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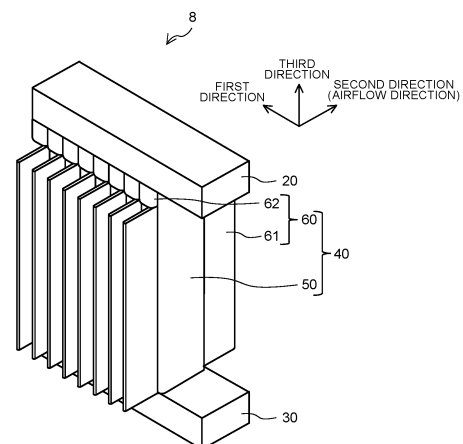
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(54) **HEAT EXCHANGER AND REFRIGERATION CYCLE APPARATUS**

(57) A heat exchanger includes a first header being configured to collect and deliver refrigerant and extending in a first direction, a second header being configured to collect and deliver refrigerant, being disposed at a position facing the first header and extending in the first direction, and a plurality of heat transfer components each extending from the first header to the second header and being provided at intervals along the first direction, wherein the heat transfer components each includes a heat transfer tube extending from the first header to the second header and allowing refrigerant to flow in its inside, and an extension portion being provided in each of the heat transfer tubes and configured to promote heat transfer property of the heat transfer tubes, and wherein the extension portion includes a base portion extending from the heat transfer tube in a second direction in which air that flows between the plurality of heat transfer tubes flows, and a spacer portion extending from the base portion in the first direction and abutting the adjacent heat transfer component.

FIG. 2



Description

Technical Field

[0001] The present disclosure relates to a heat exchanger that causes heat exchange to be performed between refrigerant and air, and also relates to a refrigeration cycle apparatus.

Background Art

[0002] Heat exchangers have been known that cause heat exchange to be performed between refrigerant and air. These heat exchangers include a finless heat exchanger that has been known as not being provided with fins in the alignment direction of heat transfer tubes. Due to the absence of the fins, the finless heat exchanger does not have means to restrain the heat transfer tubes in their alignment direction. Thus, the heat transfer tubes are more likely to be bent by a thermal stress and assembly errors. This makes it difficult for the adjacent heat transfer tubes to have a uniform pitch between them. If the adjacent heat transfer tubes have a region with a smaller pitch than the other region, this causes an uneven air flow, which leads to an increase in the airflow resistance. Thus, the region with a smaller pitch is more likely to be clogged with dust and frost formed thereon.

[0003] For the purpose of solving the above problems, Patent Literature 1 discloses a heat exchanger provided with an auxiliary member. The auxiliary member has a shape like comb teeth extending between the adjacent heat transfer tubes along the alignment direction of refrigerant flow passages. With this configuration, Patent Literature 1 is intended to maintain the adjacent heat transfer tubes at a uniform pitch.

Citation List

Patent Literature

[0004] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2018-162953

Summary of Invention

Technical Problem

[0005] The heat exchanger disclosed in Patent Literature 1 is intended to maintain the adjacent heat transfer tubes at a uniform pitch. However, due to the absence of the fins, this heat exchanger has relatively low heat transfer property of the heat transfer tubes.

[0006] The present disclosure has been achieved to solve the above problems, and it is an object of the present disclosure to provide a heat exchanger that improves heat transfer property of heat transfer tubes, while having a uniform pitch between the heat transfer tubes, and to provide a refrigeration cycle apparatus.

Solution to Problem

[0007] A heat exchanger according to one embodiment of the present disclosure includes: a first header being configured to collect and deliver refrigerant and extending in a first direction; a second header being configured to collect and deliver refrigerant, being disposed at a position facing the first header and extending in the first direction; and a plurality of heat transfer components each extending from the first header to the second header and being provided at intervals along the first direction, wherein the heat transfer components each includes a plurality of heat transfer tubes each extending from the first header to the second header and allowing refrigerant to flow in its inside; and an extension portion being provided in each of the heat transfer tubes and configured to promote heat transfer property of the heat transfer tubes, and wherein the extension portion includes a base portion extending from the heat transfer tube in a second direction in which air that flows between the plurality of heat transfer tubes flows; and a spacer portion extending from the base portion in the first direction and abutting the adjacent heat transfer component. Advantageous Effects of Invention

[0008] According to one embodiment of the present disclosure, the heat exchanger includes the heat transfer components each including the heat transfer tubes and the extension portion. The extension portion includes the spacer portion extending from the base portion in the first direction and abutting the adjacent heat transfer component. The spacer portion abuts the adjacent heat transfer components, so that the heat transfer tubes can have a uniform pitch between them. The extension portion further includes the base portion extending from the heat transfer tube in the second direction, so that this improves heat transfer property of the heat transfer tube. In this manner, the heat exchanger can improve heat transfer property of the heat transfer tubes, while having a uniform pitch between the heat transfer tubes.

Brief Description of Drawings

[0009]

[Fig. 1] Fig. 1 is a circuit diagram illustrating a refrigeration cycle apparatus according to Embodiment 1.

[Fig. 2] Fig. 2 is a perspective view illustrating a heat exchanger according to Embodiment 1.

[Fig. 3] Fig. 3 is a front view illustrating the heat exchanger according to Embodiment 1.

[Fig. 4] Fig. 4 is a top view illustrating the heat exchanger according to Embodiment 1 with its first header removed.

[Fig. 5] Fig. 5 is a side view illustrating a method of

manufacturing the heat exchanger according to Embodiment 1.

[Fig. 6] Fig. 6 is a top view illustrating a heat exchanger according to a first modification of Embodiment 1 with its first header removed.

[Fig. 7] Fig. 7 is a top view illustrating a heat exchanger according to a second modification of Embodiment 1 with its first header removed.

[Fig. 8] Fig. 8 is a top view illustrating a heat exchanger according to a third modification of Embodiment 1 with its first header removed.

[Fig. 9] Fig. 9 is a top view illustrating a heat exchanger according to Embodiment 2 with its first header removed.

[Fig. 10] Fig. 10 is a side view illustrating a method of manufacturing the heat exchanger according to Embodiment 2.

[Fig. 11] Fig. 11 is a side view illustrating a heat exchanger according to Embodiment 3.

[Fig. 12] Fig. 12 is a top view illustrating the heat exchanger according to Embodiment 3 with its first header removed.

[Fig. 13] Fig. 13 is a side view illustrating a heat exchanger according to a first modification of Embodiment 3.

[Fig. 14] Fig. 14 is a top view illustrating the heat exchanger according to the first modification of Embodiment 3 with its first header removed.

[Fig. 15] Fig. 15 is a side view illustrating a heat exchanger according to a second modification of Embodiment 3.

[Fig. 16] Fig. 16 is a top view illustrating the heat exchanger according to the second modification of Embodiment 3 with its first header removed.

[Fig. 17] Fig. 17 is a top view illustrating a heat exchanger according to Embodiment 4 with its first header removed.

[Fig. 18] Fig. 18 is a top view illustrating a heat exchanger according to a modification of Embodiment 4 with its first header removed.

[Fig. 19] Fig. 19 is a front view illustrating a heat exchanger according to Embodiment 5.

[Fig. 20] Fig. 20 is a front view illustrating a heat

exchanger according to a modification of Embodiment 5.

[Fig. 21] Fig. 21 is a front view illustrating a heat exchanger according to Embodiment 6.

[Fig. 22] Fig. 22 is a front view illustrating a heat exchanger according to a modification of Embodiment 6.

Description of Embodiments

[0010] Embodiments of a heat exchanger and a refrigeration cycle apparatus of the present disclosure will be described hereinafter with reference to the drawings. Note that the present disclosure is not limited by the embodiments described below. In addition, the relationship of sizes of the components in the drawings described below including Fig. 1 may differ from that of actual ones. In the descriptions below, terms that represent directions are appropriately used for the sake of easily understanding the present disclosure. However, these terms are used merely for description purposes, and the present disclosure is not limited by these terms. Examples of the terms that represent directions include "upper", "lower", "right", "left", "front", and "rear".

Embodiment 1

[0011] Fig. 1 is a circuit diagram illustrating a refrigeration cycle apparatus 1 according to Embodiment 1. The refrigeration cycle apparatus 1 is, for example, an air-conditioning device that conditions air in a room, and includes an outdoor unit 2 and an indoor unit 3 as illustrated in Fig. 1. The outdoor unit 2 is provided with, for example, a compressor 6, a flow switching device 7, a heat exchanger 8, an outdoor fan 9, and an expansion unit 10. The indoor unit 3 is provided with, for example, an indoor heat exchanger 11 and an indoor fan 12.

[0012] The compressor 6, the flow switching device 7, the heat exchanger 8, the expansion unit 10, and the indoor heat exchanger 11 are connected by refrigerant pipes 5 to form a refrigerant circuit 4. The compressor 6 suctions refrigerant in a low-temperature low-pressure state, compresses the sucked refrigerant into a high-temperature high-pressure state, and discharges the compressed refrigerant. The flow switching device 7 changes the flow direction of refrigerant in the refrigerant circuit 4, and is, for example, a four-way valve. For example, the heat exchanger 8 causes heat exchange to be performed between outside air and refrigerant. The heat exchanger 8 functions as a condenser during cooling operation, or functions as an evaporator during heating operation. The outdoor fan 9 is a device to deliver outside air to the heat exchanger 8.

[0013] The expansion unit 10 is a pressure reducing valve or an expansion valve to reduce the pressure of refrigerant and expand the refrigerant. The expansion

unit 10 is, for example, an electronic expansion valve whose opening degree is adjusted. For example, the indoor heat exchanger 11 causes heat exchange to be performed between room air and refrigerant. The indoor heat exchanger 11 functions as an evaporator during cooling operation, or functions as a condenser during heating operation. The indoor fan 12 is a device to deliver room air to the indoor heat exchanger 11. Note that refrigerant may be water or antifreeze.

Operating mode, cooling operation

[0014] Next, the operating mode of the refrigeration cycle apparatus 1 is described. First, cooling operation is described. During cooling operation, refrigerant sucked into the compressor 6 is compressed by the compressor 6 into a high-temperature high-pressure gas state and then discharged. The refrigerant in the high-temperature high-pressure gas state discharged from the compressor 6 passes through the flow switching device 7, and flows into the heat exchanger 8 that functions as a condenser. In the heat exchanger 8, the refrigerant exchanges heat with outside air delivered by the outdoor fan 9, and condenses into liquid.

[0015] The refrigerant having condensed into a liquid state flows into the expansion unit 10, and is expanded and reduced in pressure in the expansion unit 10, so that the refrigerant is brought into a low-temperature low-pressure two-phase gas-liquid state. The refrigerant in the two-phase gas-liquid state flows into the indoor heat exchanger 11 that functions as an evaporator. In the indoor heat exchanger 11, the refrigerant exchanges heat with room air delivered by the indoor fan 12, and evaporates into gas. At this time, the room air is cooled and thus cooling is performed in the room. The refrigerant having evaporated into a low-temperature low-pressure gas state passes through the flow switching device 7 and is sucked into the compressor 6.

Operating mode, heating operation

[0016] Next, heating operation is described. During heating operation, refrigerant sucked into the compressor 6 is compressed by the compressor 6 into a high-temperature high-pressure gas state and then discharged. The refrigerant in the high-temperature high-pressure gas state discharged from the compressor 6 passes through the flow switching device 7 and flows into the indoor heat exchanger 11 that functions as a condenser. The refrigerant flowing into the indoor heat exchanger 11 causes heat exchange to be performed between room air delivered by the indoor fan 12, and condenses into liquid in the indoor heat exchanger 11. At this time, the room air is heated and thus heating is performed in the room.

[0017] The refrigerant having condensed into a liquid state flows into the expansion unit 10, and is expanded and reduced in pressure in the expansion unit 10, so that

the refrigerant is brought into a low-temperature low-pressure two-phase gas-liquid state. The refrigerant in the two-phase gas-liquid state flows into the heat exchanger 8 that functions as an evaporator. In the heat exchanger 8, the refrigerant exchanges heat with outside air delivered by the outdoor fan 9, and evaporates into gas. The refrigerant having evaporated into a low-temperature low-pressure gas state passes through the flow switching device 7 and is sucked into the compressor 6.

Heat exchanger 8

[0018] Fig. 2 is a perspective view illustrating the heat exchanger 8 according to Embodiment 1. As illustrated in Fig. 2, the heat exchanger 8 includes a first header 20, a second header 30, and heat transfer components 40. In Fig. 2 and the subsequent drawings, the direction in which the first header 20 and the second header 30 extend is described as "first direction", the direction in which air flows is described as "second direction", and the direction of gravitational force is described as "third direction". In the present Embodiment 1, the direction of gravitational force is defined as the third direction, however, the direction of gravitational force may be defined as the first direction or the second direction. Note that the present Embodiment 1 exemplifies a case where the heat exchanger 8 applies to an outdoor heat exchanger provided in the outdoor unit 2. However, the heat exchanger 8 may apply to the indoor heat exchanger 11 provided in the indoor unit 3. The heat exchanger 8 in the present Embodiment 1 can be used to function as a condenser or an evaporator.

First header 20

[0019] The first header 20 is a cuboid member extending in the first direction and allowing refrigerant to flow in its inside. The first header 20 is configured to collect and deliver refrigerant. Note that the first header 20 is not limited to being formed in a cuboid shape, but may be formed in a cylindrical shape or other shape. The first header 20 distributes refrigerant entering from the refrigerant pipe 5 to heat transfer tubes 50 of the heat transfer components 40, and also collects refrigerant having flowed out of the heat transfer tubes 50 to allow the refrigerant to flow out to the refrigerant pipe 5.

Second header 30

[0020] The second header 30 is disposed at a position facing the first header 20. The second header 30 is a cuboid member extending in the first direction and allowing refrigerant to flow in its inside. The second header 30 is configured to collect and deliver refrigerant. Note that the second header 30 is not limited to being formed in a cuboid shape, but may be formed in a cylindrical shape or other shape. The second header 30 distributes refrigerant entering from the refrigerant pipe 5 to the heat trans-

fer tubes 50 of the heat transfer components 40, and also collects refrigerant having flowed out of the heat transfer tubes 50 to allow the refrigerant to flow out to the refrigerant pipe 5.

Heat transfer member 40

[0021] Fig. 3 is a front view illustrating the heat exchanger 8 according to Embodiment 1. Fig. 4 is a top view illustrating the heat exchanger 8 according to Embodiment 1 with its first header 20 removed. The heat transfer components 40 are configured to transfer heat. As illustrated in Figs. 2, 3, and 4, the heat transfer components 40 extend from the first header 20 to the second header 30, and are provided at intervals along the first direction. A plurality of the heat transfer components 40 are provided. Each of the heat transfer components 40 includes a heat transfer tube 50 and extension portions 60.

Heat transfer tube 50

[0022] The heat transfer tube 50 is a flat tube in which a plurality of flow passages 51 are formed. The heat transfer tube 50 may be a circular tube. The heat transfer tube 50 is a member extending in the third direction from the first header 20 to the second header 30. Refrigerant having entered from the first header 20 or the second header 30 flows through the plurality of flow passages 51. The heat transfer tube 50 is made of, for example, aluminum, but may be made of a different kind of metal.

Extension portion 60

[0023] The extension portions 60 are provided to the heat transfer tube 50 and configured to promote heat transfer property of the heat transfer tube 50. The extension portions 60 extend along the second direction from the edges of opposite end portions of the heat transfer tube 50 in the second direction. The extension portions 60 extend in opposite directions away from each other. That is, two extension portions 60 are provided to one heat transfer tube 50. In Fig. 2, a single extension portion 60 has a length in the second direction that is slightly smaller than the length of the heat transfer tube 50 in the second direction. However, a single extension portion 60 may have a length equal to, or greater than, that of the heat transfer tube 50. The extension portions 60 are made of, for example, aluminum, but may be made of a different kind of metal. In addition, the extension portions 60 may be formed integrally with the heat transfer tube 50 by extrusion. Furthermore, the extension portions 60 may be formed separately from the heat transfer tube 50, and thereafter may be joined to the heat transfer tube 50. Each of the extension portions 60 includes a base portion 61 and a spacer portion 62.

Base portion 61

[0024] The base portion 61 is a plate-like member extending from the heat transfer tube 50 in the second direction in which air that flows between the plurality of heat transfer tubes 50 flows. The base portion 61 makes up the majority of the extension portion 60, and serves the majority of the function of promoting heat transfer property of the heat transfer tube 50.

Spacer portion 62

[0025] The spacer portion 62 is a member extending from the base portion 61 in the first direction. The spacer portion 62 is a portion of the base portion 61 that is bent to extend in the first direction. In the present Embodiment 1, the spacer portion 62 is provided at the upper end portion of the base portion 61 in the third direction, and adjacent to the first header 20. Note that the spacer portion 62 may be provided at the lower end portion of the base portion 61 in the third direction, or may be provided at a different position. As illustrated in Fig. 4, the spacer portion 62 is connected at its base end to the heat transfer tube 50, and is bent to extend along the first direction with its tip end bent to extend along the second direction. A pair of spacer portions 62 is provided at opposite end portions of the heat transfer tube 50. The tip ends of the spacer portions 62 extend along the second direction such that the tip ends face each other. The spacer portions 62 extend in the first direction by a length that is set equal to the distance between the adjacent heat transfer tubes 50, that is, a pitch between the adjacent heat transfer tubes 50.

[0026] The spacer portions 62 abut the adjacent heat transfer components 40. In the present Embodiment 1, the spacer portions 62 abut the heat transfer tubes 50 of the heat transfer components 40.

Manufacturing method

[0027] Fig. 5 is a side view illustrating a method of manufacturing the heat exchanger 8 according to Embodiment 1. Next, a method of manufacturing the spacer portions 62 is described. As illustrated in Fig. 5, the spacer portions 62 are formed by giving cuts 63 to the base portions 61 in the second direction. That is, the spacer portions 62 are formed by bending a portion of the base portions 61, separated along the cuts 63 in the second direction, toward the first direction.

[0028] According to the present Embodiment 1, the heat exchanger 8 includes the heat transfer components 40 each including the heat transfer tube 50 and the extension portions 60, and each of the extension portions 60 includes the spacer portion 62 extending from the base portion 61 in the first direction and abutting the adjacent heat transfer member 40. The spacer portions 62 abut the adjacent heat transfer components 40, so that the heat transfer tubes 50 can have a uniform pitch be-

tween them. Each of the extension portions 60 further includes the base portion 61 extending from the heat transfer tube 50 in the second direction, so that this improves the heat transfer property of the heat transfer tube 50. In this manner, the heat exchanger 8 can improve heat transfer property of the heat transfer tubes 50, while having a uniform pitch between the heat transfer tubes 50. Furthermore, in a case where the spacer portions 62 are provided at the center of the base portions 61 in the third direction, the spacer portions 62 can further minimize the variations in the pitch between the heat transfer tubes 50 in the third direction. The heat exchanger 8 allows the heat transfer tubes 50 to have a uniform pitch between them, and thus can minimize an uneven air flow and minimize the increase in power of the outdoor fan 9.

[0029] Each of the spacer portions 62 is a portion of the base portion 61 that is bent to extend in the first direction. This brings the spacer portions 62 into surface contact with the heat transfer components 40, not into line contact with the heat transfer components 40, and thus can ensure a stable pitch between the heat transfer tubes 50. Furthermore, the spacer portions 62 abut the heat transfer tubes 50 of high rigidity, and thus can ensure a stable pitch between the heat transfer tubes 50.

[0030] A related-art heat exchanger provided with an auxiliary member has been disclosed, in which the auxiliary member has a shape like comb teeth extending between the adjacent heat transfer tubes along the alignment direction of refrigerant flow passages. However, in this related-art technique, since the auxiliary member is provided separately from the heat transfer tubes, this leads to an increase in the number of parts. Since the related-art technique involves a process of assembling the auxiliary member, this also leads to an increase in the number of manufacturing processes. In contrast to this, in the present Embodiment 1, the heat transfer tube 50 can be formed integrally with the extension portions 60. This can reduce the number of parts, and accordingly reduce the number of manufacturing processes.

First modification

[0031] Fig. 6 is a top view illustrating a heat exchanger 108 according to a first modification of Embodiment 1 with its first header 20 removed. In the first modification as illustrated in Fig. 6, there are a plurality of the heat transfer tubes 50 disposed along the second direction. The first modification exemplifies a case where two heat transfer tubes 50 are disposed along the second direction. However, three or more heat transfer tubes 50 may be disposed. The base portions 61 of the extension portions 60 are provided at three locations including one end side (on the left side in Fig. 6) of one (on the left side in Fig. 6) of the heat transfer tubes 50, the other end side (on the right side in Fig. 6) of the other heat transfer tube 50 (on the right side in Fig. 6), and the middle between

one and the other of the heat transfer tubes 50. Note that only one or two base portions 61 may be provided, or four or more base portions 61 may be provided. The first modification also achieves the same effects as those achieved in Embodiment 1.

Second modification

[0032] Fig. 7 is a top view illustrating a heat exchanger 208 according to a second modification of Embodiment 1 with its first header 20 removed. Fig. 7 illustrates only two adjacent heat transfer components 40 among many heat transfer components 40 arranged in line. In the second modification as illustrated in Fig. 7, spacer portions 262 abut the adjacent extension portions 60. The second modification also achieves the same effects as those achieved in Embodiment 1.

Third modification

[0033] Fig. 8 is a top view illustrating a heat exchanger 308 according to a third modification of Embodiment 1 with its first header 20 removed. Fig. 8 illustrates only two adjacent heat transfer components 40 among many heat transfer components 40 arranged in line. In the third modification as illustrated in Fig. 8, spacer portions 362 are formed in an embossed shape extending in the first direction and then bent back. Specifically, each of the spacer portions 362 is connected at its base end to the heat transfer tube 50, then bent at a right angle to extend along the first direction, and then bent at a right angle to extend along the second direction. Then, each of the spacer portions 362 is bent at a right angle to extend back toward the direction opposite to the first direction mentioned above, and then bent at a right angle to extend along the second direction. In the manner as described above, each of the spacer portions 362 includes a protruding portion 362a. The protruding portion 362a abuts the adjacent extension portion 60. In this manner, instead of the tip end of the spacer portion 362, the protruding portion 362a of the spacer portion 362 abuts the extension portion 60, so that this increases the rigidity of the spacer portion 362.

Embodiment 2

[0034] Fig. 9 is a top view illustrating a heat exchanger 408 according to Embodiment 2 with its first header 20 removed. Fig. 9 illustrates only two adjacent heat transfer components 40 among many heat transfer components 40 arranged in line. The heat exchanger 408 in the present Embodiment 2 is different in the shape of spacer portions 462 from the heat exchangers in Embodiment 1. In the present Embodiment 2, the components in common with Embodiment 1 are denoted by the same reference signs, and thus descriptions thereof are omitted. The differences from Embodiment 1 are mainly described below.

[0035] As illustrated in Fig. 9, each of the spacer portions 462 is a portion of the base portion 61 that is bent to extend in the first direction. The spacer portions 462 are different from the spacer portions in Embodiment 1 in that the spacer portions 462 have a planar shape in top view.

Manufacturing method

[0036] Fig. 10 is a side view illustrating a method of manufacturing the heat exchanger 408 according to Embodiment 2. Next, a method of manufacturing the spacer portions 462 is described. As illustrated in Fig. 10, the spacer portions 462 are formed by giving the cuts 63 to the base portions 61 in the third direction. That is, the spacer portions 462 are formed by bending a portion of the base portions 61, separated along the cuts 63 in the third direction, toward the first direction. With this method, the spacer portions 462 have a planar shape in top view as illustrated in Fig. 9. Note that Embodiment 2 exemplifies a case where the spacer portions 462 are provided at both the upper end and the lower end of the base portions 61. However, the spacer portions 462 may be provided at either the upper end or the lower end, or may be provided at a different position.

[0037] According to the present Embodiment 2, the spacer portions 462 are formed by bending a portion of the base portions 61, separated along the cuts 63 in the third direction, toward the first direction. With this configuration, when the heat exchanger 408 functions as an evaporator, the spacer portions 462 can receive condensed water flowing down the heat transfer tubes 50. Therefore, this can help prevent interference with drainage of the condensed water from the heat exchanger 408.

Embodiment 3

[0038] Fig. 11 is a side view illustrating a heat exchanger 508 according to Embodiment 3. The heat exchanger 508 in the present Embodiment 3 is different in the shape of spacer portions 562 from the heat exchangers in Embodiments 1 and 2. In the present Embodiment 3, the components in common with Embodiments 1 and 2 are denoted by the same reference signs, and thus descriptions thereof are omitted. The differences from Embodiments 1 and 2 are mainly described below.

[0039] As illustrated in Fig. 11, each of the spacer portions 562 is a portion of the base portion 61 that is cut and raised to extend in the first direction. The spacer portions 562 are formed by giving the cuts 63 to the base portions 61 in the second direction. The spacer portions 562 are provided on the upper portion of the base portions 61 in the third direction. However, the spacer portions 562 may be provided on the lower portion or the central portion of the base portions 61 in the third direction.

[0040] Fig. 12 is a top view illustrating the heat exchanger 508 according to Embodiment 3 with its first header 20 removed. Fig. 12 illustrates two adjacent heat

transfer components 40 among many heat transfer components 40 arranged in line. As illustrated in Fig. 12, the spacer portions 562 are disposed at a position except at the edge portion of the base portions 61, so that in top view, the spacer portions 562 are disposed in between the base portions 61.

[0041] According to the present Embodiment 3, each of the spacer portions 562 is a portion of the base portion 61 that is cut and raised to extend in the first direction. This decreases the area of the spacer portions 562, and results in an increased area of the base portions 61 accordingly. Therefore, the effective heat transfer area can still be maintained in the extension portions 60 in their entirety.

First modification

[0042] Fig. 13 is a side view illustrating a heat exchanger 608 according to a first modification of Embodiment 3. In the first modification as illustrated in Fig. 13, spacer portions 662 are formed by giving the cuts 63 to the base portions 61 in the third direction in which the heat transfer tubes 50 extend. The spacer portions 662 are provided on the upper portion of the base portions 61 in the third direction. However, the spacer portions 662 may be provided on the lower portion or the central portion of the base portions 61 in the third direction.

[0043] Fig. 14 is a top view illustrating the heat exchanger 608 according to the first modification of Embodiment 3 with its first header 20 removed. Fig. 14 illustrates only two adjacent heat transfer components 40 among many heat transfer components 40 arranged in line. As illustrated in Fig. 14, the spacer portions 662 are disposed at a position except at the edge portion of the base portions 61, so that in top view, the spacer portions 662 are disposed in between the base portions 61.

[0044] According to the first modification, each of the spacer portions 662 is a portion of the base portion 61 that is cut and raised to extend in the first direction. This decreases the area of the spacer portions 662, and results in an increased area of the base portions 61 accordingly. Therefore, similarly to Embodiment 3, the effective heat transfer area can still be maintained in the extension portions 60 in their entirety. The spacer portions 662 are formed by bending a portion of the base portions 61, separated along the cuts 63 in the third direction, toward the first direction. With this configuration, the spacer portions 662 can receive condensed water flowing down the heat transfer tubes 50. Therefore, this can help prevent interference with drainage of the condensed water from the heat exchanger 608.

Second modification

[0045] Fig. 15 is a side view illustrating a heat exchanger 708 according to a second modification of Embodiment 3. In the second modification as illustrated in Fig. 15, spacer portions 762 are formed in a burring shape by

punching holes 64 in the base portions 61. The spacer portions 762 are provided on the upper portion of the base portions 61 in the third direction. However, the spacer portions 762 may be provided on the lower portion or the central portion of the base portions 61 in the third direction.

[0046] Fig. 16 is a top view illustrating the heat exchanger 708 according to the second modification of Embodiment 3 with its first header 20 removed. Fig. 16 illustrates only two adjacent heat transfer components 40 among many heat transfer components 40 arranged in line. As illustrated in Fig. 16, the spacer portions 762 are disposed at a position except at the edge portion of the base portions 61, so that in top view, the spacer portions 762 are disposed in between the base portions 61.

[0047] According to the second modification, each of the spacer portions 762 is a portion of the base portion 61 that is cut and raised to extend in the first direction. This decreases the area of the spacer portions 762, and results in an increased area of the base portions 61 accordingly. Therefore, similarly to Embodiment 3, the effective heat transfer area can still be maintained in the extension portions 60 in their entirety.

Embodiment 4

[0048] Fig. 17 is a top view illustrating a heat exchanger 808 according to Embodiment 4 with its first header 20 removed. The heat exchanger 808 in the present Embodiment 4 is different in the shape of spacer portions 862 from the heat exchangers in Embodiments 1 to 3. In the present Embodiment 4, the components in common with Embodiments 1 to 3 are denoted by the same reference signs, and thus descriptions thereof are omitted. The differences from Embodiments 1 to 3 are mainly described below.

[0049] Fig. 17 illustrates only one of many heat transfer components 40 arranged in line. As illustrated in Fig. 17, two spacer portions 862 are provided and disposed at positions symmetrical to the center of the heat transfer tube 50, and the cuts 63 are given to the base portions 61 in the second direction. That is, one of the spacer portions 862 on one end side of the heat transfer tube 50 extends toward one adjacent heat transfer member 40, while the other spacer portion 862 on the other end side of the heat transfer tube 50 extends toward another adjacent heat transfer member 40.

[0050] According to the present Embodiment 4, two spacer portions 862 are provided and disposed at positions symmetrical to the center of the heat transfer tube 50. Due to this configuration, when the heat transfer tubes 50 are aligned with each other during the process of assembling the heat exchanger 808, even though the front and back sides of the heat transfer tube 50 are reversed, the shape of the spacer portions 862 remains unchanged regardless of orientation. Therefore, when the heat exchanger 808 is assembled, it is unnecessary to orient a plurality of heat transfer tubes 50 toward the same direc-

tion. This simplifies the process of aligning the heat transfer tubes 50 with each other. Note that the spacer portions 862 may be formed by bending a portion of the base portions 61, or may be formed by cutting and raising a portion of the base portions 61.

Modification

[0051] Fig. 18 is a top view illustrating a heat exchanger 908 according to a modification of Embodiment 4 with its first header 20 removed. Fig. 18 illustrates only one of many heat transfer components 40 arranged in line. In the modification as illustrated in Fig. 18, two spacer portions 962 are provided and disposed at positions symmetrical to the center of the heat transfer tube 50, and the cuts 63 are given to the base portions 61 in the third direction in which the heat transfer tubes 50 extend.

[0052] According to the modification, the two spacer portions 962 are provided and disposed at positions symmetrical to the center of the heat transfer tube 50. Due to this configuration, when the heat transfer tubes 50 are aligned with each other during the process of assembling the heat exchanger 908, even though the front and back sides of the heat transfer tube 50 are reversed, the shape of the spacer portions 962 remains unchanged regardless of orientation. Therefore, when the heat exchanger 908 is assembled, it is unnecessary to orient a plurality of heat transfer tubes 50 toward the same direction. This simplifies the process of aligning the heat transfer tubes 50 with each other. The spacer portions 962 are formed by bending a portion of the base portions 61, separated along the cuts 63 in the third direction, toward the first direction. With this configuration, the spacer portions 962 can receive condensed water flowing down the heat transfer tubes 50. Therefore, this can help prevent interference with drainage of the condensed water from the heat exchanger 908.

Embodiment 5

[0053] Fig. 19 is a front view illustrating a heat exchanger 1008 according to Embodiment 5. The heat exchanger 1008 in the present Embodiment 5 is different from the heat exchangers in Embodiments 1 to 4 in that spacer portions 1062 about the first header 20 and the second header 30. In the present Embodiment 5, the components in common with Embodiments 1 to 4 are denoted by the same reference signs, and thus descriptions thereof are omitted. The differences from Embodiments 1 to 4 are mainly described below.

[0054] As illustrated in Fig. 19, the spacer portions 1062 about the first header 20 and the second header 30, and the cuts 63 are given to the base portions 61 in the second direction. Specifically, the spacer portions 1062 are provided at the upper end portion of the base portions 61 about the first header 20, while the spacer portions 1062 are provided at the lower end portion of the base portions 61 about the second header 30. The present Em-

bodiment 5 exemplifies a case where the spacer portions 1062 abut the first header 20 and the second header 30. However, the spacer portions 1062 may abut either the first header 20 or the second header 30.

[0055] According to the present Embodiment 5, the spacer portions 1062 abut the first header 20 or the second header 30. Opposite end portions of the heat transfer tubes 50 protrude from the spacer portions 1062 by a length equal to the length of insertion margin S of the heat transfer tubes 50 in the third direction. That is, when the heat transfer tubes 50 are inserted into the first header 20 or the second header 30, the spacer portions 1062 function as a guide for a worker to check the length of the insertion margin S in the third direction. The spacer portions 1062 are located at the upper end portion and the lower end portion of the base portions 61. This can help prevent the spacer portions 1062 from interfering with an air flow.

Modification

[0056] Fig. 20 is a front view illustrating a heat exchanger 1108 according to a modification of Embodiment 5. In the modification as illustrated in Fig. 20, spacer portions 1162 abut the first header 20 and the second header 30. The spacer portions 1162 are formed by giving the cuts 63 to the base portions 61 in the third direction in which the heat transfer tubes 50 extend, and then bending a portion of the base portions 61 corresponding to the cuts 63 toward the first direction.

[0057] According to the modification, the spacer portions 1162 abut the first header 20 or the second header 30. Opposite end portions of the heat transfer tubes 50 protrude from the spacer portions 1162 by a length equal to the length of the insertion margin S of the heat transfer tubes 50 in the third direction. That is, when the heat transfer tubes 50 are inserted into the first header 20 or the second header 30, the spacer portions 1162 function as a guide for a worker to check the length of the insertion margin S in the third direction. The spacer portions 1162 are located at the upper end portion and the lower end portion of the base portions 61. This can help prevent the spacer portions 1162 from interfering with an air flow. Furthermore, the spacer portions 1162 are formed by bending a portion of the base portions 61, separated along the cuts 63 in the third direction, toward the first direction. With this configuration, the spacer portions 1162 can receive condensed water flowing down the heat transfer tubes 50. Therefore, this can help prevent interference with drainage of the condensed water from the heat exchanger 1108.

Embodiment 6

[0058] Fig. 21 is a front view illustrating a heat exchanger 1208 according to Embodiment 6. The heat exchanger 1208 in the present Embodiment 6 is different from the heat exchangers in Embodiments 1 to 5 in that a plurality

of spacer portions 1262 are provided along the third direction. In the present Embodiment 6, the components in common with Embodiments 1 to 5 are denoted by the same reference signs, and thus descriptions thereof are omitted. The differences from Embodiments 1 to 5 are mainly described below.

[0059] As illustrated in Fig. 21, the plurality of spacer portions 1262 are provided and located at equal intervals along the third direction in which the heat transfer tubes 50 extend. The spacer portions 1262 are formed by giving the cuts 63 to the base portions 61 in the third direction in which the heat transfer tubes 50 extend.

[0060] According to the present Embodiment 6, the spacer portions 1262 that may slightly interfere with an air flow are located at equal intervals along the third direction. This can result in equal pressure loss in the third direction in its entirety. Thus, an uneven air flow can be minimized in the third direction in its entirety. Therefore, the increase in power of the outdoor fan 9 can be minimized.

Modification

[0061] Fig. 22 is a front view illustrating a heat exchanger 1308 according to a modification of Embodiment 6. In the modification as illustrated in Fig. 22, a plurality of spacer portions 1362 are provided, in which the number of the spacer portions 1362 is greater on the downstream side of the heat transfer tube 50 than on the upstream side thereof. The spacer portions 1362 are formed by giving the cuts 63 to the base portions 61 in the third direction in which the heat transfer tubes 50 extend. The modification exemplifies a case where two of the spacer portions 1362 are disposed on the upstream side of the heat transfer tube 50, while four of the spacer portions 1362 are disposed on the downstream side of the heat transfer tube 50. However, the numbers of the spacer portions 1362 on the upstream side and on the downstream side can be appropriately changed. Note that the spacer portions 1362 on the upstream side of the heat transfer tube 50 may be omitted.

[0062] According to the modification, a plurality of the spacer portions 1362 are provided, in which the number of the spacer portions 1362 is greater on the downstream side of the heat transfer tubes 50 than on the upstream side thereof. When the heat exchanger 1308 functions as an evaporator, there is a higher probability that frost is formed on the upstream side of the heat transfer tubes 50 compared to on the downstream side thereof. In the modification, a plurality of the spacer portions 1362 are provided, in which the number of the spacer portions 1362 is greater on the downstream side of the heat transfer tubes 50 than that on the upstream side thereof. Thus, the amount of frost accumulating on the spacer portions 1362 in their entirety can be reduced.

Reference Signs List

[0063] 1: refrigeration cycle apparatus, 2: outdoor unit, 3: indoor unit, 4: refrigerant circuit, 5: refrigerant pipe, 6: compressor, 7: flow switching device, 8: heat exchanger, 9: outdoor fan, 10: expansion unit, 11: indoor heat exchanger, 12: indoor fan, 20: first header, 30: second header, 40: heat transfer member, 50: heat transfer tube, 51: flow passage, 60: extension portion, 61: base portion, 62: spacer portion, 63: cut, 64: hole, 108: heat exchanger, 208: heat exchanger, 262: spacer portion, 308: heat exchanger, 362: spacer portion, 362a: protruding portion, 408: heat exchanger, 462: spacer portion, 508: heat exchanger, 562: spacer portion, 608: heat exchanger, 662: spacer portion, 708: heat exchanger, 762: spacer portion, 808: heat exchanger, 862: spacer portion, 908: heat exchanger, 962: spacer portion, 1008: heat exchanger, 1062: spacer portion, 1108: heat exchanger, 1162: spacer portion, 1208: heat exchanger, 1262: spacer portion, 1308: heat exchanger, 1362: spacer portion

Claims

1. A heat exchanger comprising:

a first header being configured to collect and deliver refrigerant and extending in a first direction; a second header being configured to collect and deliver refrigerant, being disposed at a position facing the first header and extending in the first direction; and a plurality of heat transfer components each extending from the first header to the second header and being provided at intervals along the first direction, wherein the heat transfer components each includes a plurality of heat transfer tubes each extending from the first header to the second header and allowing refrigerant to flow in its inside; and an extension portion being provided in each of the heat transfer tubes and configured to promote heat transfer property of the heat transfer tubes, and wherein the extension portion includes a base portion extending from the heat transfer tube in a second direction in which air that flows between the plurality of heat transfer tubes flows; and a spacer portion extending from the base portion in the first direction and abutting the adjacent heat transfer component.

2. The heat exchanger of claim 1, wherein the spacer portion is a portion of the base portion that is bent to extend in the first direction.

3. The heat exchanger of claim 2, wherein the spacer

portion is formed by giving a cut to the base portion in the second direction.

4. The heat exchanger of claim 2 or 3, wherein the spacer portion is formed by giving a cut to the base portion in a third direction in which the heat transfer tube extends.

5. The heat exchanger of any one of claims 1 to 4, wherein the spacer portion is a portion of the base portion that is cut and raised to extend in the first direction.

6. The heat exchanger of claim 5, wherein the spacer portion is formed by giving a cut to the base portion in the second direction.

7. The heat exchanger of claim 5 or 6, wherein the spacer portion is formed by giving a cut to the base portion in a third direction in which the heat transfer tube extends.

8. The heat exchanger of any one of claims 5 to 7, wherein the spacer portion is formed in a burring shape by punching a hole in the base portion.

9. The heat exchanger of any one of claims 1 to 8, wherein a plurality of the spacer portions are provided and disposed at positions symmetrical to a center of the heat transfer tube.

10. The heat exchanger of any one of claims 1 to 9, wherein the spacer portion abuts the heat transfer tube.

11. The heat exchanger of any one of claims 1 to 10, wherein the spacer portion abuts the extension portion.

12. The heat exchanger of any one of claims 1 to 11, wherein the spacer portion abuts the first header or the second header.

13. The heat exchanger of any one of claims 1 to 12, wherein a plurality of the spacer portions are provided and located at equal intervals along a third direction in which the heat transfer tube extends.

14. The heat exchanger of any one of claims 1 to 13, wherein

a plurality of the spacer portions are provided, and a number of the spacer portions is greater on a downstream side of the heat transfer tube than on an upstream side thereof.

15. The heat exchanger of any one of claims 1 to 14,

wherein the spacer portion is formed in an embossed shape extending in the first direction and then bent back.

16. The heat exchanger of any one of claims 1 to 15, 5
wherein a plurality of the heat transfer tubes are provided along the second direction.
17. A refrigeration cycle apparatus, wherein the heat exchanger of any one of claims 1 to 16 functions as a 10
condenser or an evaporator.

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FIG. 1

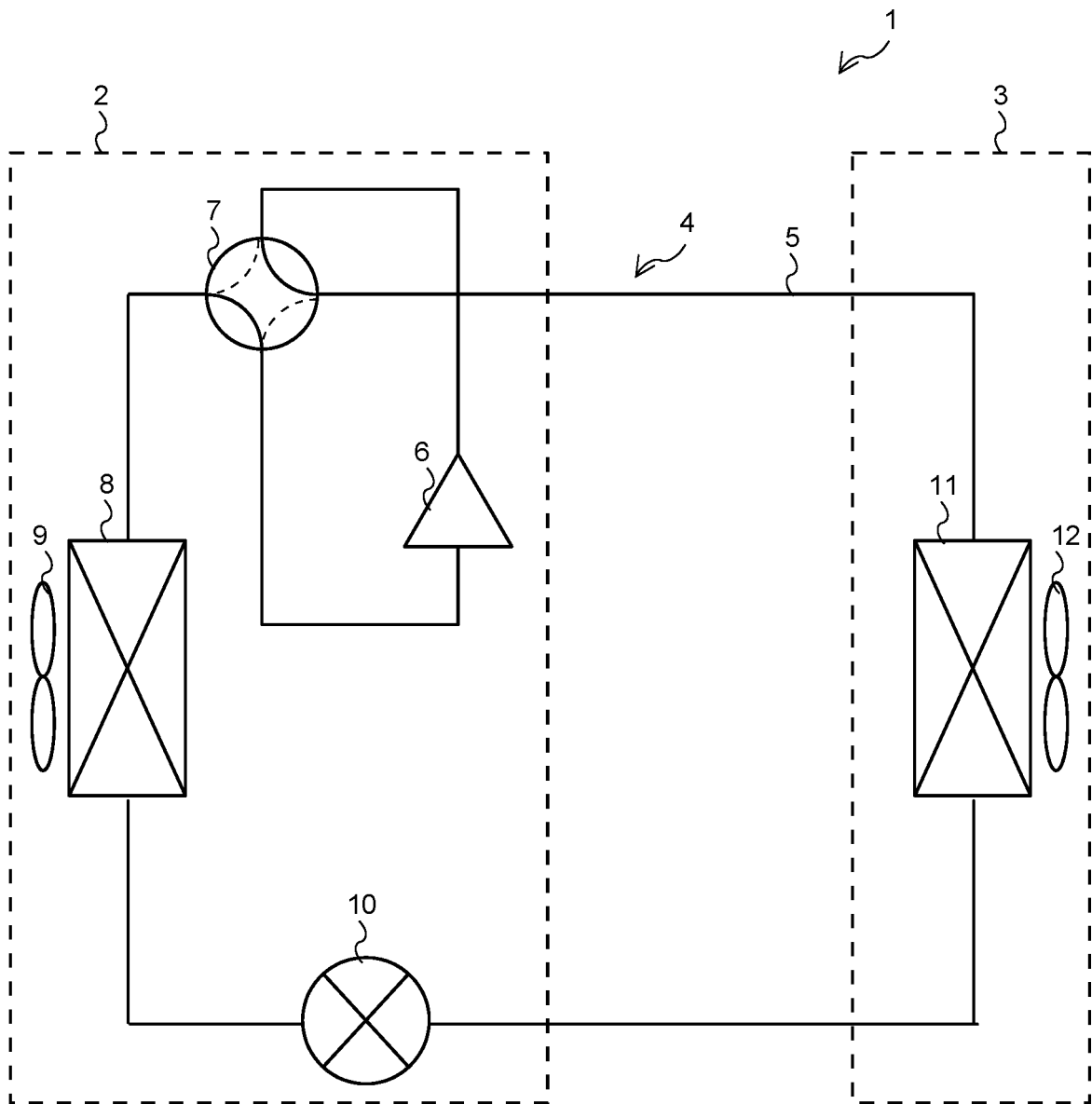


FIG. 2

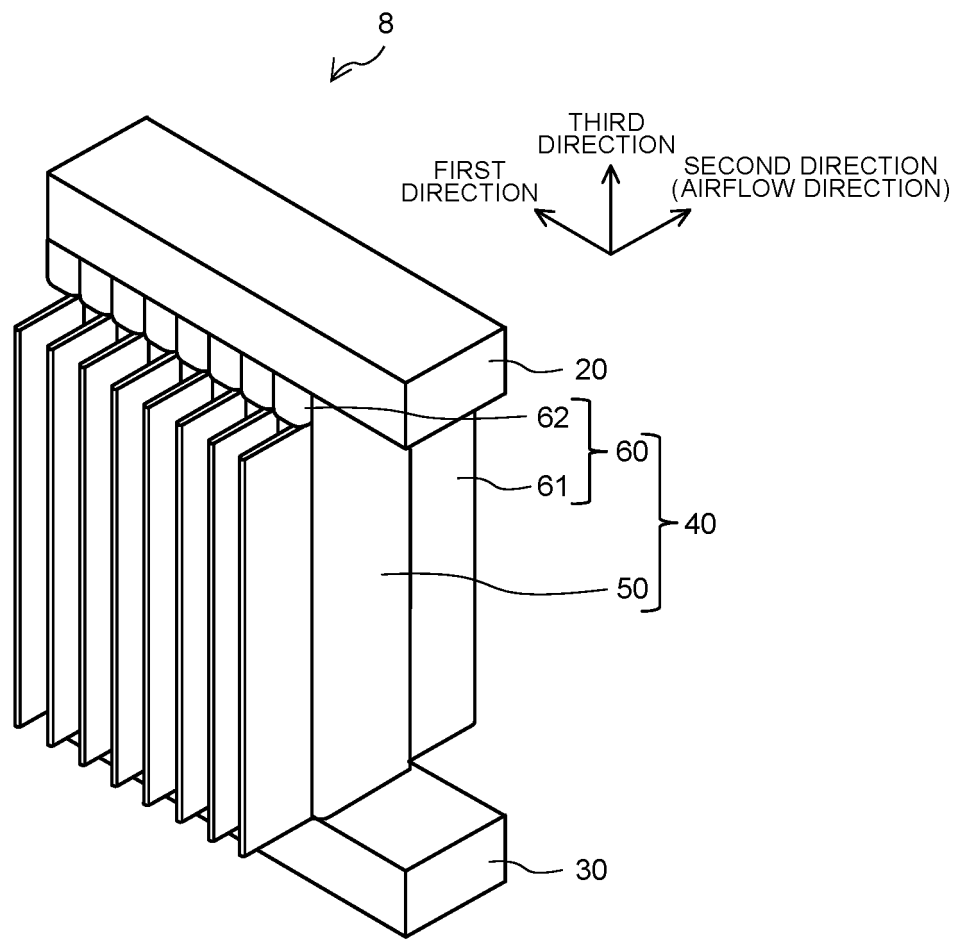


FIG. 3

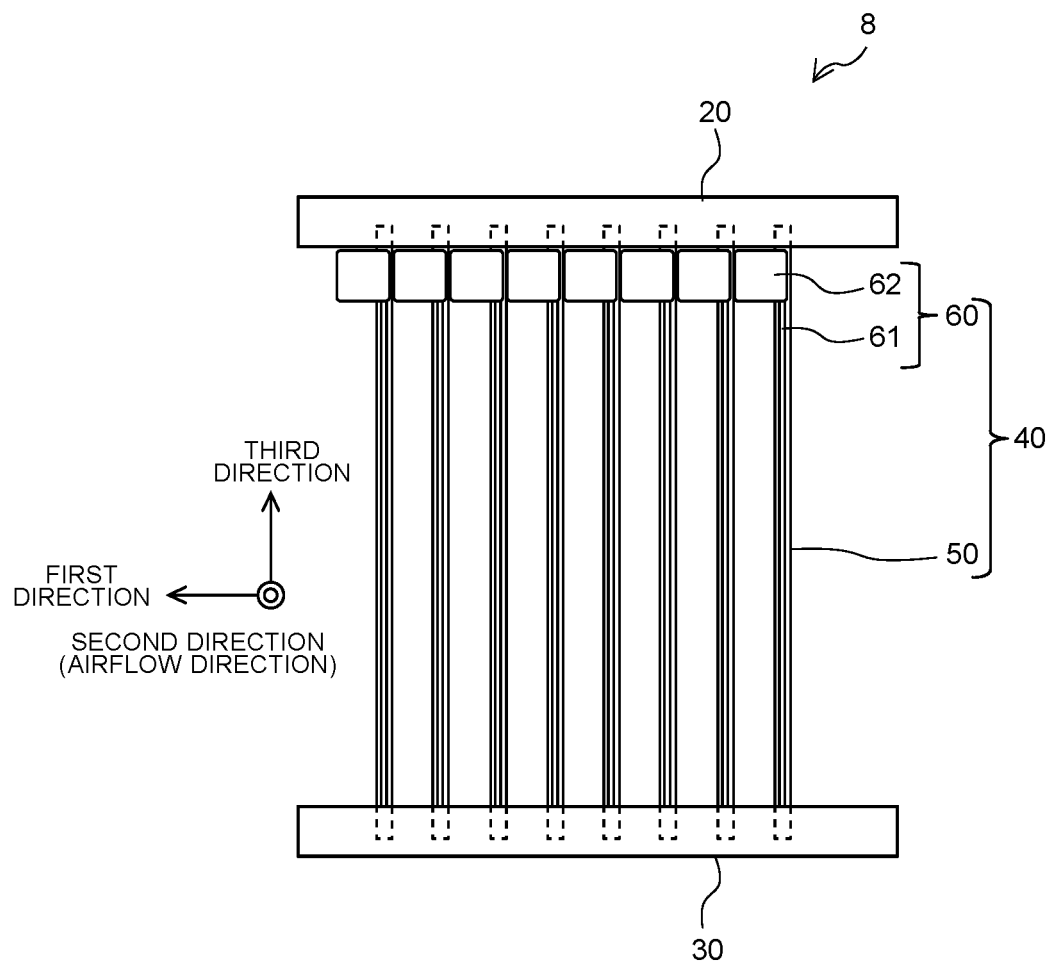


FIG. 4

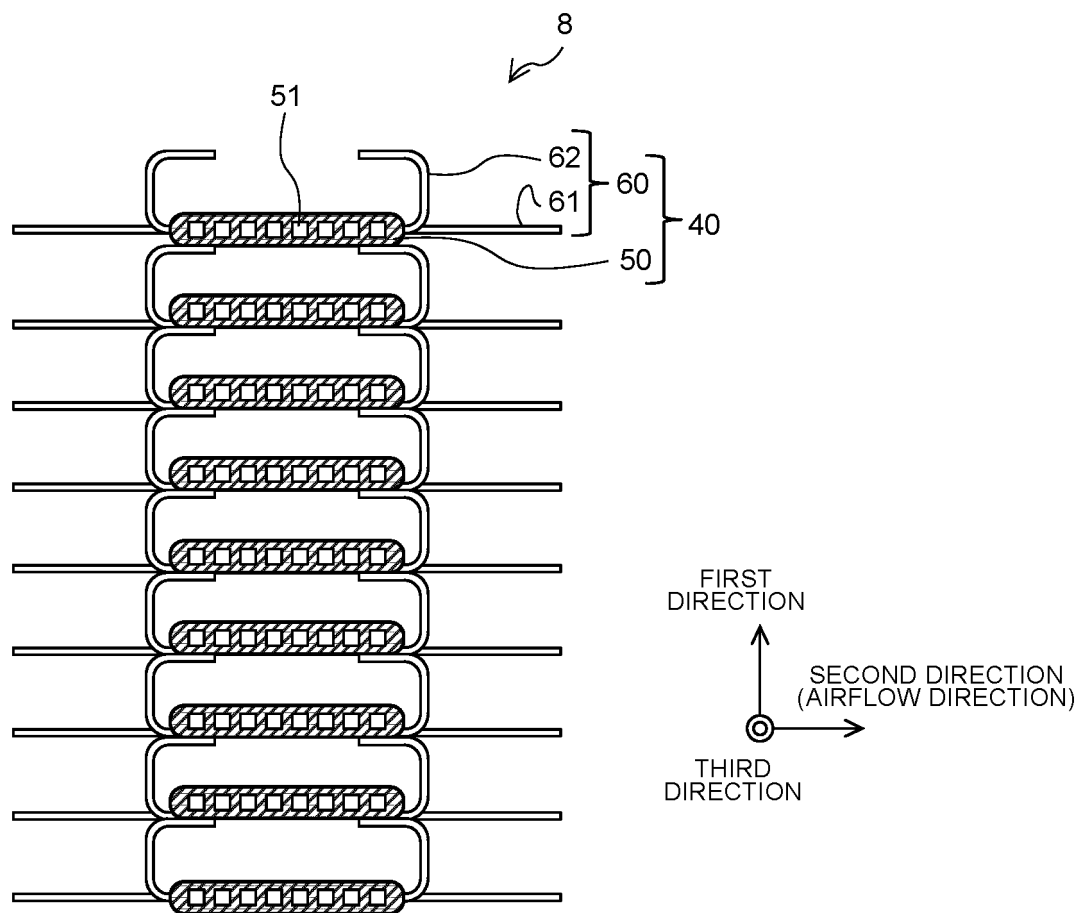


FIG. 5

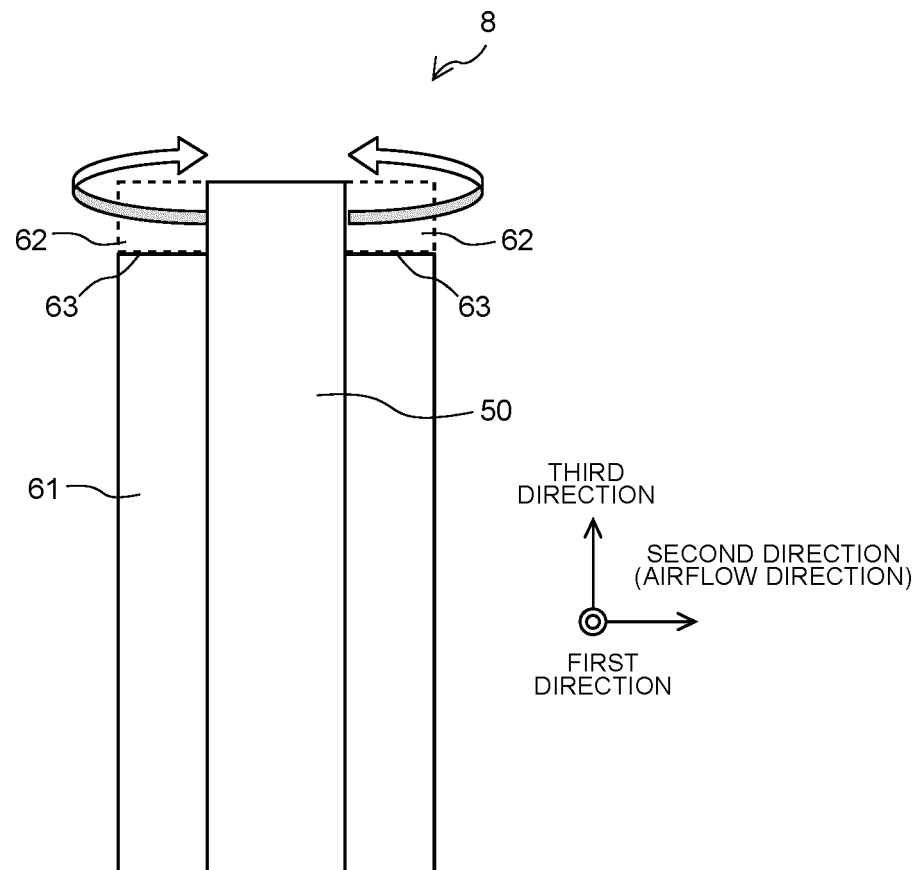


FIG. 6

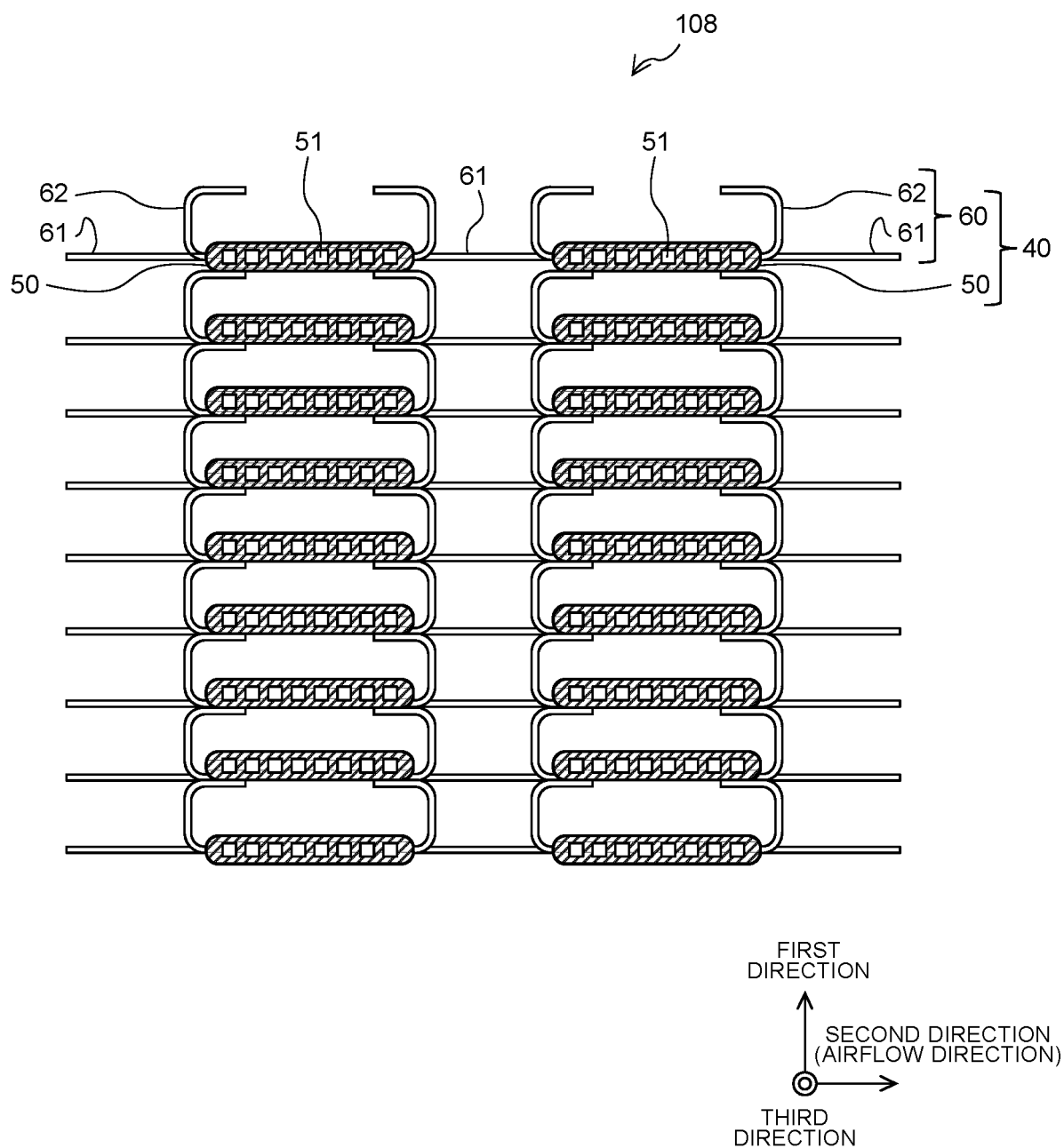


FIG. 7

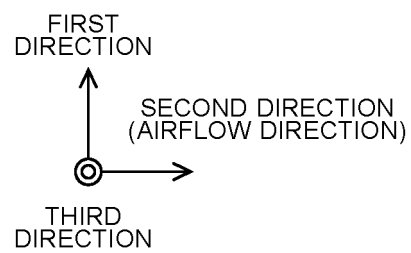
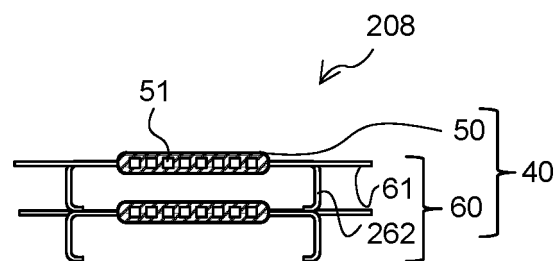


FIG. 8

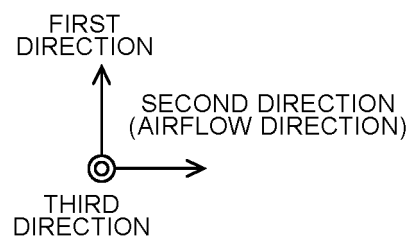
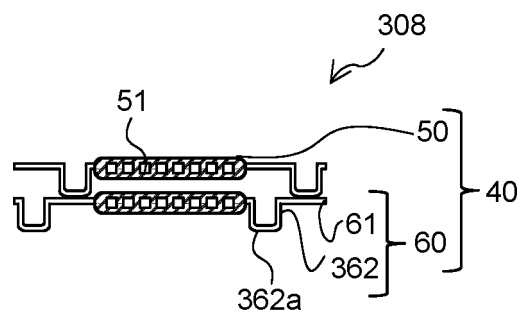


FIG. 9

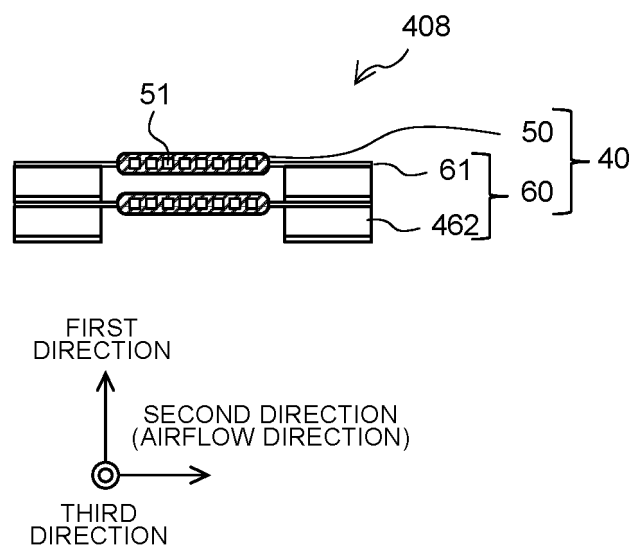


FIG. 10

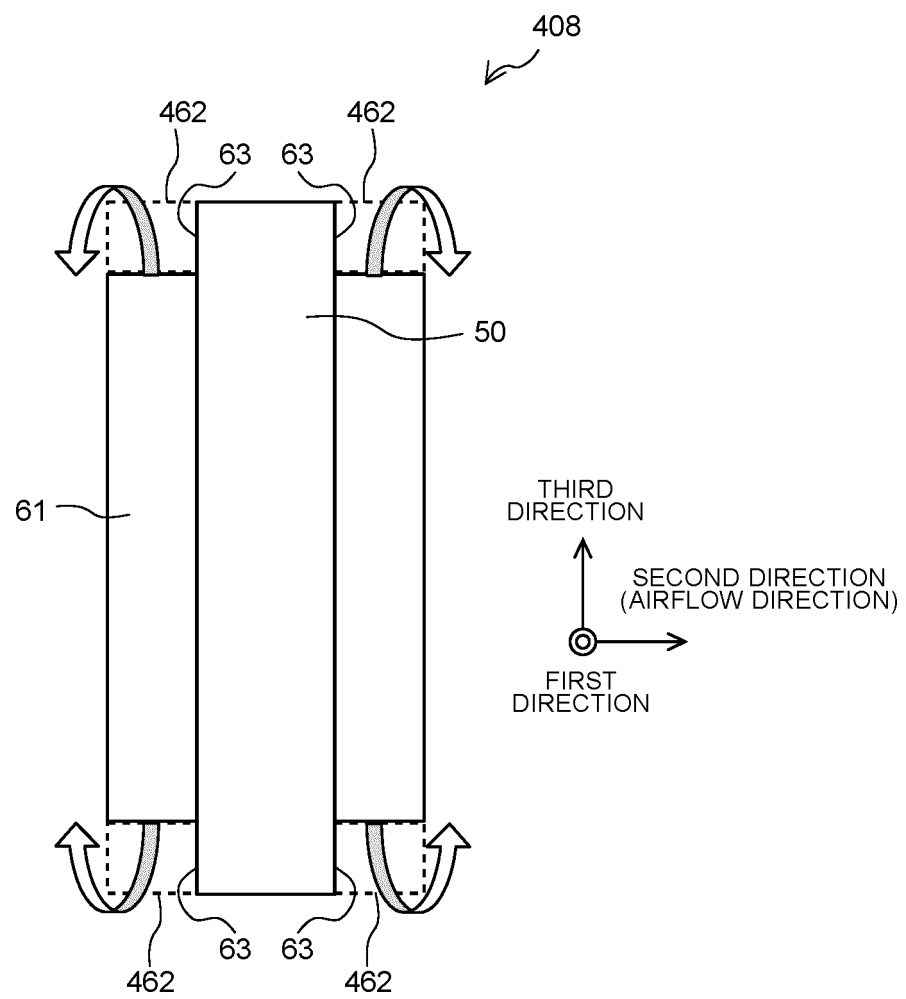


FIG. 11

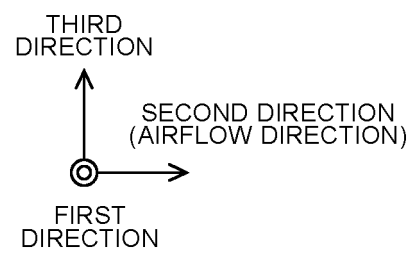
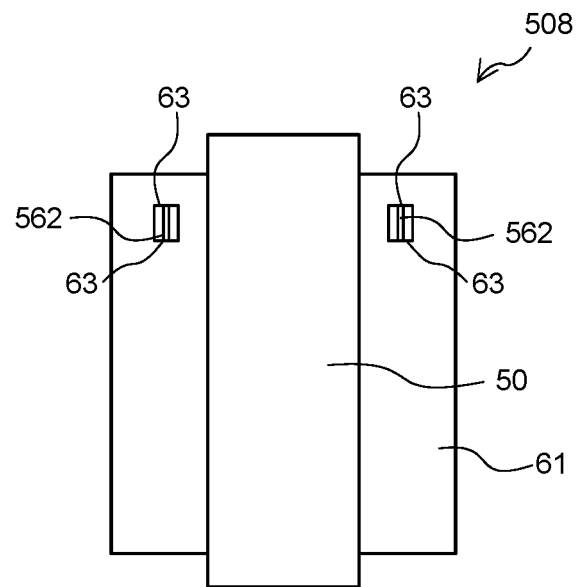


FIG. 12

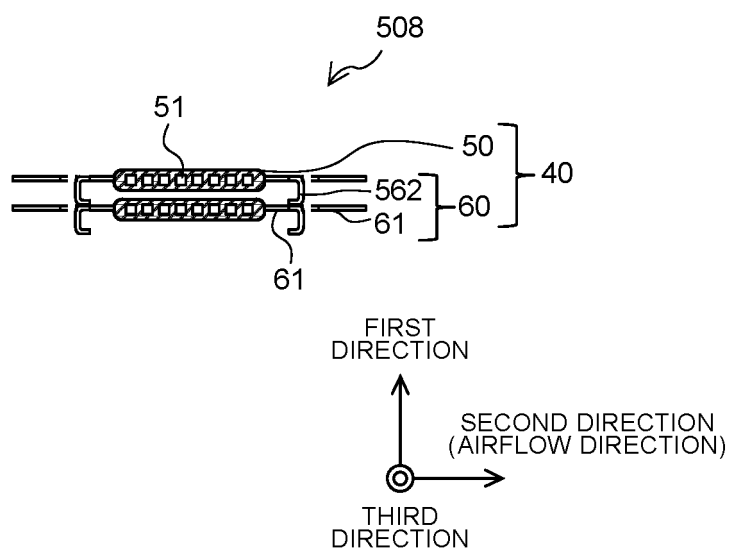


FIG. 13

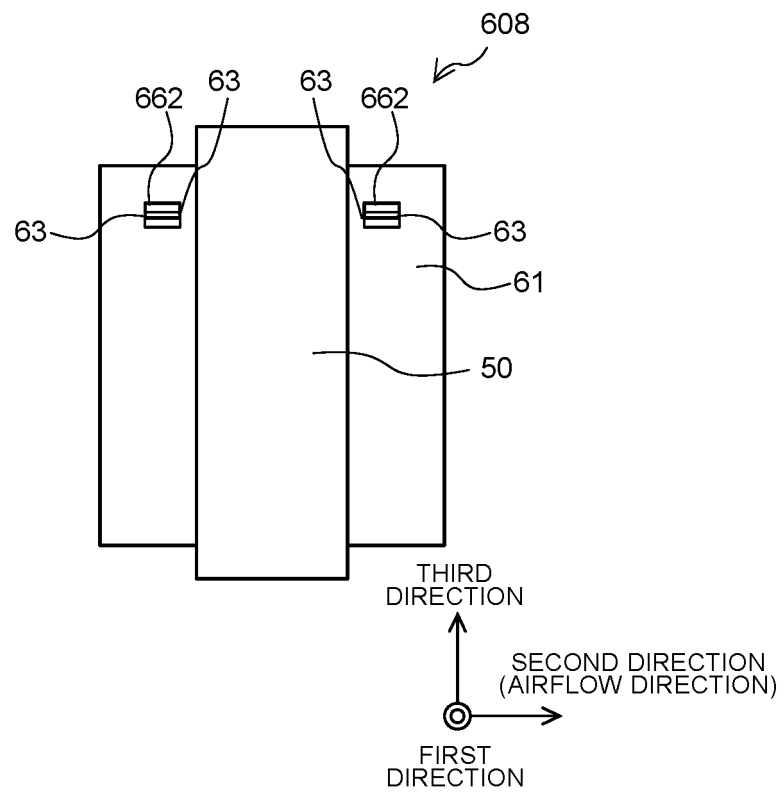


FIG. 14

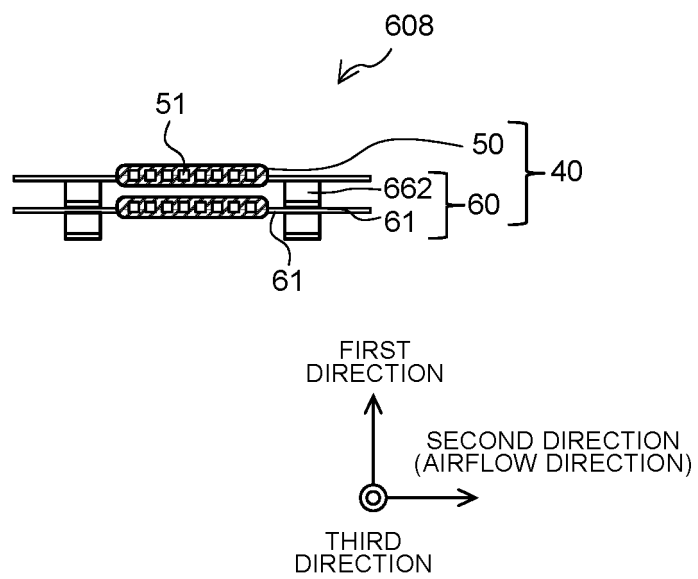


FIG. 15

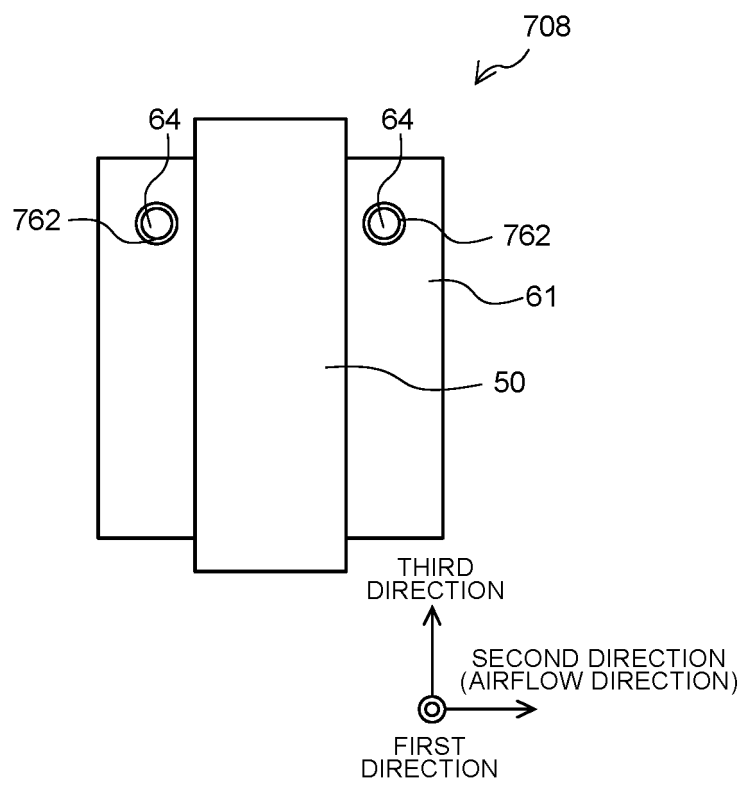


FIG. 16

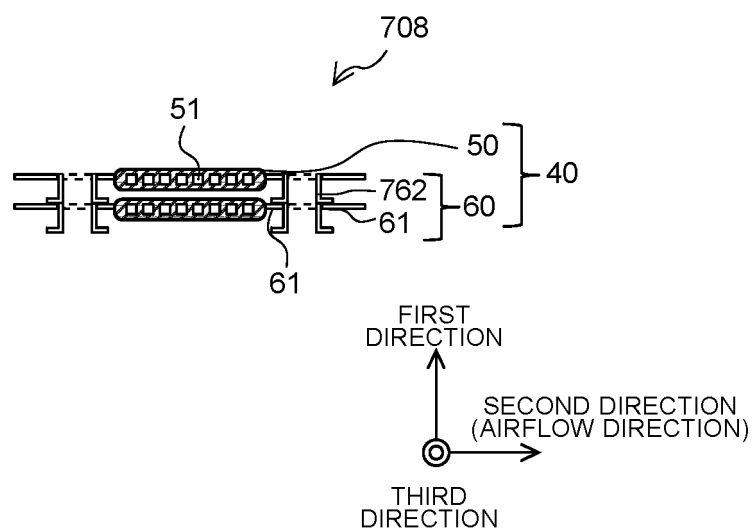


FIG. 17

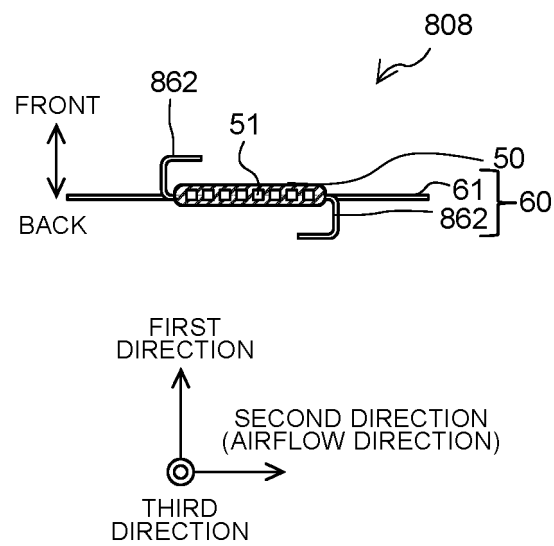


FIG. 18

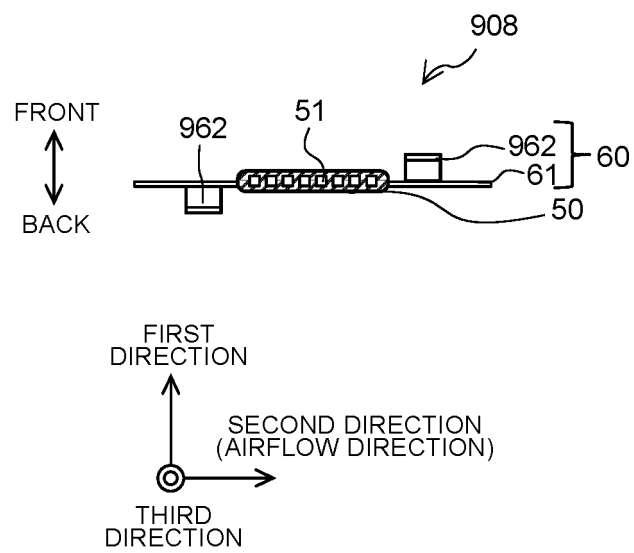


FIG. 19

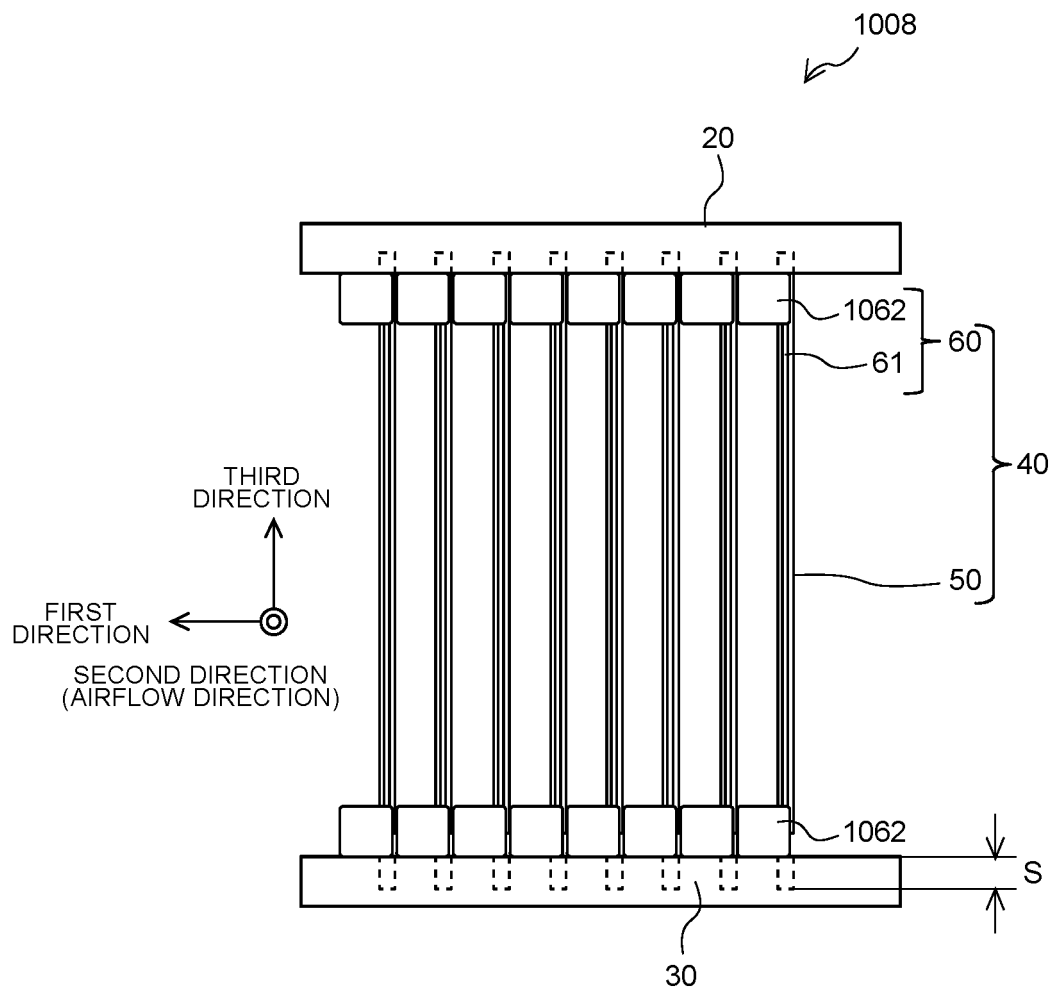


FIG. 20

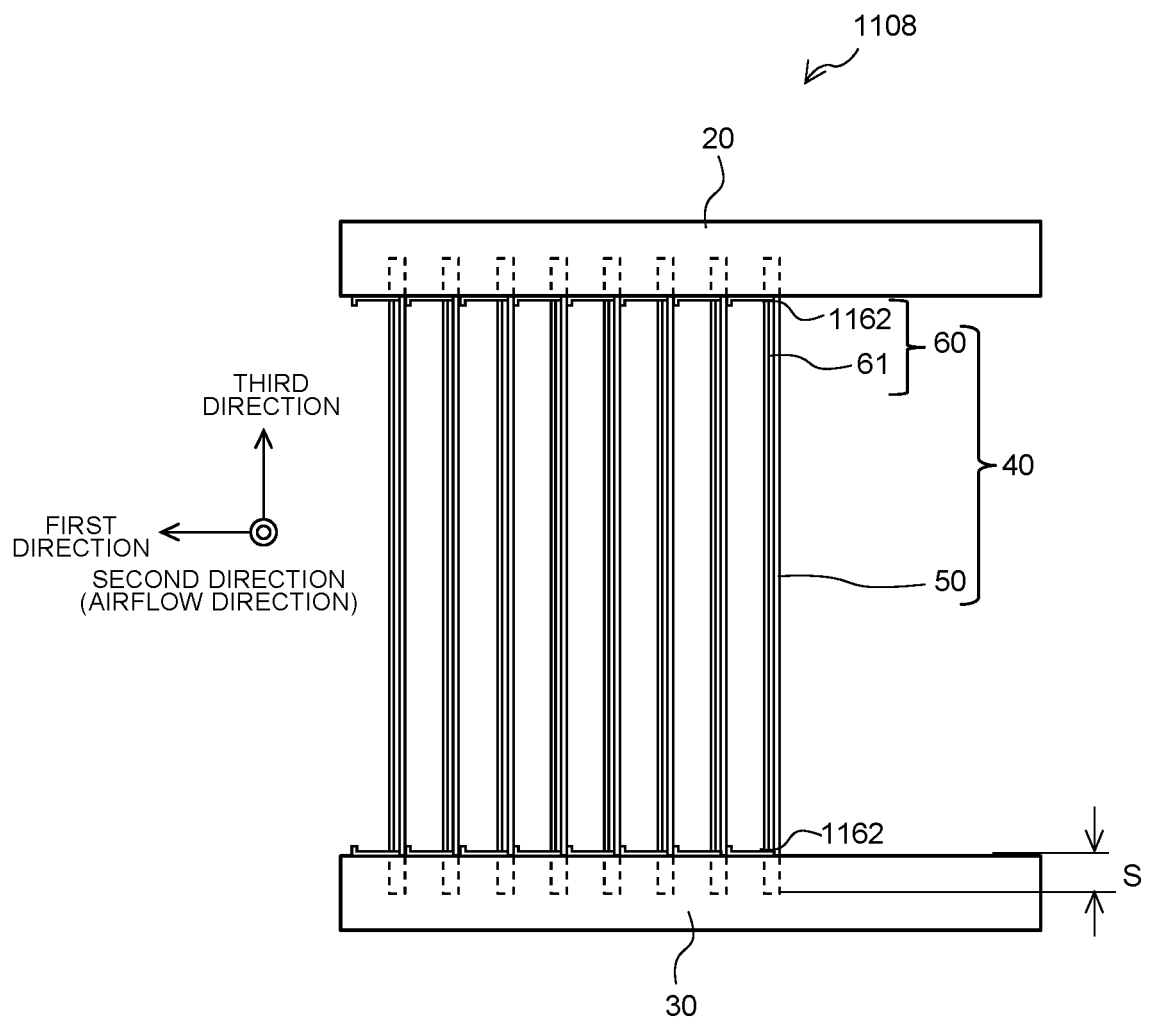


FIG. 21

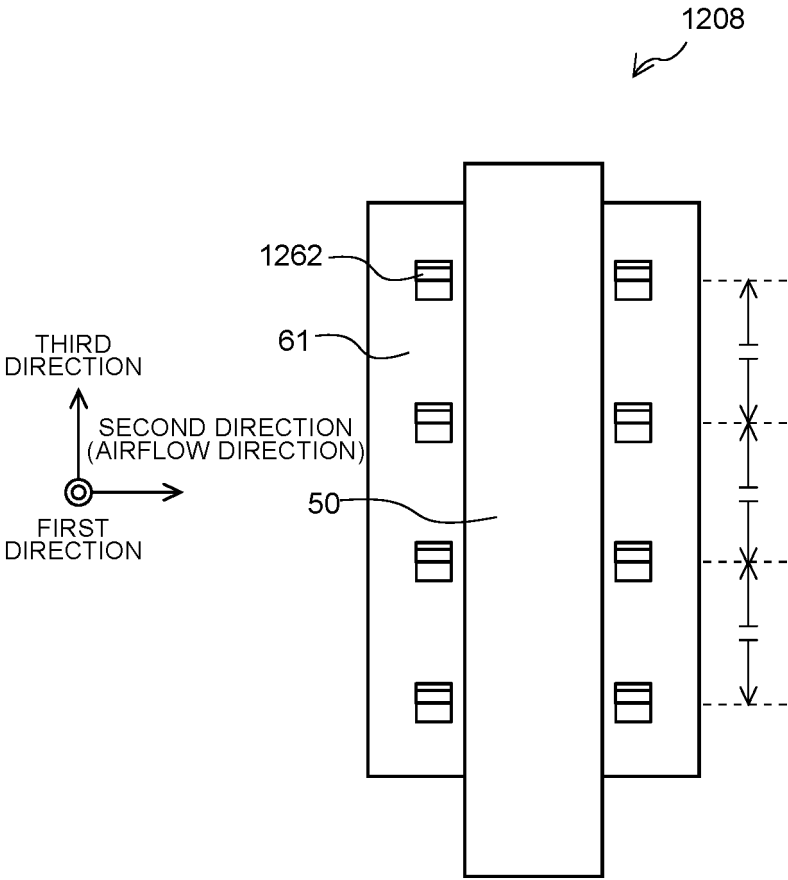
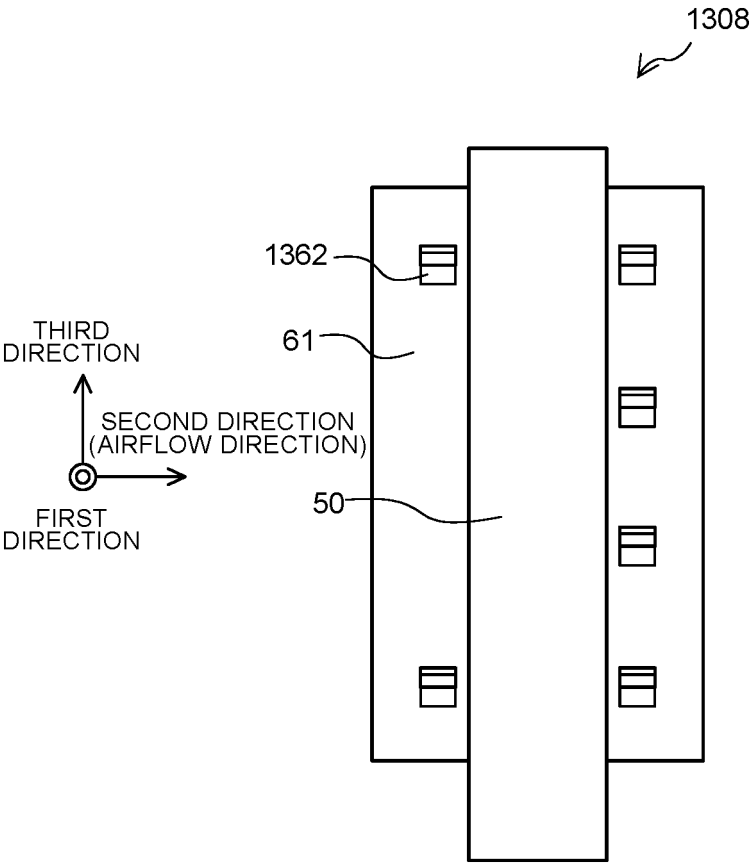


FIG. 22



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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/021578

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A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. F25B39/00 (2006.01) i, F28D1/053 (2006.01) i, F28F1/02 (2006.01) i, F28F1/16 (2006.01) i

FI: F28F1/16 Z, F28F1/02 B, F25B39/00 B, F28D1/053 A

According to International Patent Classification (IPC) or to both national classification and IPC

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl. F25B39/00-39/04, F28D1/00-13/00, F28F1/00-1/44

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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 1971-2020

Registered utility model specifications of Japan 1996-2020

Published registered utility model applications of Japan 1994-2020

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

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 110595112 A (GUANGDONG MIDEA REFRIGERATION EQUIPMENT CO., LTD.) 20 December 2019, paragraphs [0037]-[0062], fig. 1-5	1-7, 11, 13, 16-17
Y		8-9, 12, 14
A		10, 15
X	JP 2016-75450 A (HITACHI, LTD.) 12 May 2016, paragraphs [0011]-[0034], fig. 2-6	1-7, 11, 16-17
Y		8-9, 12, 14
A		10, 13, 15
X	JP 2006-84078 A (DAIKIN INDUSTRIES, LTD.) 30 March 2006, paragraphs [0035], [0038]-[0067], fig. 1, 7-13	1, 5, 7, 10, 13, 15, 17
Y		8-9, 12, 14
A		2-4, 6, 11, 16

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☒ 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
27.07.2020Date of mailing of the international search report
11.08.2020

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/021578

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y		8-9, 12, 14
A		3, 6, 11, 13, 15
Y	JP 4-198691 A (TOSHIBA CORP.) 20 July 1992, p. 1, lower right column, line 10 to p. 2, upper left column, line 10, fig. 3	8-9, 12, 14
Y	JP 2003-247794 A (TOSHIBA CARRIER CORP.) 05 September 2003, in particular, paragraph [0026]	9, 12, 14
Y	JP 2016-80325 A (CALSONIC KANSEI CORP.) 16 May 2016, in particular, paragraph [0054]	9, 12, 14
Y	JP 2000-18504 A (ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIES CO., LTD.) 18 January 2000, in particular, paragraph [0007]	9, 12, 14
Y	WO 2020/012549 A1 (MITSUBISHI ELECTRIC CORP.) 16 January 2020, paragraphs [0047]-[0049], fig. 4	14
Y	US 2015/0226495 A1 (LG ELECTRONICS INC.) 13 August 2015, paragraphs [0061]-[0069], fig. 7, 8	14
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 68592/1977 (Laid-open No. 162945/1978) (NIPPON LIGHT METAL CO., LTD.) 20 December 1978, description, p. 4, line 6 to p. 6, line 9, fig. 1-3	1-17

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

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/021578

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		KR 10-2015-0094954 A	
		CN 104833137 A	
JP 53-162945 U1	20.12.1978	(Family: none)	

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- JP 2018162953 A [0004]