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(54) **Heat exchanger**

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Description

BACKGROUND

[0001] The present disclosure relates to a heat exchanger. US 5529116 A discloses a heat exchanger having the features in the preamble of claim 1.

[0002] Heat exchangers constitute a refrigeration cycle and allow a refrigerant to flow therethrough. Also, heat exchangers are heat-exchanged with air to cool or heat the air. Such a heat exchanger may be used in refrigeration devices of air conditioners or refrigerators to serve as a condenser or evaporator according to whether a refrigerant is condensed or evaporated by the heat exchanger.

[0003] The heat exchanger is classified into a fin-and-tube type heat exchanger and a micro-channel type heat exchanger according to its shape. The fin-and-tube type heat exchanger includes a plurality of fins and a tube passing through the fins and having a circular shape or a shape similar to the circular shape. The micro-channel type heat exchanger includes a plurality of tubes (flat tubes) through which a refrigerant flows and a fin disposed between the plurality of flat tubes. Also, in both of the fin-and-tube type heat exchanger and the micro-channel type heat exchanger, a refrigerant flowing into the tube or flat tube is heat-exchanged with an external fluid, for example, air, and the fin increases a heat exchange area between the refrigerant flowing into the tube or flat tube and the external fluid.

[0004] For example, a louver may be provided as a structure for increasing the heat exchange area on the fin. The louver may be formed by cutting or bending a portion of the fin. Also, a distance (stacked distance) between the stacked fins may be reduced by the louver.

[0005] In the heat exchanger according to the related art, condensate water may be frozen to form frost on a surface of the fin when the heat exchanger serves as the evaporator at a low temperature.

[0006] Particularly, in the whole structure of the heat exchanger, the frost may be more formed on a front end-side of the heat exchanger that contacts firstly the flowing air. This is done because a temperature difference between the air and the refrigerant at the front end-side is greater than that at a rear end-side of the heat exchanger, i.e., a condensed degree of the refrigerant is relatively large.

[0007] Also, when the louver is provided on the fin, the space between the tube disposed on the front end-side of the heat exchanger and the fin may be blocked by the frost due to the narrowed stacked distance.

[0008] As described above, if a large amount of frost is formed, the passage through which the air flows may be blocked to deteriorate the heat exchange efficiency, and a time taken to perform defrosting for the heat exchanger may increase.

SUMMARY

[0009] Embodiments provide a heat exchanger that is improved in structure to delay formation of frost.

[0010] In the embodiment as defined in claim 1, a heat exchanger includes: a plurality of refrigerant tubes through which a refrigerant flows, the plurality of refrigerant tube being disposed to be spaced apart from each other in one direction; and a plurality of fins disposed between the plurality of refrigerant tubes, wherein a distance between the fins disposed on a front end-side of the plurality of refrigerant tubes is greater than that between the fins disposed on a rear end-side of the plurality of refrigerant tubes.

[0011] The front end-side of the plurality of refrigerant tubes may define an upstream side with respect to a flow direction of air, and the rear end-side of the plurality of refrigerant tubes may define a downstream side with respect to the flow direction of the air.

[0012] The plurality of refrigerant tubes may include: a plurality of first tubes defining a first row; and a plurality of second tubes disposed on one side of the plurality of first tubes to define a second row, wherein the flow direction of the air may be directed from the plurality of first tubes to the plurality of second tubes.

[0013] The plurality of fins may include: a plurality of first fins coupled to the plurality of first tubes; and a plurality of second fins coupled to the plurality of second tubes, wherein a distance between the plurality of first fins may be greater than that between the plurality of second fins.

[0014] Each of the fins may include: a ruled surface extending in one direction between the plurality of refrigerant tubes; and a curved surface bent or curved from the ruled surface, the curved surface including a tube coupling part coupled to each of the refrigerant tubes.

[0015] The plurality of refrigerant tubes may include a first tube defining the front end-side thereof and a second tube defining the rear end-side thereof, and the number (FPI) of ruled surfaces of the fins coupled to first tube may be less than that of ruled surfaces of the fins coupled to the second tube with respect to preset lengths of the first and second tubes.

[0016] The number (FPI) of the ruled surfaces of the fins coupled to the first tube may be about 17 to about 18, and the number of ruled surfaces of the fins coupled to the second tube may be about 20 to about 22.

[0017] Each of the ruled surface and the curved surface may be provided in plurality, and a distance ($2Fp_1$) between the tube coupling parts disposed on two curved surfaces adjacent to each other may be twice as much as a distance (Fp_1) between two ruled surfaces adjacent to each other.

[0018] The plurality of fins may include: a first fin including a first fin-side louver; and a second fin disposed on one side of the first fin, the second fin including a second fin-side louver.

[0019] The first fin-side louver may include first and second louvers that are aligned from the upstream side to the downstream side, and a pitch (P2) of the second louver may be greater than that (P1) of the first louver.

[0020] In a distance (S) between the first fin-side louver and the second fin-side louver, a distance (S1) at the upstream side may be greater than that (S2) at the downstream side with respect to the flow direction of the air.

[0021] The distance (S) between the first fin-side louver and the second fin-side louver may gradually decrease from the upstream side to the downstream side with respect to the flow direction of the air.

[0022] Each of the fins as defined in claim 1 includes a fin body and a plurality of louvers extending outward from one surface and the other surface of the fin body, and the plurality of louvers may include a plurality of one side louvers having a louver angle angled with respect to the fin body, which gradually increases from the upstream side to the downstream side with respect to the flow direction of the air.

[0023] The plurality of louvers may include a plurality of the other side louvers having a louver angle angled with respect to the fin body, which gradually decreases from the upstream side to the downstream side with respect to the flow direction of the air.

[0024] The plurality of one side louvers and the plurality of the other side louvers may be disposed to be spaced apart from each other on both sides of the fin body.

[0025] In another embodiment, a heat exchanger includes: first and second headers disposed to be spaced apart from each other; a plurality of first tubes extending between the first and second headers to guide a flow of a refrigerant; a plurality of second tubes spaced apart from one side of the plurality of first tubes to extend, thereby guiding the flow of the refrigerant; a first fin disposed in a space between the plurality of first tubes to roundly extend; and a second fin disposed in a space between the plurality of second tubes to roundly extend, wherein the first fin has a curvature radius different from that of the second fin.

[0026] The plurality of first tubes may define an upstream side in a flow direction of air, and the plurality of second tubes may define a downstream side in the flow direction of the air, and the first fin may have a curvature radius greater than that of the second fin.

[0027] The heat exchanger may further may include a plurality of louvers disposed on the first or second fin, wherein a pitch (P1) of the first louver disposed at the upstream side may be less than that (P2) of the second louver disposed at the downstream side with respect to a flow direction of air.

[0028] The plurality of louvers may include a first fin-side louver disposed on the first fin and a second fin-side louver disposed on the second fin, and in a distance (S) between the first fin-side louver and the second fin-side louver, a distance (S2) at the downstream side may be less than that (S1) at the upstream side with respect to the flow direction of the air.

[0029] The first or second fin may include a fin body and a plurality of louvers extending outward from one surface and the other surface of the fin body, wherein the plurality of louvers may include: a plurality of one side louvers having a louver angle angled with respect to the fin body, which gradually increases from the upstream side to the downstream side with respect to the flow direction of the air; and a plurality of the other side louvers having a louver angle angled with respect to the fin body, which gradually decreases from the upstream side to the downstream side with respect to the flow direction of the air.

[0030] The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031]

Fig. 1 is a front view of a heat exchanger according to a first embodiment.

Fig. 2 is a plan view of the heat exchanger according to the first embodiment.

Fig. 3 is a partial view of the heat exchanger according to the first embodiment.

Fig. 4 is a cross-sectional view taken along line I-I' of Fig. 1.

Fig. 5 is a graph illustrating an effect in which frost formation is delayed by a fin according to the first embodiment.

Fig. 6 is a partial view of a heat exchanger according to a second embodiment.

Fig. 7 is a view of a fin according to the second embodiment.

Fig. 8 is a view of a fin according to a third embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0032] Hereinafter, exemplary embodiments will be described with reference to the accompanying drawings. The invention may, however, be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein; rather, that alternate embodiments included in other retrogressive inventions or falling within the spirit and scope of the present disclosure will fully convey the concept of the invention to those skilled in the art.

[0033] Fig. 1 is a front view of a heat exchanger according to a first embodiment.

[0034] Referring to Fig. 1, a heat exchanger 10 according to a first embodiment includes a plurality of refrigerant tubes 100 (hereinafter, referred to as tubes) through which a refrigerant flows, a plurality of fins 200 stacked on the tubes 100, and two headers 30 and 40 connected to both ends of the tubes 100.

[0035] The plurality of tubes 100 are lengthily disposed with a predetermined length in parallel to each other in a horizontal direction and spaced apart from each other in a direction perpendicular to the longitudinal direction thereof. For example, each of the tube 100 may include a flat tube having a polygonal cross-section.

[0036] The plurality of fins 200 are disposed between the two tubes 100 adjacent to each other. The plurality of fins 200 may be bent or curved to increase a heat-exchange area.

[0037] The two headers 30 and 40 include a first header 30 and a second header 40 which are disposed to be spaced apart from each other. The tubes 100 may be connected between the first and second headers 30 and 40. Also, a flow space in which the refrigerant flows are defined in each of the first and second headers 30 and 40.

[0038] In Fig. 1, since each of the two headers 30 and 40 extends in a vertical (longitudinal) direction, the header may be called a "vertical header". However, the extension direction of the header may not be limited to the above-described direction. For example, the header may extend in a horizontal direction. Here, the tube 100 may extend in the vertical (longitudinal) direction.

[0039] Baffles 35, 43, and 45 are disposed within the two headers 30 and 40. In detail, the baffles 35, 43, and 45 include a first baffle 35 disposed within the first header 30 and second and third baffles 43 and 45 disposed within the second header 40. The baffles 35, 43, and 45 may partition refrigerant passages within each of the headers 30 and 40 to guide the refrigerant within the headers 30 and 40 so as to flow into the tubes 100.

[0040] The heat exchanger 10 includes an inflow part 50 for guiding introduction of the refrigerant into the heat exchanger 10 and a discharge part 60 for guiding discharge of the refrigerant passing through the heat exchanger 10. For example, the inflow part 50 and the discharge part 60 are provided in the second header 40, and the discharge part 60 may be disposed to be spaced upward from the inflow part 50.

[0041] Fig. 2 is a plan view of the heat exchanger according to the first embodiment, Fig. 3 is a partial view of the heat exchanger according to the first embodiment, and Fig. 4 is a cross-sectional view taken along line I-I' of Fig. 1.

[0042] Referring to Figs. 2 to 4, the heat exchanger 10 according to the first embodiment includes a plurality of tubes 110 and 120 that are arranged in two rows.

[0043] In detail, the plurality of tubes 110 and 120 include a plurality of first tubes 110 disposed between the first header 30 and the second header 40 and a plurality of second tubes 120 disposed adjacent to one side of the plurality of first tubes 110 between the first header 30 and the second header 40.

[0044] The plurality of first tubes 110 may constitute one row (a first row) and be spaced apart from each other in a vertical direction. Also, the plurality of second tubes 120 may constitute the other row (a second row) and be spaced apart from each other in the vertical direction.

[0045] The fins 200 may be disposed in a space part that is defined by the plurality of first tubes spaced apart from each other and a space part that is defined by the plurality of second tubes spaced apart from each other.

[0046] As illustrated in Fig. 2, a fluid (air) passing through the heat exchanger 10 may flow form the plurality of first tubes 110 to the plurality of second tubes 120. Thus, the plurality of first tubes 110 and the fins 200 coupled to the plurality of first tubes 110 may constitute a front end-side of the heat exchanger 10, and the plurality of second tubes 120 and the fins 200 coupled to the plurality of second tubes 120 may constitute a rear end-side of the heat exchanger 10.

[0047] The fins 200 are coupled to the plurality of first tubes 110 and the plurality of second tubes 120. In detail, the fins 200 include a first fin 210 disposed in the space between the plurality of first tubes 110 and a second fin 220 disposed in the space between the plurality of second tubes 120.

[0048] The first fin 210 includes a ruled surface 211 straightly extending in one direction, for example, in a vertical direction between the plurality of first tubes 110 and a curved surface 213 that is curved or bent with a predetermined curvature from the ruled surface 211. Also, the curved surface 213 includes a first tube coupling part 215 coupled to one surface of the first tube 110.

[0049] Since the first fin 210 is bent or curved several times to extend, each of the ruled surface 211, the curved surface 213, and the first tube coupling part 215 may be provided in plurality.

[0050] A first tube coupling part 215 of the plurality of first tube coupling parts 215 may be coupled to one first tube 110 of the two first tubes adjacent to each other, and the rest first tube coupling part 215 may be coupled to the other first tube 110 of the two first tubes 110 adjacent to each other.

[0051] A fin distance Fp_1 is defined. The fin distance Fp_1 may be understood as a distance between two ruled surfaces 211 adjacent to each other. Also, a distance spaced between the two adjacent first tube coupling parts 215 may correspond to twice as much as the fin distance $2Fp_1$. Also, the shortest distance between the first tube coupling part 215 coupled to one first tube 110 and the first tube coupling part 215 coupled to the other first tube 110 that is disposed adjacent to the first tube coupling part 215 coupled to the one first tube 110 may be defined as the fin distance Fp_1.

[0052] Although only the structure of the first fin 210 is illustrated in FIG. 3, since the second fin 220 has the same structure as the first fin 210, descriptions with respect to the second fin 220 may be quoted from those of the first fin 210.

[0053] The fin distance Fp_1 of the first fin 210 may be greater than that Fp_2 of the second fin 220. That is, in the first and second tubes 110 and 120 having the same length, the number of first fin 210 coupled to the first tube 110 may be less than that of second fin 220 coupled to the second tube 120. Here, the "number" of fins may be understood as the number of ruled surfaces of the fins.

[0054] In the tubes having a predetermined length (for example, about 1 inch), the number of disposed fins may be called a fin per inch (FPI). For example, an FPI of the first tube side may be about 15 to about 17, and an FPI of the second tube side 120 may be about 20 to about 22.

[0055] That is, since the FPI values with respect to the first and second fins 210 and 220 vary, the first fin 210 coupled to the first tube 110 may have density less than that of the second fin 220 coupled to the second tube 120, and the curved surface 213 of the first fin 210 may have a curvature radius greater than that of the curved part of the second fin 220.

[0056] Referring to Fig. 4, since the plurality of first tubes 110 constitutes the front end-side of the heat exchanger 10, and the plurality of second tubes 120 constitutes the rear end-side of the heat exchanger 10, an air flow A may pass through the first tube 110 and then pass through the second tube 120. Thus, the first tube 110 may be called a front end-side tube of the plurality of tubes 110 and 120, and the second tube 120 may be called a rear end-side tube of the plurality of tubes 110 and 120.

[0057] Also, since the number of first fins 210 coupled to the first tube 110 is relatively less, the number of second fins 220 coupled to the second tube 120 is relatively large, a flow rate of the air passing between the plurality of first tubes 110 may be greater than that of the air passing between the plurality of second tubes 210.

[0058] That is, since the number of first fins 210 is relatively less, the heat transfer performance in the first tube 110 may be reduced somewhat. However, condensation in the first tube 110 or the first fin 210 may be prevented or delayed. Also, the heat transfer performance reduced at the first tube side may be compensated while the air flows into the rear end-side of the heat exchanger 10, i.e., the second tube side.

[0059] Fig. 5 is a graph illustrating an effect in which frost formation is delayed by a fin according to the first embodiment.

[0060] Referring to Fig. 5, the above-described effects may be verifiably described. As the FIP value decreases, a time taken to form frost on the tube or fin may increase. That is, the frost formation may be delayed. Here, the "frost formation" may represent an amount of frost formed above a predetermined level, for example, a blocked degree of a space between the tube and the fin over a preset degree by the frost.

[0061] In summary, the number FPI of fins 210 disposed on the front end-side of the heat exchanger, at which the frost is quickly formed, or a large amount of frost is formed, i.e., the first tube side may be reduced to delay the time taken to form the frost.

[0062] Fig. 6 is a partial view of a heat exchanger according to a second embodiment, and Fig. 7 is a view of a fin according to the second embodiment.

[0063] Referring to Figs. 6 and 7, a heat exchanger 10 according to a second embodiment includes first and second tubes 310 and 320 that are spaced apart from each other and fins 400 stacked between the first and second tubes 310 and 320. As described in the first embodiment, each of the fins 40 may be bent or curved several times and include a ruled surface, a curved surface, and a plurality of tube coupling parts coupled to the first and second tubes 310 and 320.

[0064] The fin 400 may include a louver 450 having a portion that protrudes from one surface or the other surface of the fin 400. Here, the one surface may be a top surface of the first or second fin 410 or 420 illustrated in Fig. 7, and the other surface may be a surface opposite to the one surface.

[0065] The louver 450 may be formed by cutting at least a portion of the fin 400. Also, the louver 450 may be bent in one or the other direction to increase a contact area between air and the fin 400. The louver 450 may be provided in plurality, and the plurality of louvers 450 may be disposed to be spaced apart from each other. The air may flow along the louver 450 while passing through one side of the fin 400. For example, the air may flow from one surface to the other surface of the fin 400 or from the other surface to one surface of the fin 400 along the louver 450.

[0066] In detail, the fins 400 include first and second fins 410 and 420 that are spaced apart from each other. The first and second fins 410 and 420 may be understood as portions corresponding to the "ruled surface" described in the first embodiment.

[0067] The first fin 410 includes a first fin body 411 defining a flat surface and a plurality of fin-side louvers 460 extending outward from one surface and the other surface of the first fin body 411. The plurality of first fin-side louvers 460 include a first louver 461, a second louver 462, and a third louver 463 which are aligned from an upstream side to a downstream side with respect to a flow direction A of the air.

[0068] Here, the upstream side" may represent a direction in which the air is blown in, and the "downstream side" may represent a direction in which the air is blown out. That is, the upstream side may correspond to the front end-side of the heat exchanger 10, and the downstream side may correspond to the rear end-side of the heat exchanger 10.

[0069] Also, the second fin 420 includes a second fin body 421 defining a flat surface and a plurality of fin-side louvers 470 extending outward from one surface and the other surface of the second fin body 421. The plurality of second fin-side louvers 470 include a fourth louver 471, a fifth louver 472, and a sixth louver 473 which are aligned from the upstream side to the downstream side with respect to the flow direction A of the air.

[0070] The plurality of first fin-side louvers 460 may have lengths that gradually increase from the upstream side to the downstream side with respect to the flow direction A of the air.

[0071] Values of constitutions of the fin 400 will be defined. In the plurality of first fin-side louvers 460 or the plurality of second fin-side louvers 470, a distance from one end to the other end of each of the louvers 461, 462, 463, 471, 472, and 473 in the extension direction of the fin or the flow direction A of the air is defined as a pitch P.

[0072] Also, the first fin-side louver 460 may inclinedly extend with respect to the first fin body 411, and the second fin0side louver 470 may inclinedly extend with respect to the second fin body 421. Here, the inclined angle θ is defined as a "louver angle".

[0073] Also, a distance between the first fin 410 and the second fin 410 adjacent to the first fin 410 is defined as a fin distance S. Here, the fin distance S may be understood as a distance between an end of the first fin-side louver 460 and an end of the second fin-side louver 470.

[0074] In the current embodiment, the pitch P of the fin 400 may gradually increase from the upstream side to the downstream side.

[0075] Thus, the pitch P2 of the second louver 462 may be greater than that P2 of the first louver 461, and the pitch P3 of the third louver 463 may be greater than that P2 of the second louver 462. Similarly, the pitch of the fifth louver 472 may be greater than that of the fourth louver 471, and the pitch of the sixth louver 473 may be greater than that of the fifth louver 472.

[0076] Also, since the pitch P of the fin 400 gradually increases from the upstream side to the downstream side, the fin distance S may gradually decrease from the upstream side to the downstream side. For example, as illustrated in Fig. 7, a distance S2 between an end of the third louver 463 and an end of the sixth louver 473 may be less than that S1 between the end of the first louver 461 and an end of the fourth louver 471.

[0077] Here, the distances S1 and S2 may be distances in a direction perpendicular to the first and second fins 410 and 420, respectively. Also, the distance S1 may be a front end-side distance of the first and second tubes 310 and 320 or the fin 400, and the distance S2 may be a rear end-side distance.

[0078] According to the above-described constitutions, since a fin distance at the upstream side in the air flow or the front end-side of the heat exchanger 10 is greater than that at the downstream side in the air flow or the rear end-side of the heat exchanger 10, the frost formation on the front end-side of the heat exchanger 10 may be prevented or delayed.

[0079] Fig. 8 is a view of a fin according to a third embodiment.

[0080] Referring to Fig. 8, a fin 500 according to a third embodiment includes a fin body 510 defining a flat surface and a plurality of louvers 520 extending outward from one surface or the other surface of the fin body 510.

[0081] The plurality of louvers 520 include a plurality of one side louvers 521, 522, and 523 disposed on one side of the fin body 510 and a plurality of the other side louvers 524, 525, and 526 disposed on the other side of the fin body 510. The plurality of one side louvers 521, 522, and 523 and the plurality of the other side louvers 524, 525, and 526 may be partitioned by an approximately central portion of the fin body 510.

[0082] The plurality of one side louvers 521, 522, and 523 include a first louver 521, a second louver 522, and a third louver 523 which are successively disposed to be spaced apart from each other from a front end-side to a rear end-side of the heat exchanger 10, i.e., from an upstream side to a downstream side with respect to a flow direction A of air.

[0083] The first louver 521, the second louver 522, and the third louver 523 may have louver angles θ different from each other. In detail, the louver angle θ of the first louver 521 may be angled at an angle θ1 with respect to the fin body 510, and the louver angle θ of the second louver 522 may be angled at an angle θ2 with respect to the fin body 510. Also, the louver angle θ of the third louver 523 may be angled at an angle θ3 with respect to the fin body 510. Where angles are defined as $\theta1 < \theta2 < \theta3$.

[0084] That is, the louver angles θ of the first to third louvers 521, 522, and 523 gradually increase from the upstream side to the downstream side with respect to the flow direction A of the air. According to the above-described constitutions, a flow distance of the air flowing into the fin 500 may be lengthened to improve flow efficiency and heat transfer performance.

[0085] The fin 500 further includes a plurality of the other side louvers 524, 525, and 526 that are disposed to be spaced apart from each other on one side of the third louver 523. The plurality of the other side louvers 524, 525, and 526 include a fourth louver 524, a fifth louver 525, and a sixth louver 526 which are successively disposed to be spaced apart from each other from the upstream side to the downstream side with respect to the flow direction A of the air.

[0086] An approximately central portion of the fin body 510 is disposed between the third louver 523 and the fourth louver 524. That is, the plurality of one side louvers 521, 522, and 523 and the plurality of the other side louvers 524, 525, and 526 are disposed to be spaced apart from each other on both sides of the fin body 510.

[0087] The louver angles θ of the fourth, fifth, and sixth louvers 524, 525, and 526 may be different from each other. In detail, the louver angle θ of the fourth louver 524 may be angled at an angle θ4 with respect to the fin body 510, and the louver angle 8 of the fifth louver 525 may be angled at an angle θ5 with respect to the fin body 510. Also, the louver angle θ of the sixth louver 526 may be angled at an angle θ6 with respect to the fin body 510 Where angles are defined as $\theta4 > \theta5 > \theta6$.

[0088] That is, the louver angles θ of the fourth to sixth louvers 524, 525, and 526 gradually decrease from the upstream side to the downstream side with respect to the flow direction A of the air. According to the above-described constitutions, a flow distance of the air flowing into the fin 500 may be lengthened to improve flow efficiency and heat transfer performance.

[0089] According to the embodiments, since the plurality of fins disposed on the front end-side of the heat exchanger have a relatively wide distance therebetween in the flow direction of the air, the formation of the frost on the front end-side of the heat exchanger may be delayed.

[0090] Particularly, when the refrigerant tubes are arranged in two rows, the fins disposed on the first row of the refrigerant tubes that contact the air firstly may have a relatively wide distance therebetween, and the fins disposed on the second row of the refrigerant tubes that contact the air later may have a relatively narrow distance therebetween. Thus, the formation of the frost may be delayed while securing the heat transfer performance over a predetermined level.

[0091] Also, a pitch of the louver disposed on the fin may increase from the front end-side toward the rear end-side of the heat exchanger to cause the relative large louver distance between the adjacent fins at the front end-side of the heat exchanger. Thus, the frost formation on the front end-side of the heat exchanger may be delayed.

[0092] As described above, since the frost formation is delayed, the air flow may be improved to increase an amount of wind passing through the heat exchanger and reduce the pressure loss that affects the heat exchanger.

[0093] Also, since angles between the plurality of louvers disposed on the fins are different according to the flow direction of the air, the flow distance of the air may be lengthened, and thus the heat transfer performance may be improved when compared to the case in which the angles between the louvers are uniform.

[0094] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, the scope of protection of the invention is defined by the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

Claims

1. A heat exchanger (10) comprising:

a plurality of refrigerant tubes (100) through which a refrigerant flows, the plurality of refrigerant tubes (100) being disposed to be spaced apart from each other in one direction; and
a plurality of fins (200) disposed between the plurality of refrigerant tubes (100),
wherein a distance between the fins (200) disposed on a front end-side of the plurality of refrigerant tubes (100) is greater than that between the fins (200) disposed on a rear end-side of the plurality of refrigerant tubes (100),
wherein each of the fins (200) comprises a fin body (510) and a plurality of louvers (520) extending outward from one surface and the other surface of the fin body (510), and **characterised in that**
the plurality of louvers (520) comprise a plurality of one side louvers (521, 522, 523) having a louver angle angled with respect to the fin body (510), which gradually increases from the upstream side to the downstream side with respect to the flow direction of the air.

2. The heat exchanger (10) according to claim 1, wherein the front end-side of the plurality of refrigerant tubes (100) defines an upstream side with respect to a flow direction of air, and
the rear end-side of the plurality of refrigerant tubes (100) defines a downstream side with respect to the flow direction of the air.

3. The heat exchanger (10) according to claim 1 or 2, wherein the plurality of refrigerant tubes (100) comprise:

a plurality of first tubes (110) defining a first row; and
a plurality of second tubes (120) disposed on one side of the plurality of first tubes (110) to define a second row,
wherein the flow direction of the air is directed from the plurality of first tubes (110) to the plurality of second tubes (120).

4. The heat exchanger (10) according to claim 3, wherein the plurality of fins (200) comprise:

a plurality of first fins (210) coupled to the plurality of first tubes (110); and
a plurality of second fins (220) coupled to the plurality of second tubes (120),
wherein a distance between the plurality of first fins (210) is greater than that between the plurality of second fins (220).

5. The heat exchanger (10) according to any of claims 1 to 4, wherein each of the fins (200, 210, 220) comprises:

a ruled surface (211) extending in one direction between the plurality of refrigerant tubes (100); and
a curved surface (213) bent or curved from the ruled surface (211), the curved surface (213) comprising a tube coupling part (215) coupled to each of the refrigerant tubes (100).

6. The heat exchanger (10) according to claim 5, wherein the plurality of refrigerant tubes (100) comprise a first tube (110) defining the front end-side

thereof and a second tube (120) defining the rear end-side thereof, and
the number, FPI, of ruled surfaces (211) of the fins (210) coupled to first tube (110) is less than that of ruled surfaces (211) of the fins (220) coupled to the second tube (120) with respect to predetermined lengths of the first and second tubes (110, 120).

7. The heat exchanger (10) according to claim 6, wherein the number, FPI, of the ruled surfaces (211) of the fins (210) coupled to the first tube (110) is about 15 to about 17, and
the number, FPI, of ruled surfaces (211) of the fins (220) coupled to the second tube (120) is about 20 to about 22.

8. The heat exchanger (10) according to any of claims 5 to 7, wherein each of the ruled surface (211) and the curved surface (213) is provided in plurality, and a distance, $2Fp_1$, between the tube coupling parts (215) disposed on two curved surfaces (213) adjacent to each other is twice as much as a distance, Fp_1, between two ruled surfaces (211) adjacent to each other.

9. The heat exchanger (10) according to any of claims 1 to 8, wherein the plurality of fins (200) comprise:

a first fin (210) comprising a first fin-side louver (460); and
a second fin (220) disposed on one side of the first fin (210), the second fin (220) comprising a second fin-side louver (470).

10. The heat exchanger (10) according to claim 9, wherein the first fin-side louver (460) comprises first and second louvers (461, 462) that are aligned from the upstream side to the downstream side, and
a pitch, P2 of the second louver (462) is greater than that, P1, of the first louver (461).

11. The heat exchanger (10) according to claim 10, wherein, in a distance, S, between the first fin-side louver (460) and the second fin-side louver (470), a distance, S1, at the upstream side is greater than that, S2, at the downstream side with respect to the flow direction of the air.

12. The heat exchanger (10) according to claim 11, wherein the distance, S, between the first fin-side louver (460) and the second fin-side louver (470) gradually decreases from the upstream side to the downstream side with respect to the flow direction of the air.

13. The heat exchanger (10) according to any of claims 1 to 12, wherein the plurality of louvers (520) comprise a plurality of the other side louvers (524, 525, 526) having a louver angle angled with respect to the fin body (510), which gradually decreases from the upstream side to the downstream side with respect to the flow direction of the air.

14. The heat exchanger (10) according to claim 13, wherein the plurality of one side louvers (521, 522, 523) and the plurality of the other side louvers (524, 525, 526) are disposed to be spaced apart from each other on both sides of the fin body (510).

Patentansprüche

1. Wärmetauscher (10) mit:

einer Vielzahl von Kältemittelröhren (100), durch die ein Kältemittel fließt, wobei die Vielzahl der Kältemittelröhren (100) so angeordnet sind, dass sie in eine Richtung voneinander beabstandet sind; und
einer Vielzahl von Rippen (200), die zwischen der Vielzahl der Kältemittelröhren (100) angeordnet sind,
wobei ein Abstand zwischen den Rippen (200), die auf einer vorderen Endseite der Vielzahl der Kältemittelröhren (100) angeordnet sind, größer als der zwischen den Rippen (200) ist, die auf einer hinteren Endseite der Vielzahl der Kältemittelröhren (100) angeordnet sind,
wobei jede der Rippen (200) einen Rippenkörper (510) und eine Vielzahl von Lamellen (520) aufweist, die sich von einer Oberfläche und der anderen Oberfläche des Rippenkörpers (510) nach außen erstrecken, und **dadurch gekennzeichnet, dass**
die Vielzahl der Lamellen (520) eine Vielzahl von Lamellen (521, 522, 523) auf einer Seite aufweist, die einen Lamellenwinkel aufweisen, der bezüglich des Rippenkörpers (510) angewinkelt ist, der bezüglich der Strömungsrichtung der Luft allmählich von der Stromaufwärtsseite zur Stromabwärtsseite zunimmt.

2. Wärmetauscher (10) nach Anspruch 1, wobei die vordere Endseite der Vielzahl der Kältemittelröhren (100) bezüglich einer Strömungsrichtung der Luft eine Stromaufwärtsseite definiert, und
die hintere Endseite der Vielzahl der Kältemittelröhren (100) bezüglich der Strömungsrichtung der Luft eine Stromabwärtsseite definiert.

3. Wärmetauscher (10) nach Anspruch 1 oder 2, wobei die Vielzahl der Kältemittelröhren (100) aufweist:

eine Vielzahl von ersten Röhren (110), die eine erste Reihe definieren; und
eine Vielzahl von zweiten Röhren (120), die auf

einer Seite der Vielzahl der ersten Röhren (110) angeordnet sind, um eine zweite Reihe zu definieren,
wobei die Strömungsrichtung der Luft von der Vielzahl der ersten Röhren (110) zur Vielzahl der zweiten Röhren (120) gerichtet ist.

4. Wärmetauscher (10) nach Anspruch 3, wobei die Vielzahl der Rippen (200) aufweist:

eine Vielzahl von ersten Rippen (210), die mit der Vielzahl der ersten Röhren (110) gekoppelt ist; und
eine Vielzahl von zweiten Rippen (220), die mit der Vielzahl der zweiten Röhren (120) gekoppelt ist,
wobei ein Abstand zwischen der Vielzahl der ersten Rippen (210) größer als der zwischen der Vielzahl der zweiten Rippen (220) ist.

5. Wärmetauscher (10) nach einem der Ansprüche 1 bis 4, wobei jede der Rippen (200, 210, 220) aufweist:

eine Regelfläche (211), die sich in eine Richtung zwischen der Vielzahl der Kältemittelröhren (100) erstreckt; und
eine gekrümmte Fläche (213), die von der Regelfläche (211) gebogen oder gekrümmt ist, wobei die gekrümmte Fläche (213) einen Röhrenkopplungsteil (215) aufweist, der mit jeder der Kältemittelröhren (100) gekoppelt ist.

6. Wärmetauscher (10) nach Anspruch 5, wobei die Vielzahl der Kältemittelröhren (100) eine erste Röhre (110), die deren vordere Endseite definiert, und eine zweite Röhre (120) aufweist, die deren hintere Endseite definiert, und
die Anzahl, FPI, der Regelflächen (211) der Rippen (210), die mit der ersten Röhre (110) gekoppelt sind, bezüglich vorgegebener Längen der ersten und zweiten Röhre (110, 120) kleiner als jene der Regelflächen (211) der Rippen (220) ist, die mit der zweiten Röhre (120) gekoppelt sind.

7. Wärmetauscher (10) nach Anspruch 6, wobei die Anzahl, FPI, der Regelflächen (211) der Rippen (210), die mit der ersten Röhre (110) gekoppelt sind, etwa 15 bis etwa 17 beträgt, und
die Anzahl, FPI, der Regelflächen (211) der Rippen (220), die mit der zweiten Röhre (120) gekoppelt sind, etwa 20 bis etwa 22 beträgt.

8. Wärmetauscher (10) nach einem der Ansprüche 5 bis 7, wobei jede Regelfläche (211) und jede gekrümmte Fläche (213) mehrfach vorgesehen ist, und ein Abstand, $2Fp_1$, zwischen den Röhrenkopplungsteilen (215), die auf zwei zueinander benachbarten gekrümmten Flächen (213) angeordnet sind, doppelt so groß wie ein Abstand, Fp_1, zwischen zwei zueinander benachbarten Regelflächen (211) ist.

9. Wärmetauscher (10) nach einem der Ansprüche 1 bis 8, wobei die Vielzahl der Rippen (200) aufweist:

eine erste Rippe (210), die eine Lamelle (460) auf der Seite der ersten Rippe aufweist; und
eine zweite Rippe (220), die auf einer Seite der ersten Rippe (210) angeordnet ist, wobei die zweite Rippe (220) eine Lamelle (470) auf der Seite der zweiten Rippe aufweist.

10. Wärmetauscher (10) nach Anspruch 9, wobei die Lamelle auf der Seite der ersten Rippe (460) erste und zweite Lamellen (461, 462) aufweist, die von der Stromaufwärtsseite zur Stromabwärtsseite ausgerichtet sind, und
ein Zwischenraum, P2, der zweiten Lamelle (462) größer als der, P1, der ersten Lamelle (461) ist.

11. Wärmetauscher (10) nach Anspruch 10, wobei bei einem Abstand, S, zwischen der Lamelle (460) auf der Seite der ersten Rippe und der Lamelle (470) auf der Seite der zweiten Rippe ein Abstand, S1, auf der Stromaufwärtsseite bezüglich der Strömungsrichtung der Luft größer als der, S2, auf der Stromabwärtsseite ist.

12. Wärmetauscher (10) nach Anspruch 11, wobei der Abstand, S, zwischen der Lamelle (460) auf der Seite der ersten Rippe und der Lamelle (470) auf der Seite der zweiten Rippe bezüglich der Strömungsrichtung der Luft allmählich von der Stromaufwärtsseite zur Stromabwärtsseite abnimmt.

13. Wärmetauscher (10) nach einem der Ansprüche 1 bis 12, wobei die Vielzahl der Lamellen (520) eine Vielzahl von Lamellen (524, 525, 526) auf der anderen Seite aufweist, die einen Lamellenwinkel aufweisen, der bezüglich des Rippenkörpers (510) angewinkelt ist, der bezüglich der Strömungsrichtung der Luft allmählich von der Stromaufwärtsseite zur Stromabwärtsseite abnimmt.

14. Wärmetauscher (10) nach Anspruch 13, wobei die Vielzahl der Lamellen (521, 522, 523) auf einer Seite und die Vielzahl der Lamellen (524, 525, 526) auf der anderen Seite so angeordnet sind, dass sie auf beiden Seiten des Rippenkörpers (510) voneinander beabstandet sind.

Revendications

1. Échangeur de chaleur (10), comprenant :

une pluralité de tubes de réfrigérant (100) dans lesquels circule un réfrigérant, les tubes de ladite pluralité de tubes de réfrigérant (100) étant disposés de manière à être espacés l'un de l'autre dans une direction ; et
une pluralité d'ailettes (200) disposées entre les tubes de la pluralité de tubes de réfrigérant (100),
où la distance entre les ailettes (200) disposées sur un côté d'extrémité avant de la pluralité de tubes de réfrigérant (100) est supérieure à celle entre les ailettes (200) disposées sur un côté d'extrémité arrière de la pluralité de tubes de réfrigérant (100),
où chacune des ailettes (200) comprend un corps (510) d'ailette et une pluralité de lames (520) s'étendant vers l'extérieur depuis une première surface et depuis l'autre surface du corps (510) d'ailette, **caractérisé en ce que**
la pluralité de lames (520) comprend une pluralité de lames de premier côté (521, 522, 523) présentant un angle de lame par rapport au corps (510) d'ailette augmentant progressivement du côté amont vers le côté aval par rapport à la direction du flux d'air.

2. Échangeur de chaleur (10) selon la revendication 1, où le côté d'extrémité avant de la pluralité de tubes de réfrigérant (100) définit un côté amont par rapport à la direction du flux d'air, et
le côté d'extrémité arrière de la pluralité de tubes de réfrigérant (100) définit un côté aval par rapport à la direction du flux d'air.

3. Échangeur de chaleur (10) selon la revendication 1 ou la revendication 2, où la pluralité de tubes de réfrigérant (100) comprend :

une pluralité de premiers tubes (110) définissant une première rangée ; et
une pluralité de deuxièmes tubes (120) disposés sur un côté de la pluralité de premiers tubes (110) pour définir une deuxième rangée,
où la direction du flux d'air va de la pluralité de premiers tubes (110) à la pluralité de deuxièmes tubes (120).

4. Échangeur de chaleur (10) selon la revendication 3, où la pluralité d'ailettes (200) comprend :

une pluralité de premières ailettes (210) raccordées à la pluralité de premiers tubes (110) ; et
une pluralité de deuxièmes ailettes (220) raccordées à la pluralité de deuxièmes tubes (120),
la distance entre les ailettes de la pluralité de premières ailettes (210) étant supérieure à celle entre les ailettes de la pluralité de deuxièmes ailettes (220).

5. Échangeur de chaleur (10) selon l'une des revendications 1 à 4, où chacune des ailettes (200, 210, 220) comprend :

une surface droite (211) s'étendant dans une direction entre la pluralité de tubes de réfrigérant (100) ; et
une surface courbe (213) pliée ou incurvée depuis la surface droite (211), ladite surface courbe (213) comprenant une section de raccordement de tube (215) raccordée à chacun des tubes de réfrigérant (100).

6. Échangeur de chaleur (10) selon la revendication 5, où la pluralité de tubes de réfrigérant (100) comprend un premier tube (110) définissant le côté d'extrémité avant de ceux-ci et un deuxième tube (120) définissant le côté d'extrémité arrière de ceux-ci, et où
le nombre, FPI, des surfaces droites (211) des ailettes (210) raccordées au premier tube (110) est inférieur à celui des surfaces droites (211) des ailettes (220) raccordées au deuxième tube (120) par rapport à des longueurs prédéfinies du premier et du deuxième tube (110, 120).

7. Échangeur de chaleur (10) selon la revendication 6, où le nombre, FPI, des surfaces droites (211) des ailettes (210) raccordées au premier tube (110) est compris entre environ 15 et environ 17, et
le nombre, FPI, des surfaces droites (211) des ailettes (220) raccordées au deuxième tube (120) est compris entre environ 20 et environ 22.

8. Échangeur de chaleur (10) selon l'une des revendications 5 à 7, où les surfaces droites (211) ainsi que les surfaces courbes (213) sont prévues en pluralité, et où la distance, $2Fp_1$, entre les sections de raccordement de tubes (215) de deux surfaces courbes (213) adjacentes l'une à l'autre est deux fois supérieure à la distance, Fp_1, entre deux surfaces droites (211) adjacentes l'une à l'autre.

9. Échangeur de chaleur (10) selon l'une des revendications 1 à 8, où la pluralité d'ailettes (200) comprend :

une première ailette (210) comprenant une lame de premier côté d'ailette (460) ; et
une deuxième ailette (220) disposée sur un côté de la première ailette (210), ladite deuxième ailette (220) comprenant une lame de deuxième côté d'ailette (470).

10. Échangeur de chaleur (10) selon la revendication 9, où la lame de premier côté d'ailette (460) comprend une première et une deuxième lame (461, 462) alignées du côté amont vers le côté aval, et où
le pas, P2 de la deuxième lame (462) est supérieur

au pas, P1, de la première lame (461).

11. Échangeur de chaleur (10) selon la revendication 10, où, dans la distance, S, entre la lame de premier côté d'ailette (460) et la lame de deuxième côté d'ailette (470), la distance, S1, sur le côté amont est supérieure à la distance, S2, sur le côté aval par rapport à la direction du flux d'air.

12. Échangeur de chaleur (10) selon la revendication 11, où la distance, S, entre la lame de premier côté d'ailette (460) et la lame de deuxième côté d'ailette (470) diminue progressivement du côté amont au côté aval par rapport à la direction du flux d'air.

13. Échangeur de chaleur (10) selon l'une des revendications 1 à 12, où la pluralité de lames (520) comprend une pluralité de lames de second côté (524, 525, 526) présentant un angle de lame par rapport au corps (510) d'ailette diminuant progressivement du côté amont vers le côté aval par rapport à la direction du flux d'air.

14. Échangeur de chaleur (10) selon la revendication 13, où
la pluralité de lames de premier côté (521, 522, 523) et la pluralité de lames de second côté (524, 525, 526) sont disposées de manière à être espacées entre elles sur les deux côtés du corps (510) d'ailette.

Fig. 1

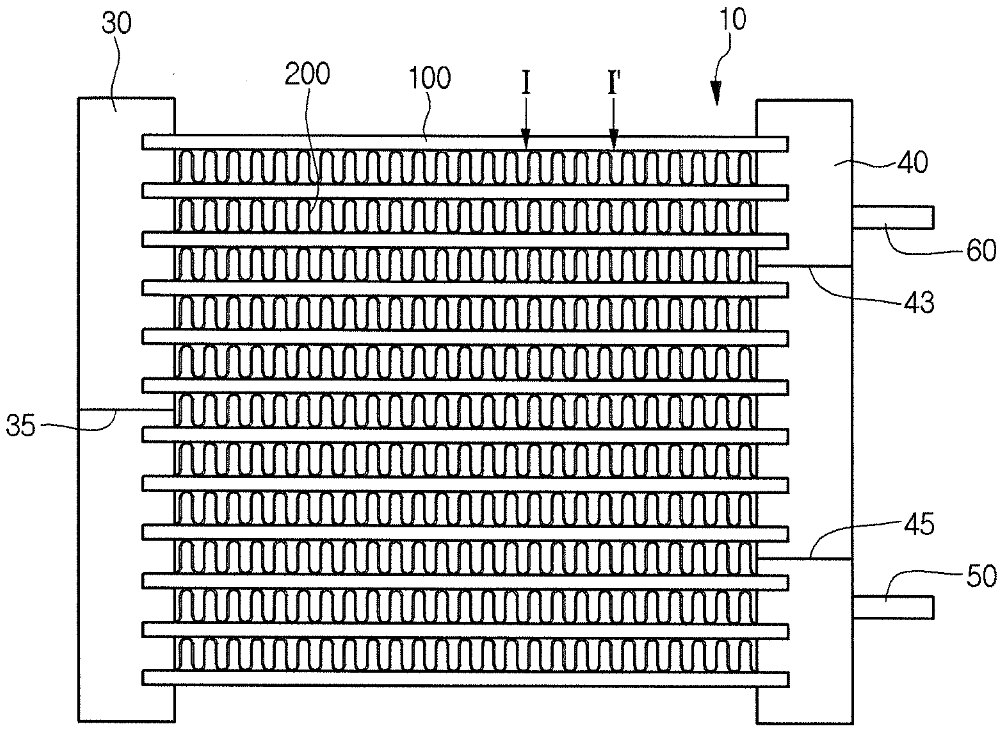


Fig. 2

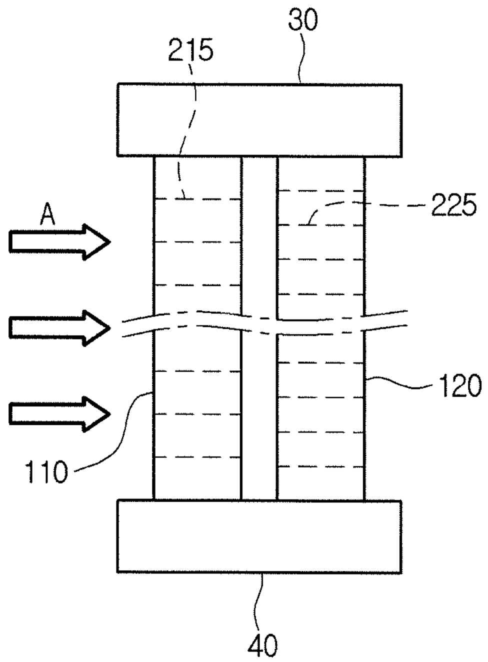


Fig. 3

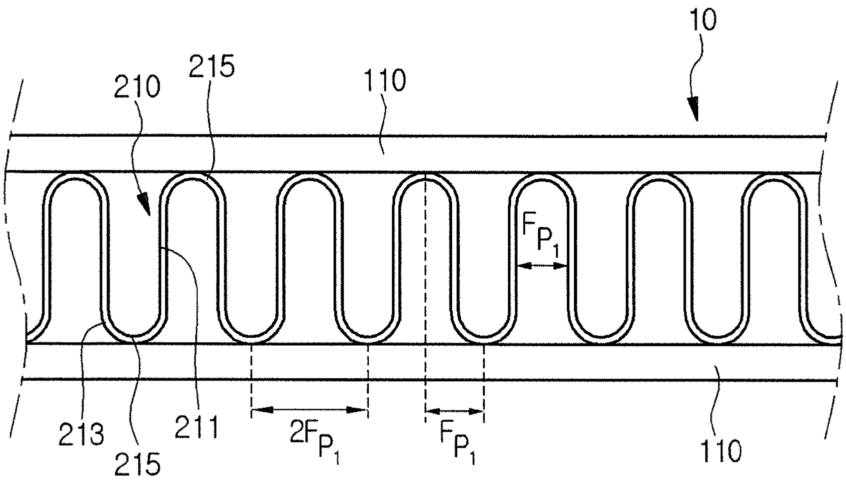


Fig. 4

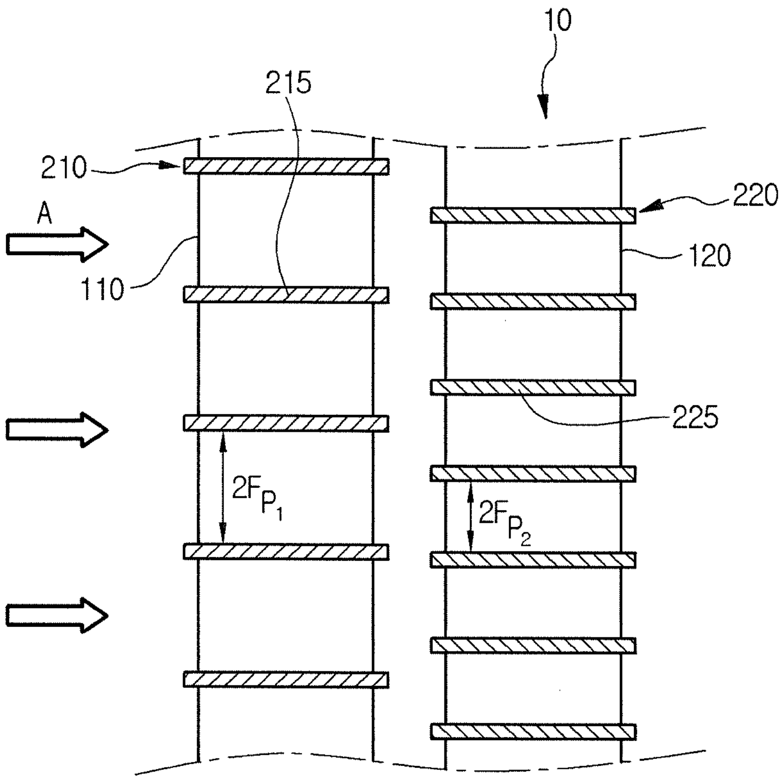
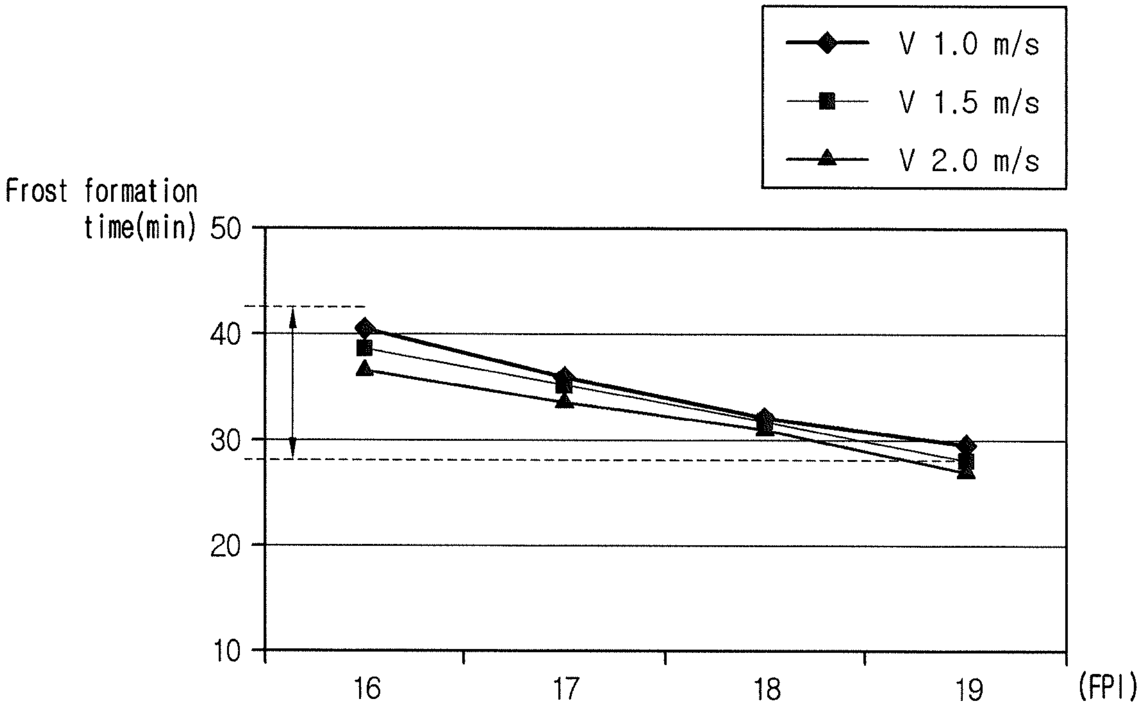


Fig. 5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V 1.5 m/s
V 2.0 m/s
Frost formation time(min)
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40
30
20
10
16
17
18
19
(FPI)

Fig. 6

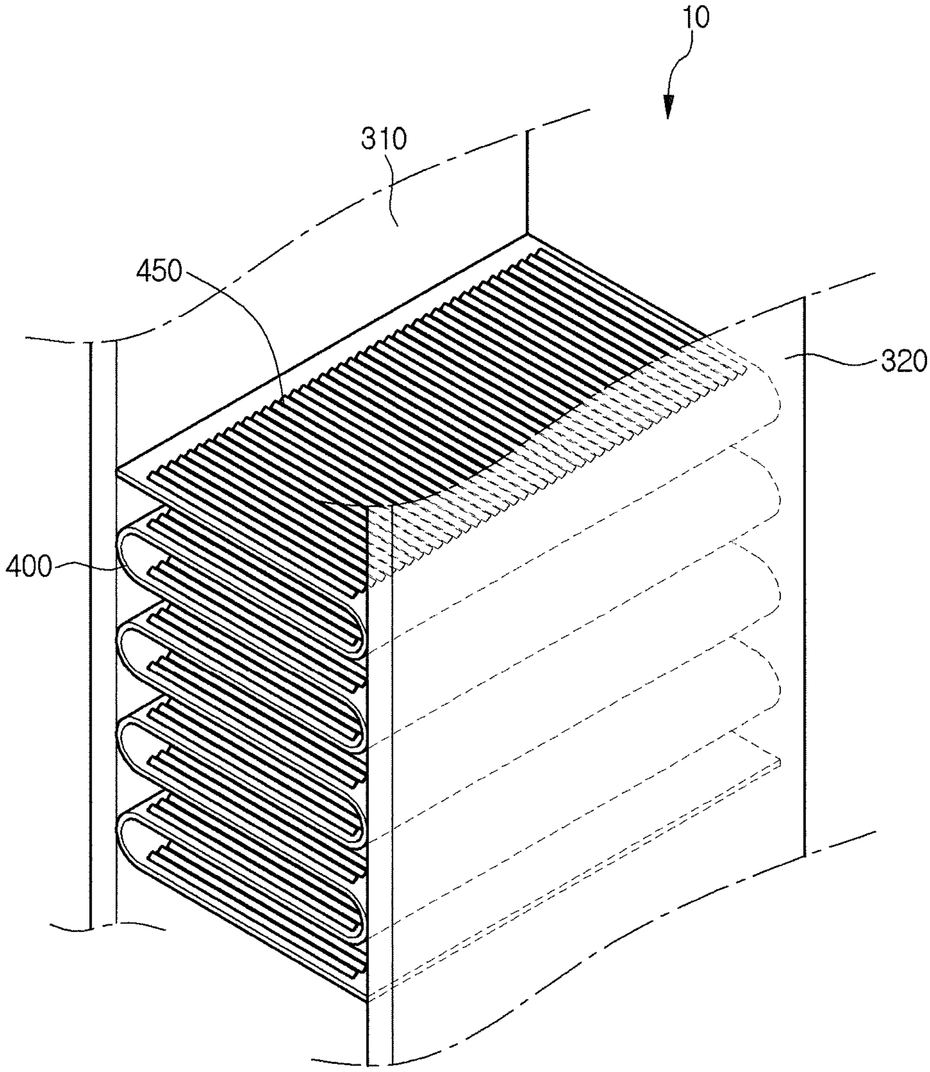


Fig. 7

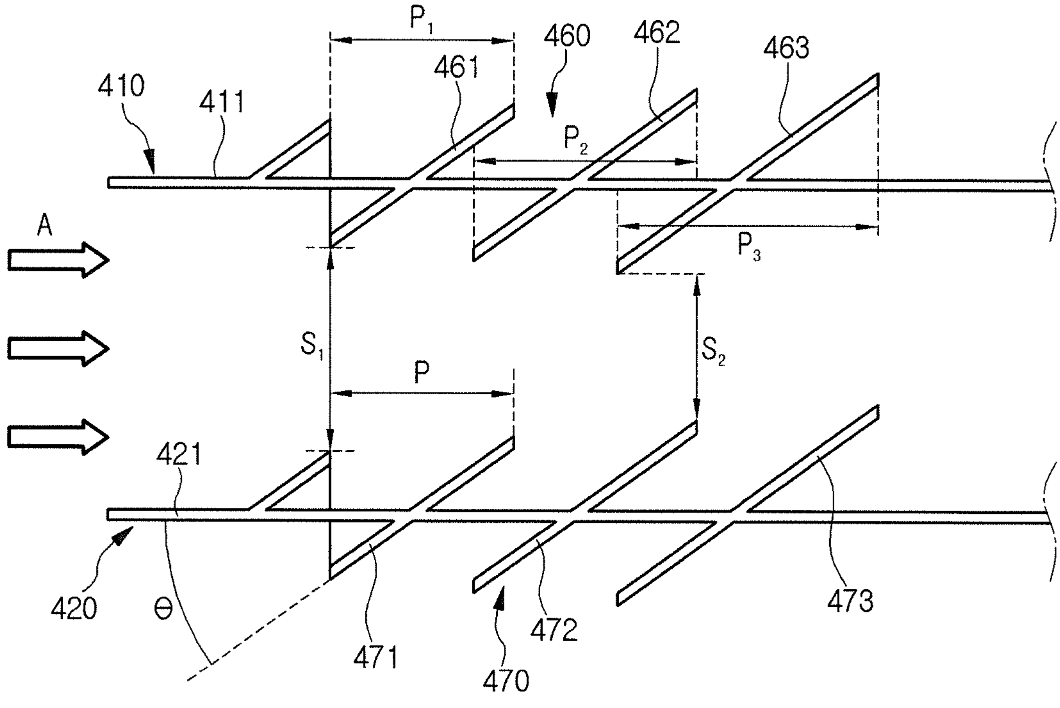
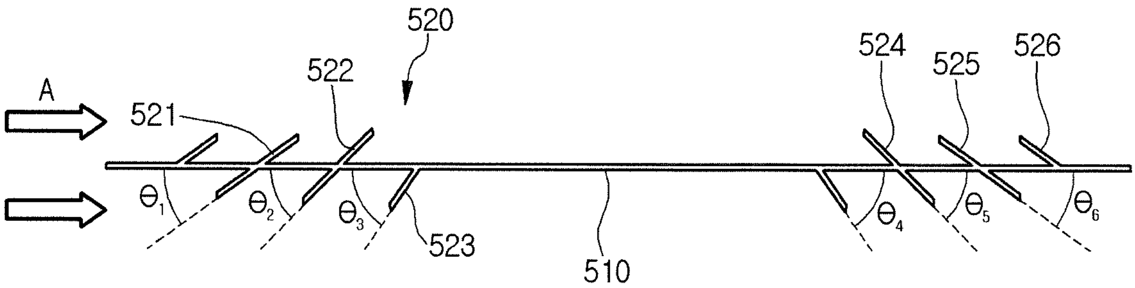


Fig. 8



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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