherein header region 11 is integrally joined to a first end of flow channel region 12, and auxiliary flow channel region 21 is integrally joined to a second end opposite to the first end of flow channel region 12.

[0039] With this configuration, first and second header flow channels 9 and 10 are gathered near the first end of plate fin 2a of heat exchanger 1. As described above, the weight of the heat exchanger can be reduced, reliability and performance can be improved, and the work of connecting tubes of a refrigeration system to first and second header flow channels 9 and 10 can be facilitated.

[0040] Further, flow channel region 12 may have heat transfer flow channel formation portion 12a for forming heat transfer flow channel 8, heat transfer flow channel formation portion 12a may have first end part 12ab and second end part 12ac opposite to the first end part, first end part 12ab may be sandwiched between two plates 16a and 16b of first header region 11a, and second end part 12ac may be sandwiched between two plates 16a and 16b of second header region 11b.

[0041] As a result, first and second header regions 11a and 11b can be easily connected to flow channel region 12 by brazing, and the brazing can be made robust and secure.

[0042] Flow channel region 12 may have a plurality of heat transfer flow channel formation portions 12a for forming the plurality of heat transfer flow channels 8, each of the plurality of heat transfer flow channel formation portions 12a may have first end part 12ab and second end part 12ac opposite to first end part 12ab, header region 11 may be constituted by two joined plates 16a and 16b, first end part 12ab of each of the plurality of heat transfer flow channel formation portions 12a may be sandwiched between two joined plates 16a and 16b of header region 11, auxiliary flow channel region 21 may be constituted by two joined plates 16a and 16b, and second end part 12ac of each of the plurality of heat transfer flow channel formation portions 12a may be sandwiched between two joined plates 16a and 16b of auxiliary flow channel region 21.

[0043] As a result, header region 11 can be easily connected to flow channel region 12 by brazing, and the brazing can be made robust and secure. In addition, auxiliary flow channel region 21 and flow channel region 12 can be easily connected by brazing, and the brazing can be made robust and secure.

(Second exemplary embodiment)

[0044] A second exemplary embodiment will be described below with reference to FIGS. 10 and 11.

[2-1. Configuration]

[0045] FIG. 10 is a diagram illustrating a refrigeration cycle of an air conditioner equipped with the plate-fin heat exchanger according to the first exemplary embodiment, and FIG. 11 is a schematic sectional view illustrating an indoor unit of the air conditioner.

[0046] In FIGS. 10 and 11, the air conditioner includes outdoor unit 51 and indoor unit 52 connected to outdoor unit 51. Outdoor unit 51 is provided with compressor 53 for compressing a refrigerant, four-way valve 54 for switching a refrigerant circuit during cooling and heating operations, outdoor heat exchanger 55 that exchanges heat between the refrigerant and outdoor air, decompressor 56 for decompressing the refrigerant, and outdoor blower 59. Indoor unit 52 is provided with indoor heat exchanger 57 for exchanging heat between the refrigerant and indoor air, and indoor blower 58. Indoor heat exchanger 57 is the plate-fin heat exchanger described in the first exemplary embodiment. Compressor 53, four-way valve 54, indoor heat exchanger 57, decompressor 56, and outdoor heat exchanger 55 are connected via the refrigerant circuit to define a heat-pump refrigeration cycle.

[2-2. Operation]

[0047] In the air conditioner having the above configuration, during cooling operation, four-way valve 54 is switched such that the discharge side of compressor 53 and outdoor heat exchanger 55 communicate with each other. Thus, the refrigerant compressed by compressor 53 transitions into a high-temperature high-pressure gas-phase refrigerant and is supplied to outdoor heat exchanger 55 through four-way valve 54. Then, the refrigerant dissipates heat by heat exchange with outdoor air to transition into a high-pressure liquid-phase refrigerant, and is supplied to decompressor 56. The refrigerant is decompressed by decompressor 56 into low-temperature low-pressure two-phase refrigerant, and supplied to indoor unit 52. In indoor unit 52, the refrigerant enters indoor heat exchanger 57, absorbs heat by heat exchange with indoor air, and evaporates to transition into a low-temperature gas refrigerant. During this cycle, the indoor air is cooled, so that an indoor space is cooled. The refrigerant then returns to outdoor unit 51, and is returned back to compressor 53 through four-way valve 54.

[0048] During heating operation, four-way valve 54 is switched such that the discharge side of compressor 53 and indoor unit 52 communicate with each other. Thus, the refrigerant compressed by compressor 53 transitions into a high-temperature high-pressure refrigerant, and is supplied to indoor unit 52 through four-way valve 54. The high-temperature high-pressure refrigerant enters indoor heat exchanger 57 and dissipates heat by heat exchange with indoor air to transition into a high-pressure liquid refrigerant. During this cycle, the indoor air is heated, so that the indoor space is heated. Then, the refrigerant is supplied to decompressor 56, is decompressed by decompressor 56 to transition into a low-temperature low-pressure two-phase refrigerant, is sent to outdoor heat exchanger 55, evaporates by heat exchange with outdoor air, and then, returns to compressor 53 through four-way valve 54.

[2-3. Effects and others]

[0049] Since the refrigeration system according to the present disclosure uses the heat exchanger described in the first exemplary embodiment as indoor heat exchanger 57, the refrigeration system is lightweight, has high performance, and is highly reliable.

[Other exemplary embodiments]

[0050] While the plate-fin heat exchanger and the refrigeration system using the plate-fin heat exchanger according to the present disclosure have been described with reference to the exemplary embodiments described above, the present disclosure is not limited thereto, and various modifications, replacements, additions, omissions, and the like are possible. For example, although the case where the first fluid is a refrigerant and the second fluid is air has been described above, the present disclosure is not limited thereto. Although the air conditioner has been described above as the refrigeration system, the refrigeration system may be a refrigerator, a refrigeration case, or a heat pump water heater using water as the second fluid. That is, the exemplary embodiments disclosed herein are illustrative in all respects and are not restrictive, and the scope of the present disclosure is defined by the claims, and includes all modifications within the meaning and scope equivalent to the claims.

[0051] As described above, the present disclosure can provide a plate-fin heat exchanger that is lightweight and highly reliable and has high performance, and a refrigeration system using the plate-fin heat exchanger. Accordingly, the present disclosure is widely applicable to heat exchangers used in domestic and industrial air-conditioners, and various refrigerating devices, and thus, is of great industrial value.

Claims

1. A plate-fin heat exchanger comprising

a plate fin including:

a first header flow channel;
a second header flow channel; and
a heat transfer flow channel connected between the first and second header flow channels,

the plate fin including:

a first header region having the first header flow channel;
a second header region having the second header flow channel; and
a flow channel region having the heat transfer flow channel,

wherein the first and second header regions are each constituted by two joined plates each having a header flow channel opening,
the flow channel region is constituted by a single plate in which the heat transfer flow channel is integrally formed, and
the first and second header regions are integrally joined to the flow channel region.

2. A plate-fin heat exchanger comprising:

a plate fin including:

a first header flow channel;
a second header flow channel; and
a plurality of heat transfer flow channels connected in series between the first and second header flow channels,

the plate fin including:

a header region having the first and second header flow channels;
a flow channel region having the plurality of heat transfer flow channels; and
an auxiliary flow channel region having a communication path connecting the plurality of heat transfer flow channels,

wherein
the header region is integrally joined to a first end of the flow channel region, and
the auxiliary flow channel region is integrally joined to a second end opposite to the first end of the flow channel region.

3. The plate-fin heat exchanger according to claim 1, wherein

the flow channel region has a heat transfer flow channel formation portion for forming the heat transfer flow channel,
the heat transfer flow channel formation portion has a first end part and a second end part opposite to the first end part,
the first end part is sandwiched between the two joined plates of the first header region, and
the second end part is sandwiched between the two joined plates of the second header region.

4. The plate-fin heat exchanger according to claim 2, wherein

the flow channel region has a plurality of heat transfer flow channel formation portions for forming the plurality of heat transfer flow channels,
each of the plurality of heat transfer flow channel formation portions has a first end part and a second end part opposite to the first end part,
the header region is constituted by two joined plates,
the first end part of each of the plurality of heat transfer flow channel formation portions is sandwiched between the two joined plates of the header region,
the auxiliary flow channel region is constituted by two joined plates, and the second end part of each of the plurality of heat transfer flow channel formation portions is sandwiched between the two joined plates of the auxiliary flow channel region.

5. A refrigeration system comprising the plate-fin heat exchanger according to any one of claims 1 to 4.

FIG. 1

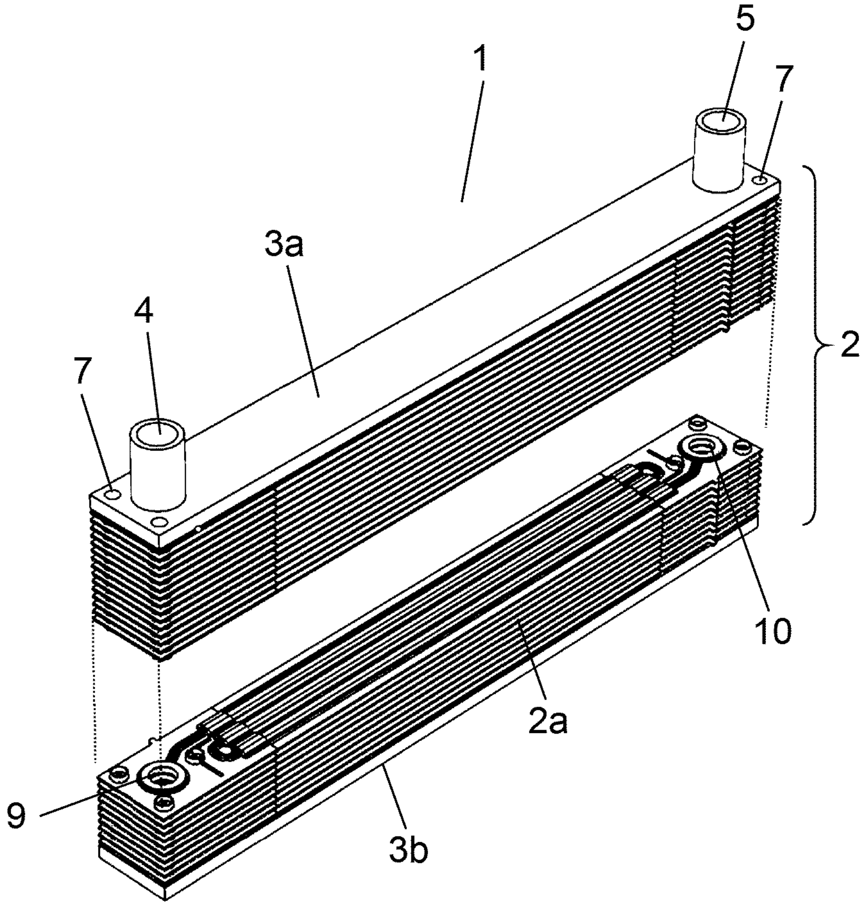


FIG. 2

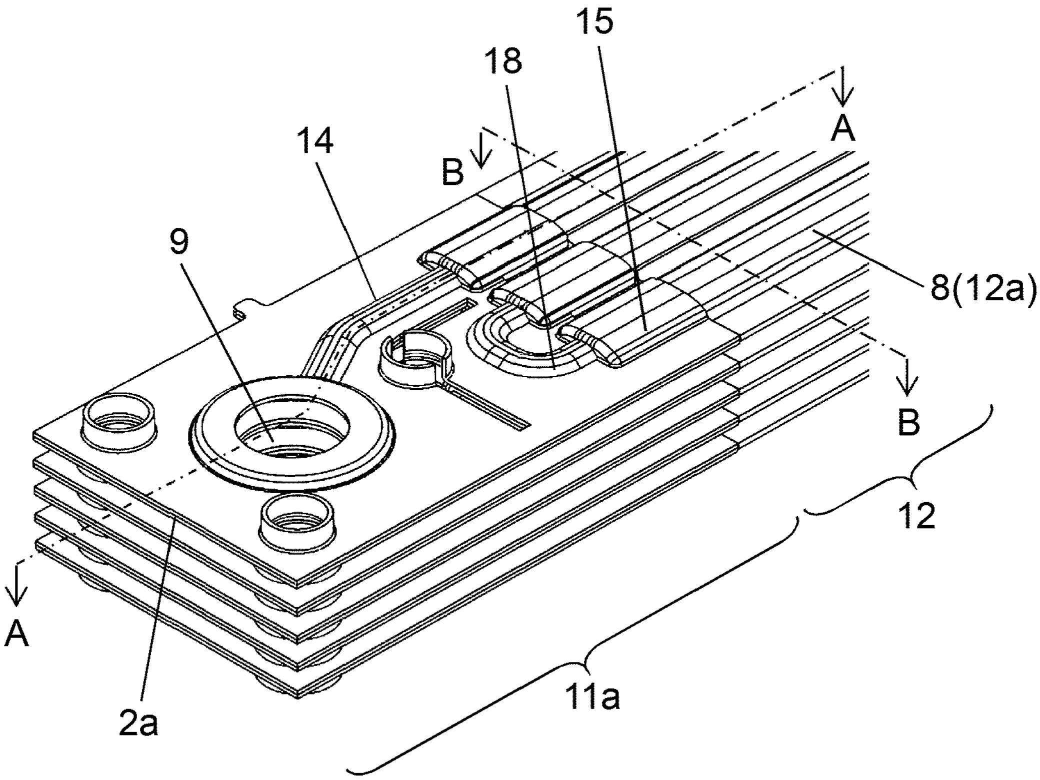


FIG. 3

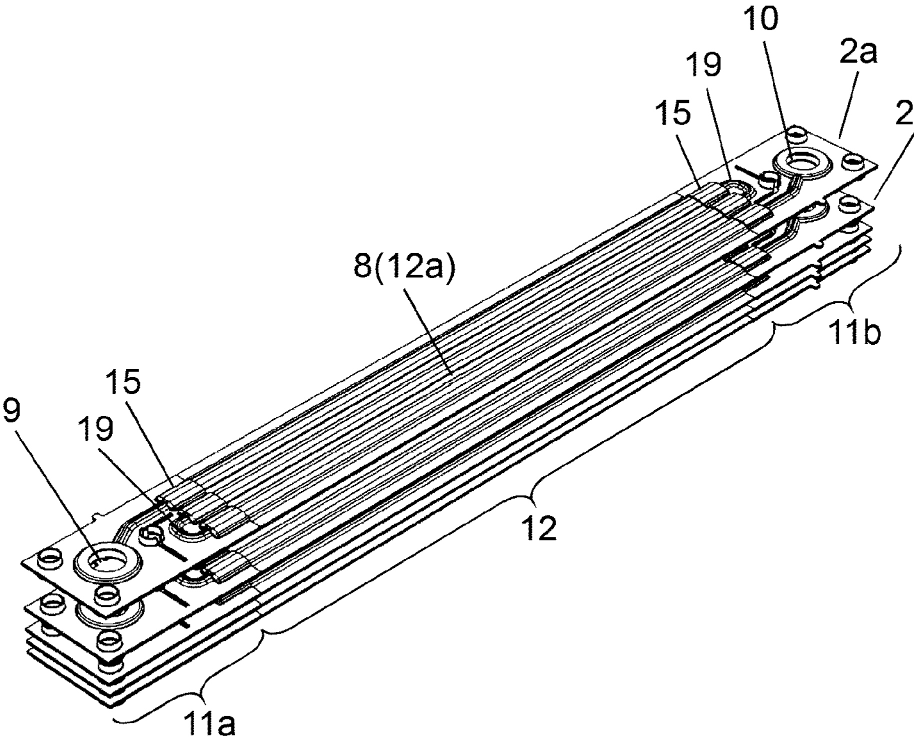

10
2a
19
15
2a
8(12a)
11b
15
9
19
12
11a

FIG. 4

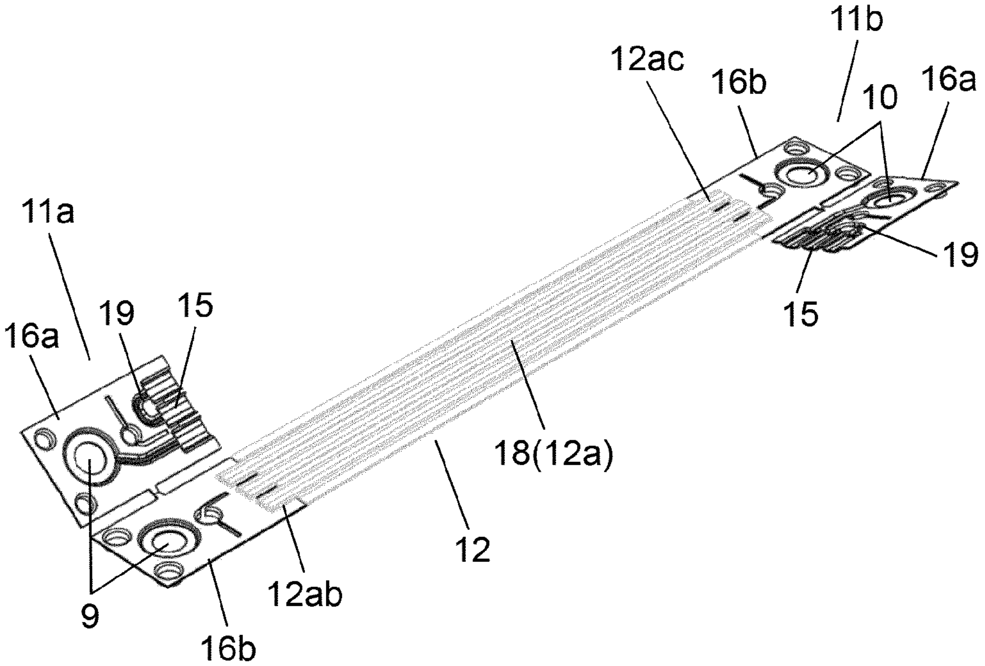

11b
12ac
16b
10
16a
11a
19
19
15
16a
15
18(12a)
12
9
12ab
16b

FIG. 5

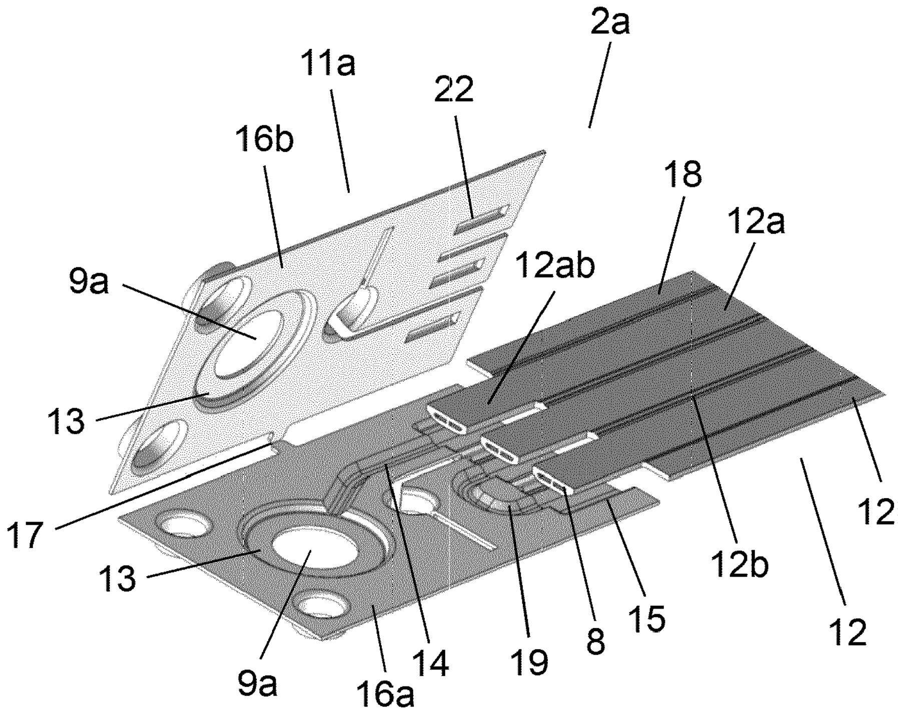

2a
11a
22
16b
18
12a
12ab
9a
13
17
13
9a
16a
14
19
8
15
12b
12b
12

FIG. 6

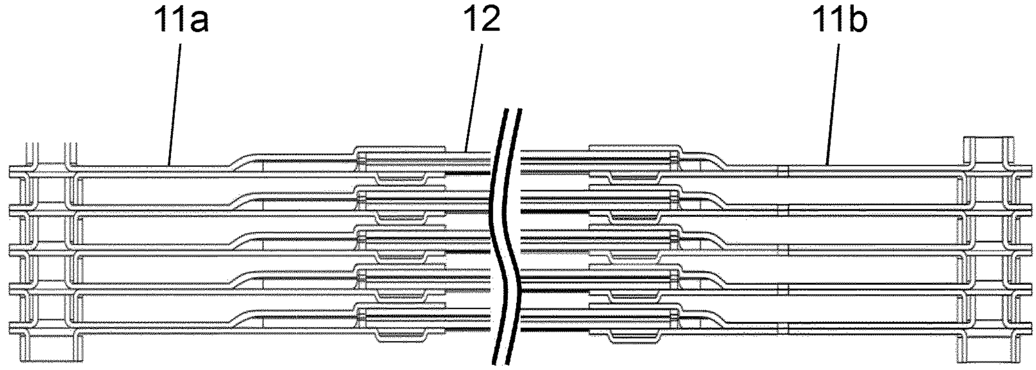

11a
12
11b

FIG. 7

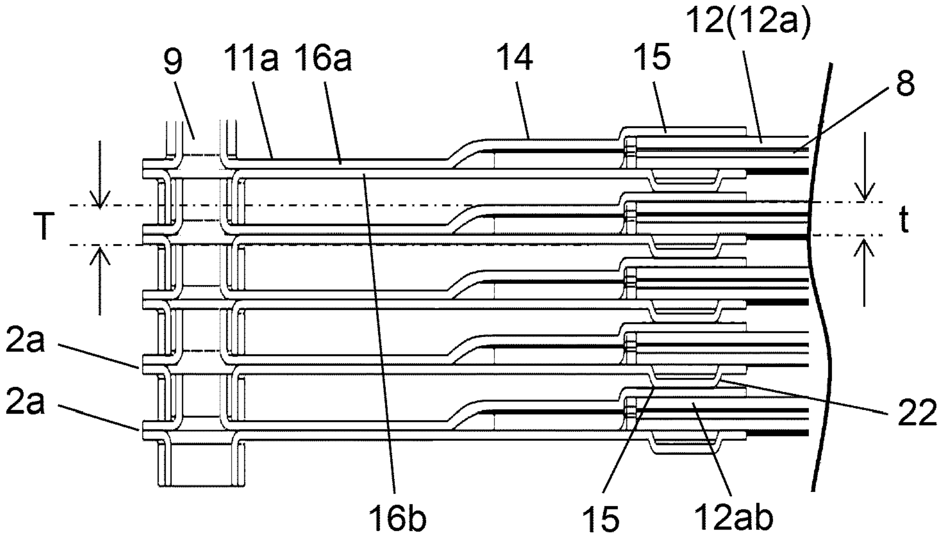

9
11a
16a
14
15
12(12a)
8
T
t
2a
2a
22
16b
15
12ab

FIG. 8

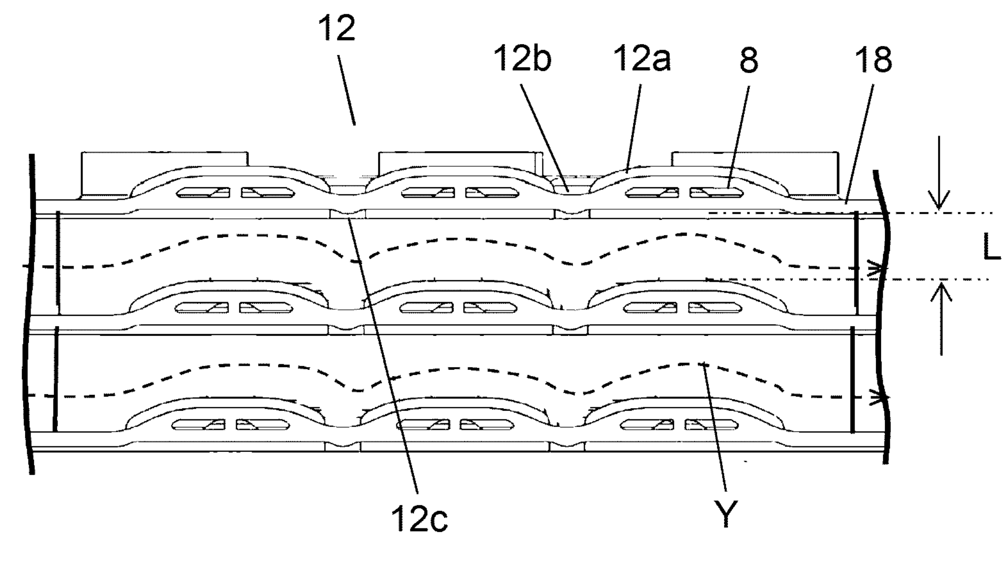

12
12b
12a
8
18
L
12c
Y

FIG. 9

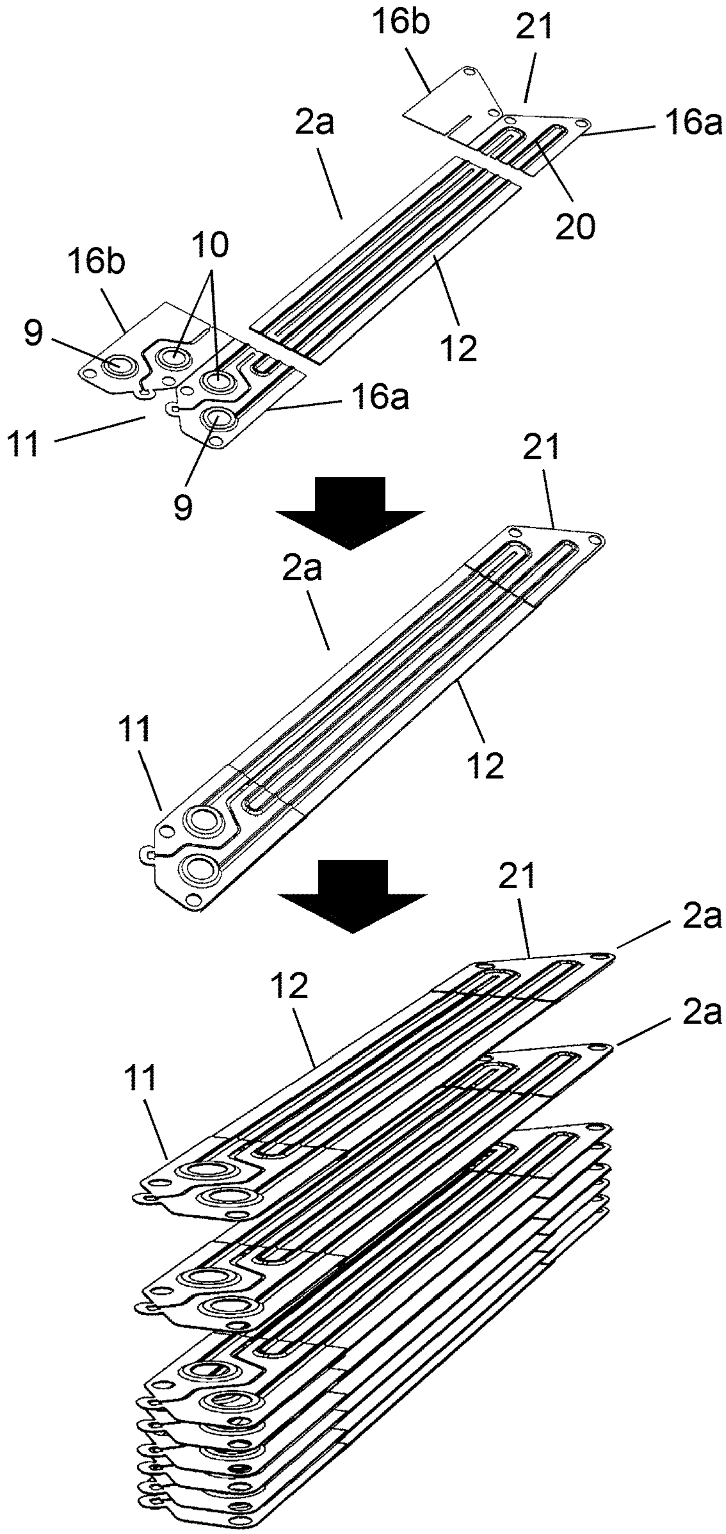


FIG. 10

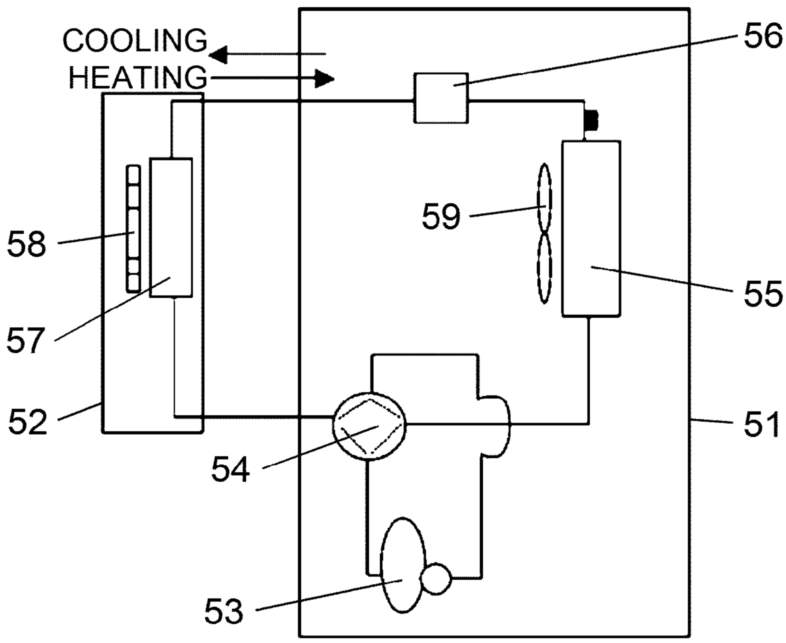
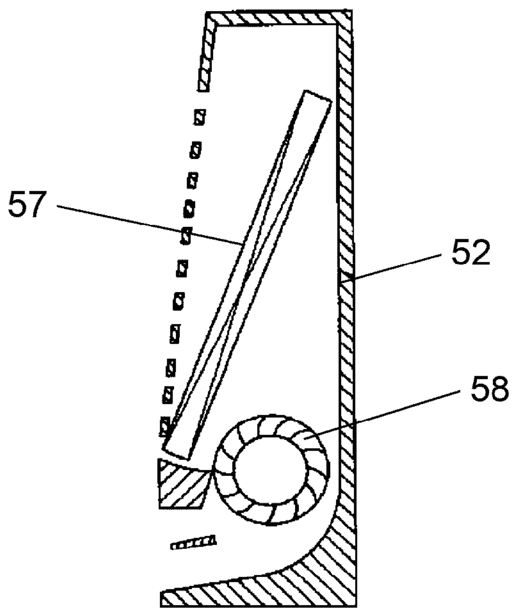


FIG. 11



Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 21 20 3587

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 4 846 268 A (BELDAM RICHARD P [CA] ET AL) 11 July 1989 (1989-07-11) * column 3, line 40 - column 6, line 30; figures 1b,2,3 *	1,3,5	INV. F28D1/03
X	US 5 634 519 A (LAVERAN JEAN-LOUIS [FR]) 3 June 1997 (1997-06-03) * column 3, line 53 - column 5, line 32; figures 1-7 *	1,3	
X	US 6 467 536 B1 (ABATE GUGLIEMO WILLIAM [US] ET AL) 22 October 2002 (2002-10-22) * column 2, line 13 - column 3, line 19; figures 1-5 *	2,4,5	
X	US 4 969 512 A (HISAO AOKI [JP] ET AL) 13 November 1990 (1990-11-13) * the whole document *	2,4,5	
X	US 2020/158388 A1 (VREELAND GARY SCOTT [US] ET AL) 21 May 2020 (2020-05-21) * paragraph [0028] - paragraph [0036]; figures 2-3 *	2,5	TECHNICAL FIELDS SEARCHED (IPC)
X	FR 2 864 215 A1 (VALEO CLIMATISATION [FR]) 24 June 2005 (2005-06-24) * page 8, line 11 - page 18, line 29; figures 1-5c *	2,4	F28D F28F

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	28 March 2022	Jessen, Flemming

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 21 20 3587

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

28-03-2022

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 4846268	A	11-07-1989	CA	1275647	C	30-10-1990
			EP	0324226	A1	19-07-1989
			JP	H01179891	A	17-07-1989
			US	4846268	A	11-07-1989
US 5634519	A	03-06-1997	DE	69521843	T2	04-04-2002
			EP	0686823	A1	13-12-1995
			FR	2721099	A1	15-12-1995
			US	5634519	A	03-06-1997
US 6467536	B1	22-10-2002	US	6467536	B1	22-10-2002
			US	2002179291	A1	05-12-2002
US 4969512	A	13-11-1990	EP	0325452	A1	26-07-1989
			JP	H0619965	Y2	25-05-1994
			JP	H01111955	U	27-07-1989
			US	4969512	A	13-11-1990
US 2020158388	A1	21-05-2020	NONE			
FR 2864215	A1	24-06-2005	FR	2864215	A1	24-06-2005
			WO	2005061980	A2	07-07-2005

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2018066532 A **[0003]**