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

(11) EP 3 845 851 A1

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

(43) Date of publication:
07.07.2021 Bulletin 2021/27

(21) Application number: **18932105.2**

(22) Date of filing: **27.08.2018**

(51) Int Cl.:
F28F 1/20 *(2006.01)* ***F25B 39/00*** *(2006.01)*
F28D 1/053 *(2006.01)*

(86) International application number:
PCT/JP2018/031502

(87) International publication number:
WO 2020/044391 (05.03.2020 Gazette 2020/10)

(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
KH MA MD TN

(71) Applicant: **Mitsubishi Electric Corporation**
Tokyo 100-8310 (JP)

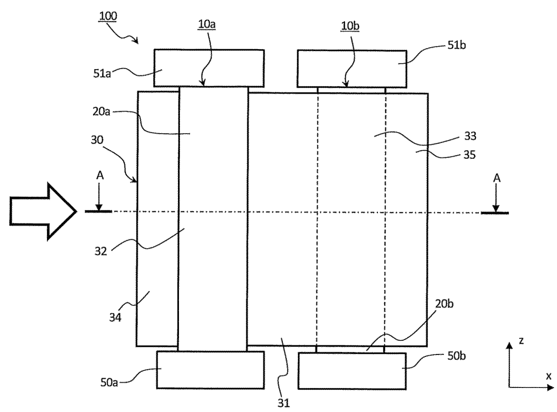
(72) Inventors:
- **ISHIBASHI, Akira**
  Tokyo 100-8310 (JP)
- **MAEDA, Tsuyoshi**
  Tokyo 100-8310 (JP)
- **NAKAMURA, Shin**
  Tokyo 100-8310 (JP)

(74) Representative: **Mewburn Ellis LLP**
Aurora Building
Counterslip
Bristol BS1 6BX (GB)

(54) HEAT EXCHANGER, HEAT EXCHANGER UNIT, AND REFRIGERATION CYCLE DEVICE

(57) A heat-exchanger, a heat-exchanger unit, and a refrigeration-cycle apparatus are provided that allow for improved pressure resistance of tubes through which refrigerant passes, reduced weight of heat transfer fins, and easy manufacture. The heat-exchanger includes a first flat-tube group, a second flat-tube group, and a fin. The first flat-tube group includes plural flat tubes each having a pipe axis, and the flat tubes included in the first flat-tube group are arranged in such a manner that the pipe axes of the flat tubes included in the first flat-tube group are arranged in parallel to each other. One of the flat tubes included in the first flat-tube group is a first flat tube. The second flat-tube group is provided adjacent to the first flat-tube group, the second flat-tube group includes plural flat tubes each having a pipe axis, and the flat tubes included in the second flat-tube group are arranged in such a manner that the pipe axes of the flat tubes included in the second flat-tube group are arranged in parallel to each other. One of the flat tubes included in the second flat-tube group is a second flat tube. The fin is provided to the first flat-tube group and the second flat-tube group. The fin includes a first portion connecting an end of a longitudinal axis of the first flat tube in a section perpendicular to the pipe axis of the first flat tube and an end of a longitudinal axis of the second flat tube in a section perpendicular to the pipe axis of the second flat tube.

FIG. 2



EP 3 845 851 A1

Description

Technical Field

[0001] The present disclosure relates to a heat-exchanger, a heat-exchanger unit including a heat-exchanger, and a refrigeration-cycle apparatus. More specifically, the present disclosure relates to the structure of fins attached to flat tubes.

Background Art

[0002] In some multi-tube heat-exchanger designed to improve the heat-exchange performance, two plates are bonded together, tubular body parts with a small diameter are arranged in a staggered manner, and the tubular body parts are connected to each other by heat transfer fins (see, for example, Patent Literature 1).

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2006-084078

Summary of Invention

Technical Problem

[0004] In the heat-exchanger disclosed in Patent Literature 1, each tubular body part is formed by bonding two plates together. A problem with this configuration is that, to ensure the pressure resistance of the tubular body parts, the heat transfer fins need to be made thicker as well, leading to increased weight. Another problem with the above-mentioned configuration is that the brazing filler metal used to bond and join the two plates together penetrates into a refrigerant passage in the tubular body parts.

[0005] The present disclosure has been made to address the above-mentioned problems, and accordingly it is an object of the present disclosure to provide a heat-exchanger, a heat-exchanger unit, and a refrigeration-cycle apparatus that allow for improved pressure resistance of tubes through which refrigerant passes, reduced weight of heat transfer fins, and easy manufacture.

Solution to Problem

[0006] A heat-exchanger according to an embodiment of the present disclosure includes a first flat-tube group, a second flat-tube group, and a fin. The first flat-tube group includes plural flat tubes each having a pipe axis, and the flat tubes included in the first flat-tube group are arranged in such a manner that the pipe axes of the flat tubes included in the first flat-tube group are arranged in parallel to each other. One of the flat tubes included in the first flat-tube group is a first flat tube. The second flat-tube group is provided adjacent to the first flat-tube group, the second flat-tube group includes plural flat tubes each having a pipe axis, and the flat tubes included in the second flat-tube group are arranged in such a manner that the pipe axes of the flat tubes included in the second flat-tube group are arranged in parallel to each other. One of the flat tubes included in the second flat-tube group is a second flat tube. The fin is provided to the first flat-tube group and the second flat-tube group. The fin includes a first portion connecting an end of a longitudinal axis of the first flat tube in a section perpendicular to the pipe axis of the first flat tube and an end of a longitudinal axis of the second flat tube in a section perpendicular to the pipe axis of the second flat tube.

[0007] A heat-exchanger unit according to an embodiment of the present disclosure includes the heat-exchanger described above.

[0008] A refrigeration-cycle apparatus according to an embodiment of the present disclosure includes the heat-exchanger unit described above.

Advantageous Effects of Invention

[0009] According to an embodiment of the present disclosure, plural flat-tube groups each including plural flat tubes are connected by a fin. This configuration makes it possible to improve the pressure resistance of the tubes through which refrigerant is passed, and reduce the thickness of the fin to thereby also reduce the weight of the fin. Furthermore, a heat-exchanger, a heat-exchanger unit, and a refrigeration-cycle apparatus that have improved heat-exchange performance and are also easy to manufacture can be provided.

Brief Description of Drawings

[0010]

[Fig. 1] Fig. 1 is a front view of a heat-exchanger according to Embodiment 1.

[Fig. 2] Fig. 2 is a side view of the heat-exchanger according to Embodiment 1.

[Fig. 3] Fig. 3 illustrates a refrigeration-cycle apparatus employing the heat-exchanger according to Embodiment 1.

[Fig. 4] Fig. 4 illustrates a sectional structure of the heat-exchanger illustrated in Fig. 2.

[Fig. 5] Fig. 5 is a side view of a heat-exchanger representing a modification of the heat-exchanger according to Embodiment 1.

[Fig. 6] Fig. 6 illustrates a sectional structure of the heat-exchanger representing a modification of the heat-exchanger according to Embodiment 1.

[Fig. 7] Fig. 7 is an enlarged view of a slit as seen in the x-direction.

[Fig. 8] Fig. 8 illustrates a sectional structure of a heat-exchanger representing a modification of the heat-exchanger according to Embodiment 1.

Description of Embodiments

[0011] An embodiment of a heat-exchanger, and an embodiment of a heat-exchanger unit will be described below. It is to be understood that the drawings are only illustrative of one example, and not intended to limit the present disclosure. Elements designated by the same reference signs in the drawings represent the same or corresponding elements throughout the specification. Further, in the drawings below, the relative sizes of various components may differ from the actual relative sizes.

Embodiment 1

[0012] Fig. 1 is a front view of a heat-exchanger 100 according to Embodiment 1. Fig. 2 is a side view of the heat-exchanger 100 according to Embodiment 1. Fig. 3 illustrates a refrigeration-cycle apparatus 1 employing the heat-exchanger 100 according to Embodiment 1. The heat-exchanger 100 illustrated in Figs. 1 and 2 is incorporated in the refrigeration-cycle apparatus 1 such as an air-conditioning apparatus and a refrigerator. As illustrated in Fig. 3, the refrigeration-cycle apparatus 1 includes a compressor 3, a four-way valve 4, an outdoor heat-exchanger 5, an expansion device 6, and an indoor heat-exchanger 7, which are connected by a refrigerant pipe 90 to form a refrigerant circuit. If, for instance, the refrigeration-cycle apparatus 1 is an air-conditioning apparatus, refrigerant flows in the refrigerant pipe 90, and the four-way valve 4 switches the flows of refrigerant to switch the refrigeration-cycle apparatus 1 to a heating operation, a refrigeration operation, or a defrost operation.

[0013] The outdoor heat-exchanger 5 incorporated in an outdoor unit 8 is provided with a fan 2 disposed close to the outdoor heat-exchanger 5, and the indoor heat-exchanger 7 incorporated in an indoor unit 9 is provided with another fan 2 disposed close to the indoor heat-exchanger 7. In the outdoor unit 8, the fan 2 sends outside air to the outdoor heat-exchanger 5 for heat exchange between the outside air and refrigerant. In the indoor unit 9, the fan 2 sends indoor air to the indoor heat-exchanger 7 for heat exchange between the indoor air and refrigerant to thereby condition the temperature of the indoor air. The heat-exchanger 100 can be used in the refrigeration-cycle apparatus 1 as the outdoor heat-exchanger 5 incorporated in the outdoor unit 8, and as the indoor heat-exchanger 7 incorporated in the indoor unit 9. The heat-exchanger 100 is used as a condenser or an evaporator. Units in which the heat-exchanger 100 is incorporated, such as the outdoor unit 8 and the indoor unit 9, will be specifically referred to as heat-exchanger units.

[0014] The heat-exchanger 100 illustrated in Fig. 1 includes two flat-tube groups 10. Of the two flat-tube groups 10, one will be referred to as first flat-tube group 10a, and the other will be referred to as second flat-tube group 10b. In the following description, the flat-tube groups 10a and 10b will be sometimes collectively referred to as flat-tube group 10. The first flat-tube group 10a and the second flat-tube group 10b are arranged in the x-direction. The flat-tube group 10 includes plural flat tubes 20. The flat tubes 20 are represented as flat tubes 20a and 20b illustrated in Figs. 1 and 2. The flat tubes 20 in each flat-tube group 10 are disposed in the y-direction with their pipe axes arranged in parallel to each other. In Embodiment 1, the pipe axes of the flat tubes 20 are oriented in the z-direction. In Embodiment 1, the reverse z-direction coincides with the direction of gravity. Alternatively, however, the heat-exchanger 100 may be disposed with the z-axis inclined from the direction of gravity. Each of the flat tubes 20a of the first flat-tube group 10a is connected to a lower-end header 50a at a lower end in the direction of the pipe axis, and connected to an upper-end header 51a at an upper end in the direction of the pipe axis. Likewise, each of the flat tubes 20b of the second flat-tube group 10b is connected to a lower-end header 50b at a lower end in the direction of the pipe axis, and connected to an upper-end header 51b at an upper end in the direction of the pipe axis. Although the heat-exchanger 100 includes two flat-tube groups 10a and 10b in Embodiment 1, the heat-exchanger 100 may include more than two flat-tube groups 10.

[0015] Fig. 4 illustrates a sectional structure of the heat-exchanger 100 illustrated in Fig. 2. Fig. 4 represents a section perpendicular to the pipe axes of the flat tubes 20 included in each of the flat-tube groups 10, and illustrates the structure of a section corresponding to a section along A-A of Fig. 2. Fig. 4 shows some of the flat tubes 20 constituting each flat-tube group 10. The flat tubes 20a of the first flat-tube group 10a, and the flat tubes 20b of the second flat-tube group 10b are arranged in such a manner that, in a section perpendicular to the pipe axes of the flat tubes 20a and 20b, their longitudinal axes are oriented in the x-direction and their lateral axes are oriented in the y-direction. The flat tubes 20a of the first flat-tube group 10a, and the flat tubes 20b of the second flat-tube group 10b are arranged in a staggered manner. That is, the second flat tube 20b included in the second flat-tube group 10b is disposed at a location offset in the y-direction from an extension of the longitudinal axis of the first flat tube 20a included in the first flat-tube group 10a, and when the flat tubes 20a and 20b are viewed in the x-direction, the second flat tube 20b lies on an extension of the gap between two first flat tubes 20a that are adjacent to each other. The first flat tube 20a and the second flat tube 20b will be sometimes collectively referred to as flat tube 20 hereinafter.

[0016] As illustrated in Fig. 4, a fin 30 is provided to the first flat tube 20a of the first flat-tube group 10a, and to the second flat tube 20b of the second flat-tube group 10b. The fin 30 is formed by bending a single plate-like part. The fin 30 is disposed in such a manner that a plate face of the fin 30 is positioned along the first flat tube 20a and the other plate face of the fin 30 is positioned along the second flat tube 20b. In Embodiment 1, the pipe axis of the first flat tube 20a and the pipe axis of the second flat tube 20b coincide with the direction of gravity, and thus the fin 30 is disposed with its plate faces extending in the direction of gravity. The above-mentioned configuration of the heat-exchanger 100 ensures that condensed water that forms on the fin 30 because of condensation when the heat-exchanger 100 is used as an evaporator, or melted water resulting from defrost operation performed when frost forms, can be smoothly discharged from the fin 30. This makes it possible to maintain high heat-exchange performance of the heat-exchanger 100.

[0017] The fin 30 includes a first portion 31, a second portion 32, a third portion 33, a fourth portion 34, and a fifth portion 35. The first portion 31 is disposed between the first flat tube 20a and the second flat tube 20b. The second portion 32 is joined to the first flat tube 20a. The third portion 33 is joined to the second flat tube 20b. The fourth portion 34 is extended in the reverse x-direction from an end 21a of the first flat tube 20a. The fifth portion 35 is extended in the x-direction from an end 22b of the second flat tube 20b.

[0018] The fin 30 and the first flat tube 20a are in contact with each other at the second portion 32, and joined together by brazing or other methods. The second portion 32 is formed by bending the plate-like part into the shape of a recess that conforms to the shape of a side surface of the first flat tube 20a. The first flat tube 20a fits in the recess. The fin 30 and the second flat tube 20b are in contact with each other at the third portion 33, and joined together by brazing or other methods. The third portion 33 is also formed by bending the plate-like part into the shape of a recess that conforms to the shape of a side surface of the second flat tube 20b. The second flat tube 20b fits in the recess. The recess provided at the second portion 32 of the fin 30, and the recess provided at the third portion 33 of the fin 30 are oriented in different directions. The recess provided at the second portion 32 opens in the y-direction, and the recess provided at the third portion 33 opens in the reverse y-direction. That is, the first flat tube 20a is attached to a plate face 38, which is one plate face of the fin 30 oriented in the y-direction, and the second flat tube 20b is attached to a plate face 39, which is the other plate face of the fin 30 oriented in the reverse y-direction.

[0019] As illustrated in Fig. 4, the first flat tube 20a and the second flat tube 20b each fit in a recess provided at a single fin 30. This arrangement allows the fin 30, the first flat tube 20a, and the second flat tube 20b to be handled as an integral component at the time of manufacture. That is, prior to joining the two flat tubes 20 to the lower-end headers 50a and 50b and to the upper-end headers 51a and 51b, the two flat tubes 20 can be fit into the corresponding recesses provided at a single fin 30 to integrate the flat tubes 20 with the fin 30. This makes it possible to easily determine relative positions of the two flat tubes 20 prior to the joining process, thus improving the ease of assembly.

[0020] The fin 30 includes the first portion 31 located between the first flat-tube group 10a and the second flat-tube group 10b. The first portion 31 is positioned to connect an end of the recess in which the first flat tube 20a fits and an end of the recess in which the second flat tube 20b fits. In other words, the first portion 31 is positioned to connect an end 22a and an end 21b. The end 22a is an end of the first flat tube 20a located closer to the second flat-tube group 10b than is the other end of the first flat tube 20a, and the end 21b is an end of the second flat tube 20b located closer to the first flat-tube group 10a than is the other end of the second flat tube 20b. In Embodiment 1, the first portion 31 is placed with an inclination with respect to the longitudinal axes of the first and second flat tubes 20a and 20b.

[0021] As illustrated in Fig. 4, in Embodiment 1, air flows into the heat-exchanger 100 in the x-direction. Because of the inclined placement of the first portion 31 of the fin 30 as described above, air flows in a meandering manner in the gap between the first flat tube 20a, the second flat tube 20b, and the fin 30. This results in increased heat-transfer area and consequently improved heat-transfer performance of the heat-exchanger 100. As the airflow is deflected at the first portion 31 of the fin 30, incoming air collides with a side wall 23b of the second flat tube 20b. The collision of air causes disturbances in the flow of air between the second flat tubes 20b. This facilitates to equalize the temperatures of air coming into contact with various parts of the second flat tubes 20b, thus making the quality of refrigerant flowing in each second flat tube 20b uniform. As a result, the heat-exchanger 100 improves in heat-exchange performance.

[0022] The fin 30 includes the fourth portion 34 in the shape of a flat plate extended from the end 21a, which is an end of the first flat tube 20a oriented in the reverse x-direction. That is, the fourth portion 34 is extended from the end 21a, which is an end of the first flat tube 20a opposite to the end 22a from which the first portion 31 is extended. Further, the fin 30 includes the fifth portion 35 in the shape of a flat plate extended from the end 22b, which is an end of the second flat tube 20b oriented in the x-direction. That is, the fifth portion 35 is extended from the end 22b, which is an end of the second flat tube 20b opposite to the end 21b from which the first portion 31 is extended. Because of the presence of the fourth and fifth portions 34 and 35 in the fin 30, the heat-exchanger 100 has increased heat-transfer area and improved heat-transfer performance.

[0023] Fig. 5 is a side view of a heat-exchanger 100a representing a modification of the heat-exchanger 100 according to Embodiment 1. Fig. 6 illustrates a sectional structure of the heat-exchanger 100a representing a modification of the heat-exchanger 100 according to Embodiment 1. Fig. 7 is an enlarged view of a slit 41 as seen in the x-direction. Fig. 6 illustrates the structure of a section corresponding to a section taken along B-B of Fig. 5. The heat-exchanger 100a has the slits 41 provided in the fourth portion 34, which is the most windward portion of the fin 30 and extended from the end 21a of the first flat tube 20a. The slits 41 are each formed by cutting and raising a part of the fourth portion 34 in a direction perpendicular to the plate face. As illustrated in Fig. 7, the fourth portion 34, which has a plate-like shape, includes a parallel portion 45 and a rising portion 44. The parallel portion 45 is formed by cutting and raising a part of the fourth portion 34, and positioned substantially in parallel to the fourth portion 34. The rising portion 44 is a part of the fourth portion 34 that connects both ends of the parallel portion 45 to the plate face of the fourth portion 34. Providing the parallel portion 45 in parallel to the plate face of the fourth portion 34 of the fin 30 helps to reduce the boundary layer of air flowing in parallel to the surface of the fourth portion 34. This makes it possible to improve heat-transfer performance while reducing an increase in the resistance to airflow.

[0024] The heat-exchanger 100a also includes the slits 41 provided in the fifth portion 35, which is the most leeward portion of the fin 30 and extended from the end 21b of the second flat tube 20b. The slits 41 provided in the fifth portion 35 are similar in structure to the slits 41 provided in the fourth portion 34. This helps to reduce the boundary layer of air flowing in parallel to the surface of the fifth portion 35, thus making it possible to improve heat-transfer performance while reducing an increase in the resistance to airflow.

[0025] Further, the heat-exchanger 100a has louvers 40 provided in the first portion 31 located between the first flat tube 20a and the second flat tube 20b. The louvers 40 each are a tongue-shaped part that is formed by cutting and raising a part of the first portion 31 having a plate-like shape, and is extended in the x-direction in parallel to the longitudinal axes of the first and second flat tubes 20a and 20b. The louver 40 has, at its proximal portion, an opening that extends through the plate of the first portion 31. The louver 40 is extended in parallel to the flow of air passing between the first flat tubes 20a. Thus, air passes through a hole provided in a part of the plate of the first portion 31 where the louver 40 is provided. As a result, a flow of air parallel to the longitudinal axis of the flat tube 20 can be created also at a location where the first portion 31 inclined from the first flat tube 20a is provided. Therefore, the presence of the louver 40 makes it possible to improve heat-transfer performance while reducing an increase in the resistance to airflow through the heat-exchanger 100a.

[0026] The heat-exchanger 100, 100a is manufactured through a process described below. First, the fins 30, the first flat-tube group 10a, and the second flat-tube group 10b are combined with each other. Each flat tube 20 is fit into the corresponding recess provided at the fin 30. With the first flat tube 20a, the second flat tube 20b, and the fin 30 integrated together, an end in the direction of the pipe axis of each of the first and second flat tubes 20a and 20b is inserted into the lower-end header 50a or 50b, or into the upper-end header 51a or 51b. Then, the fin 30 is pulled from the fourth portion 34 and the fifth portion 35, which are located at opposite ends in the x-direction illustrated in Figs. 4 and 6. Thus, the second portion 32 of the fin 30 is pressed against the first flat tube 20a, and the third portion 33 of the fin 30 is pressed against the second flat tube 20b. This ensures more secure contact between the fin 30 and the flat tubes 20, thus improving the accuracy of mounting of the fin 30 to the flat tubes 20. With this state maintained, a set of the flat tubes 20a and a set of the flat tubes 20b are respectively inserted into the lower-end header 50a and the lower-end header 50b and into the upper-end header 51a and the upper-end header 51b. Then, brazing filler metal is placed at the joints between the flat tubes 20a and 20b and the respective lower-end headers 50a and 50b, at the joints between the flat tubes 20a and 20b and the respective upper-end headers 51a and 51b, and at the joints between the flat tubes 20a and 20b and the fin 30, and then the resulting assembly is put into a furnace for brazing. With the heat-exchanger 100, 100a, use of the fins 30 allows the first flat-tube group 10a and the second flat-tube group 10b to be handled integrally, thus allowing for easy assembly and easy manufacture.

[0027] In Embodiment 1, the first flat tube 20a and the second flat tube 20b are arranged in a staggered manner with their longitudinal axes arranged in parallel to each other, and thus the first portion 31 is positioned with an inclination from both the first flat tube 20a and the second flat tube 20b. However, this arrangement is not intended to be limiting. Although the heat-exchanger 100a including both the louvers 40 and the slits 41 has been described above as a modification of the heat-exchanger 100 according to Embodiment 1, a heat-exchanger including only one of the louvers 40 and the slits 41 may be used as a modification of the heat-exchanger 100.

[0028] Fig. 8 illustrates a sectional structure of a heat-exchanger 100b representing a modification of the heat-exchanger 100 according to Embodiment 1. Fig. 8 illustrates the structure of a section corresponding to a section taken along A-A of Fig. 2. In the heat-exchanger 100b according to the modification, the first portion 31 of the fin 30, the second portion 32 into which the first flat tube 20a fits, and the third portion 33 into which the second flat tube 20b fits are parallel to each other. The fourth portion 34, which is the most windward portion of the fin 30, and the fifth portion 35, which is the most leeward portion of the fin 30, are inclined with respect to the first portion 31, the second portion 32 into which the first flat tube 20a fits, and the third portion 33 into which the second flat tube 20b fits. Consequently, as air flows into the heat-exchanger 100 in the x-direction, the air collides with a side wall 23a of the first flat tube 20a. The collision of air causes disturbances in the flow of air between the first flat tubes 20a. This facilitates to equalize the temperatures of air coming into contact with various parts of the first flat tube 20a, thus making the quality of refrigerant flowing in each first flat tube 20a uniform. As a result, the heat-exchanger 100b improves in heat-exchange performance.

[0029] The heat-exchanger 100, 100a, 100b according to Embodiment 1 can be used as at least one of the outdoor heat-exchanger 5 and the indoor heat-exchanger 7 of the refrigeration-cycle apparatus 1 illustrated in Fig. 3 to thereby provide the refrigeration-cycle apparatus 1 with enhanced energy efficiency. In this regard, energy efficiency is defined as follows: "heating energy efficiency = indoor heat-exchanger (condenser) capacity/total input"; and "cooling energy efficiency = indoor heat-exchanger (evaporator) capacity/total input".

[0030] For the heat-exchanger 100, 100a, 100b, the heat-exchanger unit, and the refrigeration-cycle apparatus 1 employing the heat-exchanger unit that have been described above with reference to Embodiment 1, the effects of the heat-exchanger 100, 100a, 100b, the heat-exchanger unit, and the refrigeration-cycle apparatus 1 can be accomplished when a refrigerant such as R410A, R32, and HF01234yf is used. Further, although the foregoing description of Embodiment 1 is directed to using air and refrigerant as exemplary working fluids, the same effects as mentioned above can be attained also by using other kinds of gas, liquid, or gas-liquid mixture fluids.

[0031] The respective structures of the heat-exchangers 100, 100a, 100b according to Embodiment 1 can be combined with each other as appropriate. For example, one or both of the louvers 40 and the slits 41 of the heat-exchanger 100a may be used in the heat-exchanger 100b.

Reference Signs List

[0032] 1 refrigeration-cycle apparatus 2 fan 3 compressor 4 four-way valve 5 outdoor heat-exchanger 6 expansion device 7 indoor heat-exchanger 8 outdoor unit 9 indoor unit 10 flat-tube group 10a (first) flat-tube group 10b (second) flat-tube group 20 flat tube 20a (first) flat tube 20b (second) flat tube 21a end 21b end 22a end 22b end 23a side wall 23b side wall 30 fin 31 first portion 32 second portion 33 third portion 34 fourth portion 35 fifth portion 38 plate face 39 plate face 40 louver 41 slit 44 rising portion 45 parallel portion 50 lower-end header 50a lower-end header 50b lower-end header 51 upper-end header 51a upper-end header 51b upper-end header 90 refrigerant pipe 100 heat-exchanger 100a heat-exchanger 100b heat-exchanger

Claims

1. A heat-exchanger, comprising:

a first flat-tube group including a plurality of flat tubes each having a pipe axis, the plurality of flat tubes included in the first flat-tube group being arranged in such a manner that the pipe axes of the plurality of flat tubes included in the first flat-tube group are arranged in parallel to each other, one of the plurality of flat tubes included in the first flat-tube group being a first flat tube;

a second flat-tube group provided adjacent to the first flat-tube group, the second flat-tube group including a plurality of flat tubes each having a pipe axis, the plurality of flat tubes included in the second flat-tube group being arranged in such a manner that the pipe axes of the plurality of flat tubes included in the second flat-tube group are arranged in parallel to each other, one of the plurality of flat tubes included in the second flat-tube group being a second flat tube; and

a fin provided to the first flat-tube group and the second flat-tube group,

the fin including a first portion connecting an end of a longitudinal axis of the first flat tube in a section perpendicular to the pipe axis of the first flat tube and an end of a longitudinal axis of the second flat tube in a section perpendicular to the pipe axis of the second flat tube.

2. The heat-exchanger of claim 1, wherein the plurality of flat tubes of the first flat-tube group and the plurality of flat tubes of the second flat-tube group are arranged in a staggered manner.

3. The heat-exchanger of claim 1 or 2,
wherein the fin includes
a second portion joined to a side wall of the first flat tube, and
a third portion joined to a side wall of the second flat tube,
wherein, at the second portion, one face of a plate of the fin is joined to the first flat tube, and
wherein, at the third portion, an other face of the plate is joined to the second flat tube.

4. The heat-exchanger of any one of claims 1 to 3, wherein the first portion of the fin located between the first flat-tube group and the second flat-tube group, which are provided adjacent to each other, is inclined with respect to the longitudinal axes of the plurality of flat tubes.

5. The heat-exchanger of claim 4,
wherein the first portion includes
a louver extended from the plate in a direction transverse to the pipe axis, and
an opening provided in the plate at a proximal portion of the louver, the opening extending through the plate.

6. The heat-exchanger of claim 5, wherein the louver is parallel to the longitudinal axes of the plurality of flat tubes.

7. The heat-exchanger of any one of claims 1 to 6,
wherein the fin includes

a fourth portion extended from an end of the longitudinal axis of the first flat tube opposite to the end from which the first portion is extended, and
a fifth portion extended from an end of the longitudinal axis of the second flat tube opposite to the end from which the first portion is extended, and
wherein at least one of the fourth portion and the fifth portion includes a slit provided in the plate.

8. A heat-exchanger unit, comprising the heat-exchanger of any of claims 1 to 7.

9. A refrigeration-cycle apparatus, comprising the heat-exchanger unit of claim 8.

FIG. 1

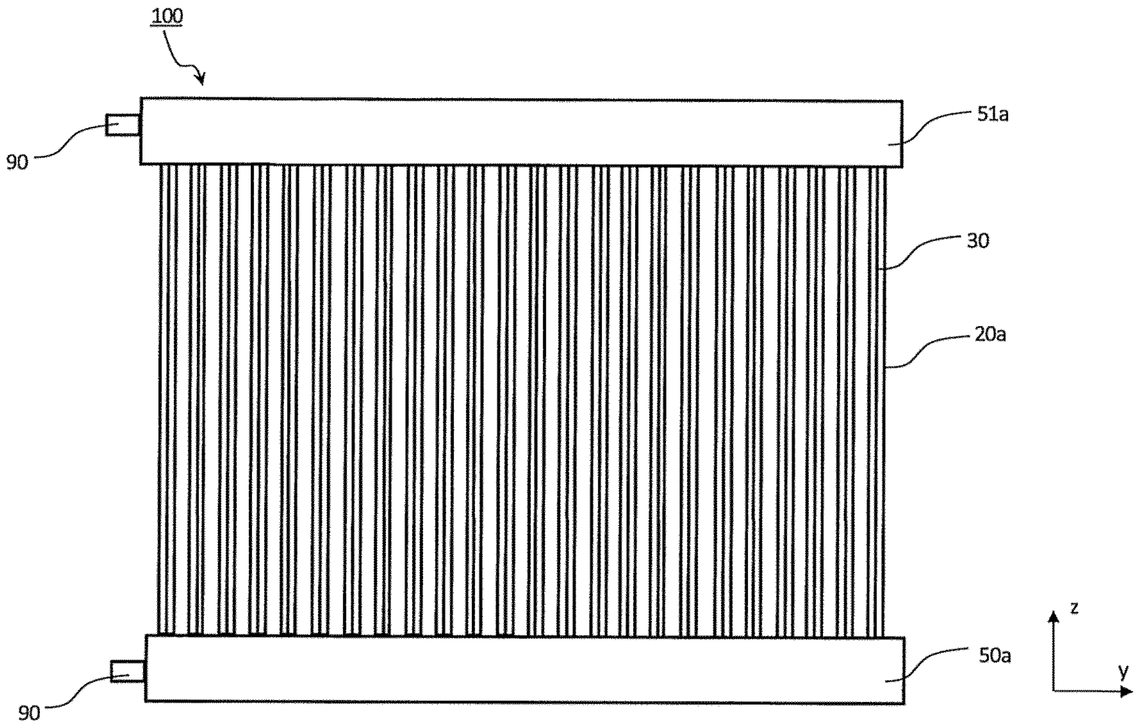


FIG. 2

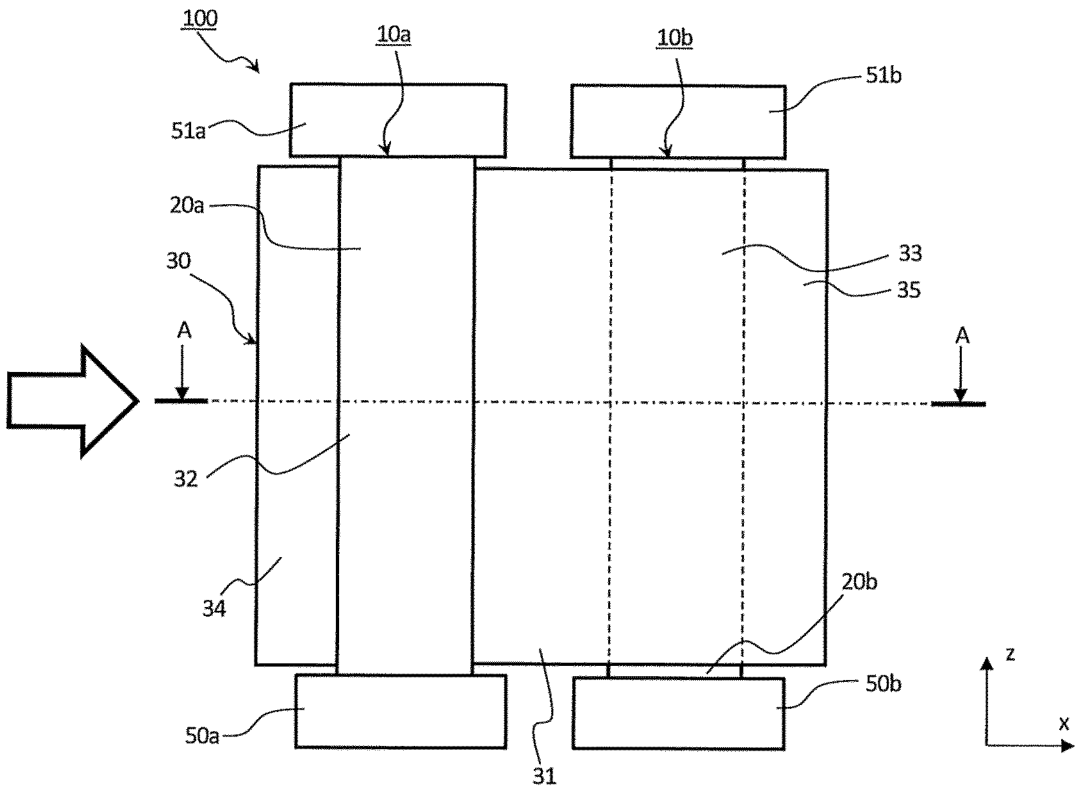


FIG. 3

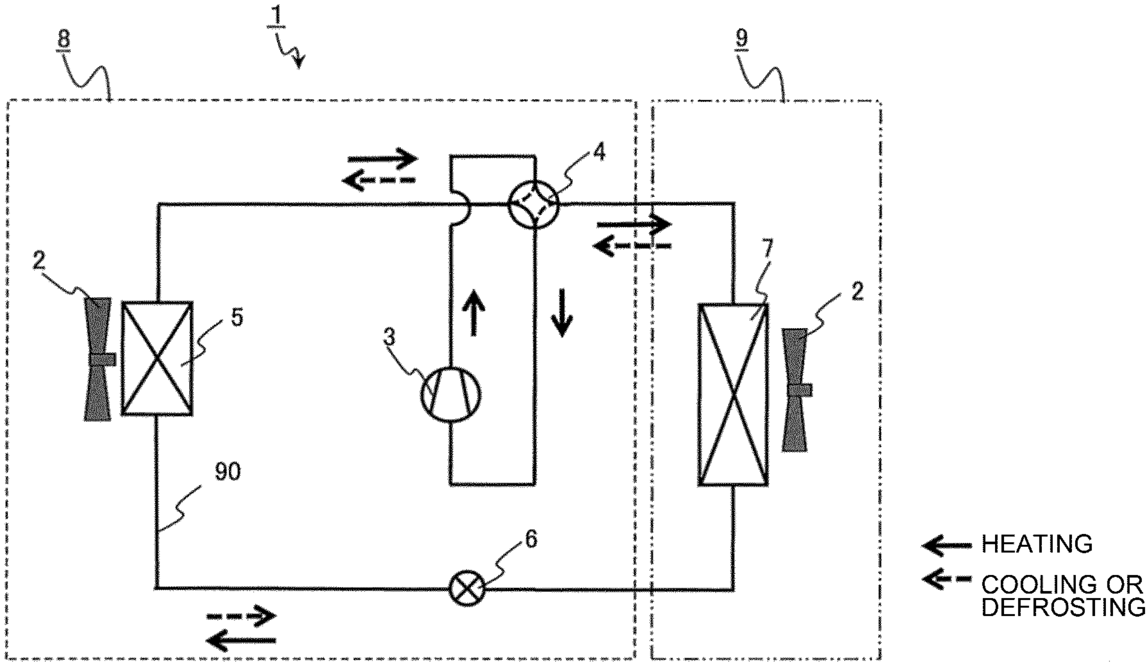

1
8
9
4
2
5
3
7
2
90
6
HEATING
COOLING OR DEFROSTING

FIG. 4

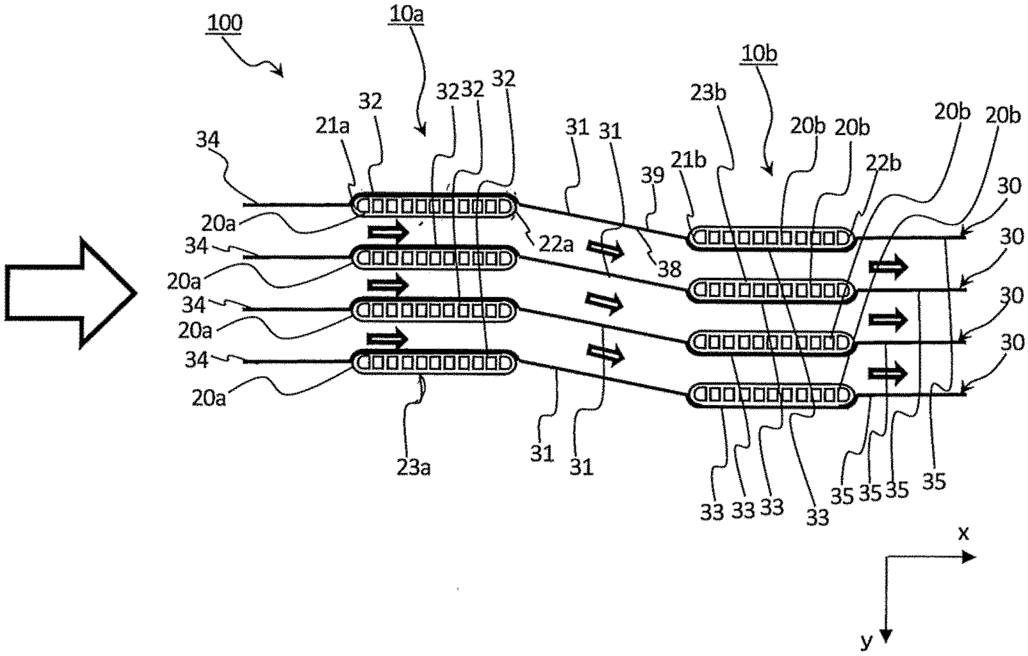

100
10a
10b
34
21a
32
32 32
32
31 31
39
21b
23b
20b 20b
20b 20b
22b
30
20a
22a
38
23a
31
33 33 33
33
35 35 35
35
x
y

FIG. 5

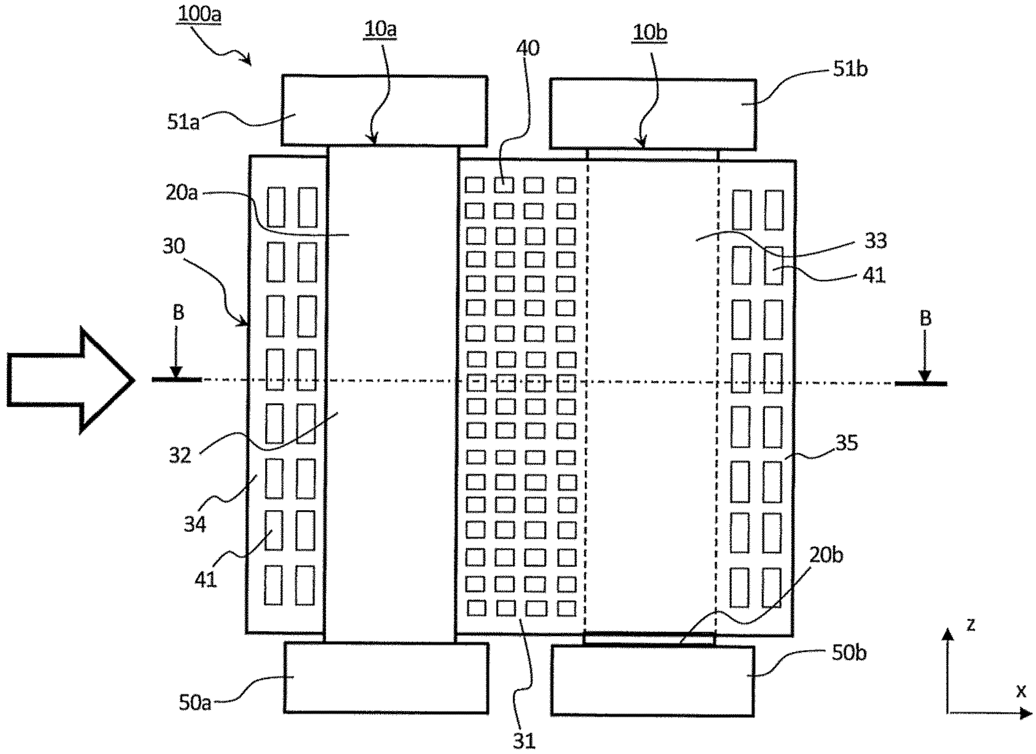

100a
10a
40
10b
51b
51a
20a
33
30
41
B
B
32
35
34
41
20b
z
50b
50a
x
31

FIG. 6

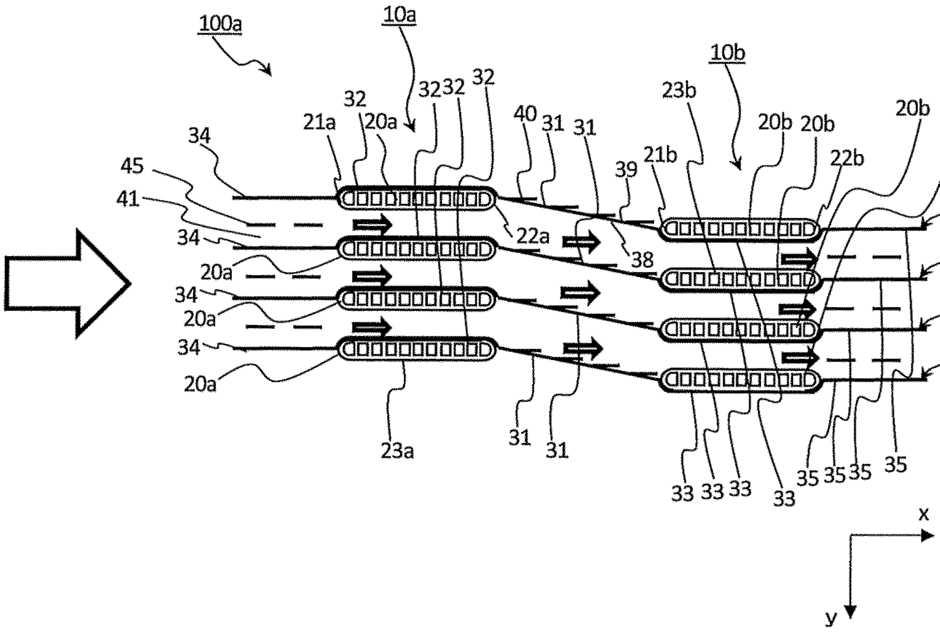

100a
10a
10b
32
32
32
32
23b
34
21a
20a
40
31
31
20b
20b
20b
20b
45
39
21b
22b
41
30
34
22a
38
30
20a
34
30
20a
34
30
20a
23a
31
31
33
33
33
33
35
35
35
35
x
y

FIG. 7

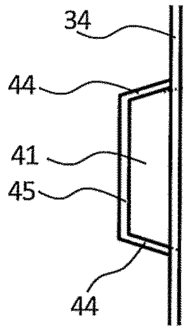
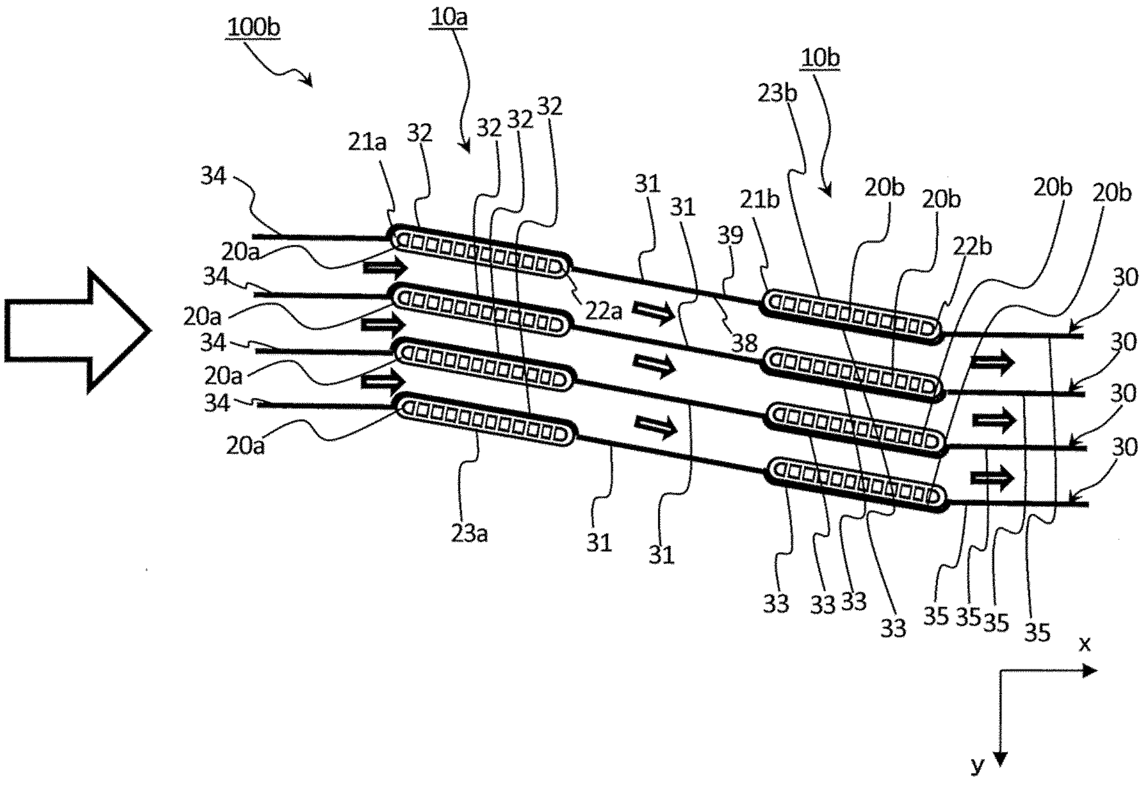

34
44
41
45
44

FIG. 8


100b
10a
10b
23b
21a
32
32
32
32
34
31
31
21b
20b
20b
20b
20b
39
22b
20a
22a
38
30
34
20a
34
20a
34
20a
23a
31
31
33
33
33
33
35
35
35
35
x
y

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2018/031502

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F28F1/20(2006.01)i, F25B39/00(2006.01)i, F28D1/053(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)
Int. Cl. F28F1/20, F25B39/00, F28D1/053

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	WO 2002/016834 A2 (ENGINEERED DYNAMICS CORPORATION) 28 February 2002, page 11, line 20 to page 12, line 3, fig. 9, 10 & AU 8655201 A	1-2, 4, 8 3, 5-6 7
X Y A	US 2014/0027098 A1 (CARRIER CORPORATION) 30 January 2014, fig. 1-14, paragraphs [0001]-[0032] & WO 2012/142070 A1 & CN 103477177 A	1, 7-9 3 2, 4-6
Y	DE 1927605 A (HERMANNS DR PETER) 03 December 1970, fig. 1, 2 (Family: none)	3
Y	JP 2000-088297 A (HITACHI, LTD.) 31 March 2000, paragraph [0052], fig. 17 & US 6253567 B1, column 8, line 65 to column 9, line 8, fig. 17 & EP 987502 A2	3

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07.11.2018	20.11.2018

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/031502

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 1124526 B2 (LICENTIA GMBH) 01 March 1962, fig. 1, 2 (Family: none)	5-6
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 152900/1989 (Laid-open No. 096574/1991) (SHOWA ALUMINUM CORP.) 02 October 1991, entire text, all drawings (Family: none)	1-9
A	JP 07-305986 A (SANDEN CORP.) 21 November 1995, entire text, all drawings & US 5494099 A & EP 683371 A1	1-9
A	WO 2018/064696 A1 (EULER-ROLLS, Thomas) 12 April 2018, entire text, all drawings & AT 518986 A	1-9

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

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 2006084078 A **[0003]**