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(54) HEAT EXCHANGER AND AIR CONDITIONING SYSTEM

(57) Embodiments of the present invention relate to a heat exchanger and an air conditioning system having the same. The heat exchanger includes a plurality of fins and a row of heat transfer tubes. The fin includes a fin body and a plurality of columns of heat exchange tube slots formed in the fin body. The column of heat exchange tube slots includes a plurality of heat exchange tube slots arranged in a first direction, the plurality of fins being arranged in a second direction perpendicular to the first direction, and the plurality of columns of heat exchange tube slots being arranged in a third direction perpendicular to the first direction and the second direction. The row of heat exchange tubes is provided in the heat exchange tube slot of the column of heat exchange tube slots, and the row of heat exchange tubes includes one heat exchange tube or a plurality of heat exchange tubes. A length of at least one heat exchange tube slot in the third direction is greater than a heat exchange tube size of the row of heat exchange tubes inserted in the at least one heat exchange tube slot in the third direction. Therefore, the performance of the heat exchanger and the air conditioning system can be improved.

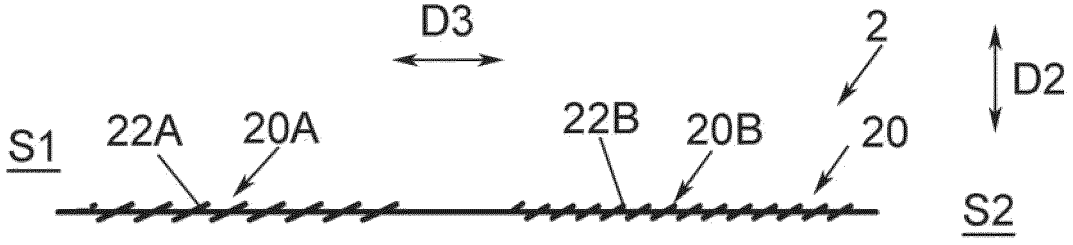

Fig. 15

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Description

TECHNICAL FIELD

[0001] Embodiments of the present invention relate to a heat exchanger and an air conditioning system having the same.

BACKGROUND

[0002] A heat exchanger includes heat exchange tubes and fins having heat exchange tube slots. The heat exchange tube slots have openings on a side of the heat exchanger, or the heat exchange tube slots have no opening. The heat exchange tubes are inserted into the heat exchange tube slots of the fins.

SUMMARY

[0003] An object of embodiments of the present invention is to provide a heat exchanger and an air conditioning system having the same, thereby, for example, improving the performance of the heat exchanger and the air conditioning system.

[0004] Embodiments of the present invention provide a heat exchanger including: a plurality of fins, each of the plurality of fins including a fin body and a plurality of columns of heat exchange tube slots formed in the fin body, each of the plurality of columns of heat exchange tube slots including a plurality of heat exchange tube slots arranged in a first direction, the plurality of fins being arranged in a second direction perpendicular to the first direction, and the plurality of columns of heat exchange tube slots of each of the plurality of fins being arranged in a third direction perpendicular to the first direction and the second direction; wherein at least two heat exchange tube slots of the plurality of heat exchange tube slots of the plurality of columns of heat exchange tube slots of at least one fin of the plurality of fins have different sizes in the third direction.

[0005] According to embodiments of the present invention, at least two heat exchange tube slots of the plurality of heat exchange tube slots of at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of at least one fin of the plurality of fins have different sizes in the third direction.

[0006] According to embodiments of the present invention, at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least one column of heat exchange tube slots, positioned on a first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of at least one fin of the plurality of fins and at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least another column of heat exchange tube slots, positioned on a second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the at least one fin of the plurality of fins have different sizes in the third direction.

[0007] According to embodiments of the present invention, a length of at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least one column of heat exchange tube slots, positioned on a first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of at least one fin of the plurality of fins in the third direction is less than that of at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least another column of heat exchange tube slots, positioned on a second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the at least one fin of the plurality of fins in the third direction.

[0008] According to embodiments of the present invention, the heat exchanger further includes a row of heat exchange tubes provided in each heat exchange tube slot of the plurality of heat exchange tube slots of each column of heat exchange tube slots of the plurality of columns of heat exchange tube slots, the row of heat exchange tubes including one heat exchange tube or a plurality of heat exchange tubes, wherein a length of at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of at least one fin of the plurality of fins in the third direction is greater than a heat exchange tube size of the row of heat exchange tubes inserted in the at least one heat exchange tube slot in the third direction, in the case that the row of heat exchange tubes includes the one heat exchange tube, the heat exchange tube size is a size of the one heat exchange tube in the third direction, and in the case that the row of heat exchange tubes includes the plurality of heat exchange tubes, the heat exchange tube size is a sum of sizes of the plurality of heat exchange tubes in the third direction.

[0009] According to embodiments of the present invention, the fin body of the fin is inclined relative to a plane defined by the first direction and the second direction.

[0010] According to embodiments of the present invention, an angle between the fin body of the fin and the plane defined by the first direction and the third direction is less than or equal to 45 degrees.

[0011] According to embodiments of the present invention, the plurality of heat exchange tube slots of at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of at least one fin of the plurality of fins include a plurality of first heat exchange tube slots and a plurality of second heat exchange tube slots, a length SL1 of the first heat exchange tube slot and a length SL2 of the second heat exchange tube slot satisfy the following relationship of: $SL2 \geq n*SL1$, where, n is a positive integer.

[0012] According to embodiments of the present in-

vention, n is greater than or equal to 2.

[0013] According to embodiments of the present invention, the plurality of first heat exchange tube slots includes a plurality of sets of first heat exchange tube slots, each set of first heat exchange tube slots including at least one first heat exchange tube slot; the plurality of second heat exchange tube slots includes a plurality of sets of second heat exchange tube slots, each set of second heat exchange tube slots including at least one second heat exchange tube slot; and the plurality of sets of first heat exchange tube slots and the plurality of sets of second heat exchange tube slots are alternately arranged in the first direction.

[0014] According to embodiments of the present invention, a plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots of the at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of the at least one fin of the plurality of fins have the same number and/or the same size of the heat exchange tubes.

[0015] According to embodiments of the present invention, spacing between the plurality of heat exchange tube slots of at least one column of heat exchange tube slots, positioned on a first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins is different from spacing between the plurality of heat exchange tube slots of at least another column of heat exchange tube slots, positioned on a second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins.

[0016] According to embodiments of the present invention, spacing between the plurality of heat exchange tube slots of at least one column of heat exchange tube slots, positioned on a first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins is greater than spacing between the plurality of heat exchange tube slots of at least another column of heat exchange tube slots, positioned on a second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins.

[0017] According to embodiments of the present invention, spacing between the plurality of heat exchange tube slots of at least one column of heat exchange tube slots, positioned on a first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins is substantially equal to spacing between the plurality of heat exchange tube slots of at least another column of heat exchange tube slots, positioned on a second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins.

[0018] According to embodiments of the present invention, the heat exchange tube size of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes in the plurality of heat exchange tube slots of the at least one column of heat exchange tube slots, positioned on the first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins is different from that of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes in the plurality of heat exchange tube slots of the at least another column of heat exchange tube slots, positioned on the second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins.

[0019] According to embodiments of the present invention, the heat exchange tube size of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes in the plurality of heat exchange tube slots of the at least one column of heat exchange tube slots, positioned on the first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins is less than that of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes in the plurality of heat exchange tube slots of the at least another column of heat exchange tube slots, positioned on the second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins.

[0020] According to embodiments of the present invention, a heat transfer efficiency between the one heat exchange tube of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots of at least one column of heat exchange tube slots, positioned on a first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins and at least one fin of the plurality of fins, or a heat transfer efficiency between at least one heat exchange tube of the plurality of heat exchange tubes of the at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots of the at least one column of heat exchange tube slots, positioned on the first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins and the at least one fin of the plurality of fins, is less than a heat transfer efficiency between the one heat exchange tube of at least one row of heat exchange tubes of a plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots of at least another column of heat exchange tube slots, positioned on a second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins and at least one fin of the plurality of fins, or a heat transfer efficiency between at least one heat exchange tube of the plurality of heat exchange tubes of the at least one row of heat exchange tubes of the plurality of rows of

heat exchange tubes provided in the plurality of heat exchange tube slots of the at least another column of heat exchange tube slots, positioned on the second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins and the at least one fin of the plurality of fins.

[0021] According to embodiments of the present invention, the fin body of the plurality of fins includes a first fin body portion positioned on the a first side of the heat exchanger in the third direction and a second fin body portion positioned on a second side of the heat exchanger opposite to the first side in the third direction, and the fin includes a first louver provided on the first fin body portion, and a second louver provided on the second fin body portion, wherein the heat exchange efficiency of the first louver is lower than that of the second louver.

[0022] According to embodiments of the present invention, the number of the first louver is less than that of the second louver; and/or an inclination angle of the first louver relative to the first fin body portion is less than that of the second louver relative to the second fin body portion.

[0023] According to embodiments of the present invention, the fin body of the plurality of fins includes a first fin body portion positioned on a first side of the heat exchanger in the third direction and a second fin body portion positioned on a second side of the heat exchanger opposite to the first side in the third direction, and the fin includes a second louver provided on the second fin body portion, and there is no louver provided on the first fin body portion.

[0024] According to embodiments of the present invention, a size of the heat exchange tube in the third direction is greater than or equal to 6 mm and less than or equal to 20 mm.

[0025] According to embodiments of the present invention, structure parameters of the one heat exchange tube, or structure parameters of at least one heat exchange tube of the plurality of heat exchange tubes, of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots of at least one column of heat exchange tube slots, positioned on a first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins are different from structure parameters of the one heat exchange tube, or structure parameters of at least one heat exchange tube of the plurality of heat exchange tubes, of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots of at least another column of heat exchange tube slots, positioned on a second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins.

[0026] According to embodiments of the present invention, the structural parameters include at least one of: a size of the heat exchange tube in the first direction, the number of holes of the heat exchange tube, an aperture of the hole of the heat exchange tube, and a thickness of a wall between adjacent holes of the heat exchange tube.

[0027] According to embodiments of the present invention, the plurality of heat exchange tube slots of at least one column of heat exchange tube slots, positioned on a first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of at least one fin of the plurality of fins and the plurality of heat exchange tube slots of at least another column of heat exchange tube slots, positioned on a second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the at least one fin of the plurality of fins are alternately arranged in the first direction.

[0028] According to embodiments of the present invention, at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least one column of heat exchange tube slots, positioned on a first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins and at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least another column of heat exchange tube slots, positioned on a second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins are displaced from each other in the first direction and, when viewed in the first direction, partially overlap.

[0029] According to embodiments of the present invention, the heat exchange tube slot of the column of heat exchange tube slots of the fin has a first slot edge and a second slot edge, the first slot edge and the second slot edge being respectively positioned on outermost sides of the heat exchange tube slot in the third direction, and the first slot edge of the heat exchange tube slot of the fin being closer to the first side of the heat exchanger in the third direction than the second slot edge of the heat exchange tube slot of the fin; and the first slot edges of the plurality of heat exchange tube slots of at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of the plurality of fins are substantially aligned with each other in the third direction, and/or the second slot edges of the plurality of heat exchange tube slots of the at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of the plurality of fins are substantially aligned with each other in the third direction.

[0030] According to embodiments of the present invention, the plurality of heat exchange tube slots of at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of the plurality of fins have substantially the same size in the third direction.

[0031] According to embodiments of the present invention, the fin body of the fin has a substantially flat shape.

[0032] According to embodiments of the present invention, the plurality of columns of heat exchange tube slots of the plurality of fins include a first column of heat exchange tube slots and a second column of heat exchange tube slots positioned on a first side and a second side of the heat exchanger opposite to each other in the third direction, respectively.

[0033] According to embodiments of the present invention, the plurality of heat exchange tube slots of the first column of heat exchange tube slots of the plurality of fins has an opening towards the first side of the heat exchanger, and the plurality of heat exchange tube slots of the second column of heat exchange tube slots of the plurality of fins has an opening towards the second side of the heat exchanger.

[0034] According to embodiments of the present invention, the heat exchange tube slot of the column of heat exchange tube slots of the fin has a first slot edge and a second slot edge, the first slot edge and the second slot edge being positioned on outermost sides of the heat exchange tube slot in the third direction, respectively, and the first slot edge of the heat exchange tube slot of the fin being closer to the first side of the heat exchanger in the third direction than the second slot edge of the heat exchange tube slot of the fin; and the second slot edges of at least two heat exchange tube slots of the plurality of heat exchange tube slots of a first column of heat exchange tube slots of the plurality of fins are displaced from each other in the third direction, and/or the first slot edges of at least two heat exchange tube slots of the plurality of heat exchange tube slots of a second column of heat exchange tube slots of the plurality of fins are displaced from each other in the third direction.

[0035] According to embodiments of the present invention, at least one heat exchange tube slot of the plurality of heat exchange tube slots of the first column of heat exchange tube slots of the plurality of fins and at least one heat exchange tube slot of the plurality of heat exchange tube slots of the second column of heat exchange tube slots of the plurality of fins are displaced from each other in the first direction.

[0036] According to embodiments of the present invention, at least one heat exchange tube slot of the plurality of heat exchange tube slots of the first column of heat exchange tube slots of the plurality of fins and at least one heat exchange tube slot of the plurality of heat exchange tube slots of the second column of heat exchange tube slots of the plurality of fins are substantially aligned with each other in the first direction.

[0037] According to embodiments of the present invention, the plurality of heat exchange tube slots of the first column of heat exchange tube slots of the plurality of fins includes a plurality of first heat exchange tube slots and a plurality of second heat exchange tube slots, a length of the first heat exchange tube slot of the first column of heat exchange tube slots is less than that of the second heat exchange tube slot of the first column of heat exchange tube slots; the plurality of heat exchange tube slots of the second column of heat exchange tube slots of the plurality of fins includes a plurality of first heat exchange tube slots and a plurality of second heat exchange tube slots, a length of the first heat exchange tube slot of the second column of heat exchange tube slots is less than that of the second heat exchange tube slot of the second column of heat exchange tube slots; and at least one first heat exchange tube slot of the plurality of first heat exchange tube slots of the first column of heat exchange tube slots of the plurality of fins and at least one second heat exchange tube slot of the plurality of second heat exchange tube slots of the second column of heat exchange tube slots of the plurality of fins are substantially aligned with each other in the first direction.

[0038] According to embodiments of the present invention, the plurality of heat exchange tube slots of the first column of heat exchange tube slots of the plurality of fins are substantially aligned with each other in the third direction, and/or the plurality of heat exchange tube slots of the second column of heat exchange tube slots of the plurality of fins are substantially aligned with each other in the third direction.

[0039] According to embodiments of the present invention, the heat exchange tube slot of the column of heat exchange tube slots of the fin has a first slot edge and a second slot edge, the first slot edge and the second slot edge being respectively positioned on the outermost sides of the heat exchange tube slot in the third direction, and the first slot edge of the heat exchange tube slot of the fin being closer to the first side of the heat exchanger in the third direction than the second slot edge of the heat exchange tube slot of the fin; and the second slot edges of the plurality of heat exchange tube slots of the first column of heat exchange tube slots of the plurality of fins are substantially aligned with each other in the third direction, and/or the first slot edges of the plurality of heat exchange tube slots of the second column of heat exchange tube slots of the plurality of fins are substantially aligned with each other in the third direction.

[0040] According to embodiments of the present invention, the heat exchanger further includes a row of heat exchange tubes provided in each heat exchange tube slot of the plurality of heat exchange tube slots of each column of heat exchange tube slots of the plurality of columns of heat exchange tube slots, the row of heat exchange tubes including one heat exchange tube or a plurality of heat exchange tubes, wherein a length of at least one heat exchange tube slot of the plurality of heat exchange tube slots of the first column of heat exchange tube slots of at least one fin of the plurality of fins in the third direction is greater than a heat exchange tube size of the row of heat exchange tubes inserted in the at least one heat exchange tube slot in the third direction, in the case that the row of heat exchange tubes includes the one heat exchange tube, the heat exchange tube size is a size of the one heat exchange tube in the third direction, and in the case that the row of heat exchange tubes includes the plurality of heat exchange tubes, the heat

exchange tube size is a sum of sizes of the plurality of heat exchange tubes in the third direction; and/or a length of at least one heat exchange tube slot of the plurality of heat exchange tube slots of the second column of heat exchange tube slots of the at least one fin of the plurality of fins in the third direction is greater than the heat exchange tube size of the row of heat exchange tubes inserted in the at least one heat exchange tube slot in the third direction,

[0041] According to embodiments of the present invention, the heat exchanger further includes a row of heat exchange tubes provided in each heat exchange tube slot of the plurality of heat exchange tube slots of each column of heat exchange tube slots of the plurality of columns of heat exchange tube slots, the row of heat exchange tubes including one heat exchange tube or a plurality of heat exchange tubes, wherein a length of at least one heat exchange tube slot of the plurality of heat exchange tube slots of the first column of heat exchange tube slots of at least one fin of the plurality of fins in the third direction is substantially equal to a heat exchange tube size of the row of heat exchange tubes inserted in the at least one heat exchange tube slot in the third direction, in the case that the row of heat exchange tubes includes the one heat exchange tube, the heat exchange tube size is a size of the one heat exchange tube in the third direction, and in the case that the row of heat exchange tubes includes the plurality of heat exchange tubes, the heat exchange tube size is a sum of sizes of the plurality of heat exchange tubes in the third direction; and/or a length of at least one heat exchange tube slot of the plurality of heat exchange tube slots of the second column of heat exchange tube slots of the at least one fin of the plurality of fins in the third direction is greater than the heat exchange tube size of the row of heat exchange tubes inserted in the at least one heat exchange tube slot in the third direction,

[0042] According to embodiments of the present invention, the heat exchange tubes of the rows of heat exchange tubes provided in the heat exchange tube slots of the plurality of columns of heat exchange tube slots of the plurality of fins include a plurality of columns of heat exchange tubes arranged in the third direction, each column of heat exchange tubes of the plurality of columns of heat exchange tubes including a plurality of heat exchange tubes arranged in the first direction.

[0043] According to embodiments of the present invention, the heat exchange tube of the plurality of columns of heat exchange tubes includes a first end positioned on one side of the heat exchange tube in the second direction and a second end positioned on the other side of the heat exchange tube in the second direction; and the heat exchanger further includes: a first header connected and fluidly communicated with the first ends of the heat exchange tubes; and a second header connected and fluidly communicated with the second ends of the heat exchange tubes.

[0044] According to embodiments of the present invention, the heat exchange tube of the plurality of columns of heat exchange tubes includes a first end positioned on one side of the heat exchange tube in the second direction and a second end positioned on the other side of the heat exchange tube in the second direction; and the heat exchanger further includes: a first header connected and fluidly communicated with the first ends of the heat exchange tubes of the plurality columns of heat exchange tubes; and two second headers, one of the two second headers being connected and fluidly communicated with the second ends of the heat exchange tubes of at least one column of heat exchange tubes of the plurality of columns of heat exchange tubes, and the other of the two second headers being connected and fluidly communicated with the second ends of the heat exchange tubes of at least another column of heat exchange tubes of the plurality of columns of heat exchange tubes.

[0045] According to embodiments of the present invention, the heat exchange tube of the plurality of columns of heat exchange tubes includes a first end positioned on one side of the heat exchange tube in the second direction and a second end positioned on the other side of the heat exchange tube in the second direction; and the heat exchanger further includes: a connection portion, by which the first ends of the heat exchange tubes of one column of heat exchange tubes of the plurality columns of heat exchange tubes and the first ends of the heat exchange tubes of another column of heat exchange tubes of the plurality columns of heat exchange tubes are connected and fluidly communicated with each other; and two second headers, one of the two second headers being connected and fluidly communicated with the second ends of the heat exchange tubes of the one column of heat exchange tubes, and the other of the two second headers being connected and fluidly communicated with the second ends of the heat exchange tubes of the another column of heat exchange tubes.

[0046] According to embodiments of the present invention, the connection portion includes a plurality of connection tubes, by which the first ends of the heat exchange tubes of the one column of heat exchange tubes are connected and fluidly communicated with the first ends of the heat exchange tubes of the another column of heat exchange tubes of the plurality of connection tubes, respectively.

[0047] According to embodiments of the present invention, the heat exchange tube of the one column of heat exchange tubes, the connection tube, and the heat exchange tube of the another column of heat exchange tubes, which are connected with each other, are formed by bending one tube.

[0048] According to embodiments of the present invention, the heat exchange tube of the plurality of columns of heat exchange tubes includes a first end positioned on one side of the heat exchange tube in the second direction and a second end positioned on the

other side of the heat exchange tube in the second direction; and the heat exchanger further includes: two first headers and two second headers, one of the two first headers and one of the two second headers being connected and fluidly communicated with the first ends and the second ends of the heat exchange tubes of at least one column of heat exchange tubes of the plurality of columns of heat exchange tubes, respectively, and the other of the two first headers and the other of the two second headers being connected and fluidly communicated with the first ends and the second ends of the heat exchange tubes of at least another column of heat exchange tubes of the plurality of columns of heat exchange tubes, respectively.

[0049] According to embodiments of the present invention, in use, at least a portion of the heat exchange tube extends substantially vertically.

[0050] According to embodiments of the present invention, each of at least some fins is formed by one plate.

[0051] Embodiments of the present invention further provide an air conditioning system including the above-mentioned heater exchanger.

[0052] With the heat exchanger and the air conditioning system having the same according to the embodiments of the present invention, for example, the performance of the heat exchanger and the air conditioning system may be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0053]

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

Fig. 2 is a schematic left view of the heat exchanger shown in Fig. 1;

Fig. 3 is a schematic front view of a heat exchanger according to an embodiment of the present invention;

Fig. 4 is a schematic left view of the heat exchanger shown in Fig. 3;

Fig. 5 is a schematic front view of a heat exchanger according to an embodiment of the present invention;

Fig. 6 is a schematic left view of the heat exchanger shown in Fig. 5;

Fig. 7 is a schematic top view of a fin of a heat exchanger according to an embodiment of the present invention;

Fig. 8 is a schematic top view of a fin of a heat exchanger according to an embodiment of the present invention;

Fig. 9 is a schematic top view of a fin of a heat exchanger according to an embodiment of the present invention;

Fig. 10 is a schematic top view of a fin of a heat exchanger according to an embodiment of the present invention;

Fig. 11 is a schematic top view of a fin of a heat exchanger according to an embodiment of the present invention;

Fig. 12 is a schematic top view of a fin of a heat exchanger according to an embodiment of the present invention;

Fig. 13 is a schematic front view of the fin of the heat exchanger shown in Fig. 12;

Fig. 14 is a schematic top view of a fin of a heat exchanger according to an embodiment of the present invention;

Fig. 15 is a schematic front view of the fin of the heat exchanger shown in Fig. 14;

Fig. 16 is a schematic top view showing a fitting relationship between a fin and a heat exchange tube of a heat exchanger according to an embodiment of the present invention;

Fig. 17 is a schematic top view showing a fitting relationship between a fin and a heat exchange tube of a heat exchanger according to an embodiment of the present invention;

Fig. 18 is a schematic top view showing a fitting relationship between a fin and a heat exchange tube of a heat exchanger according to an embodiment of the present invention; and

Fig. 19 is a schematic top view showing a fitting relationship between a fin and a heat exchange tube of a heat exchanger according to an embodiment of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

[0054] The present invention is further explained below by means of specific embodiments in conjunction with the drawings.

[0055] Referring to Figs. 1-19, a heat exchanger 100 according to an embodiment of the present invention includes: a plurality of fins 2. Each fin of the plurality of fins 2 includes a fin body 20 and a plurality of columns of heat exchange tube slots formed in the fin body 20. For example, Figs. 7-12, 14 and 16-19 show a first column of heat exchange tube slots including a plurality of heat exchange tube slots 21A and a second column of heat exchange tube slots including a plurality of heat exchange tube slots 21B, the first column of heat exchange tube slots and the second column of heat exchange tube slots being positioned on a first side S1 and a second side S2 of the heat exchanger 100 opposite to each other in a third direction D3, respectively. In addition, the fin 2 may include three or more columns of heat exchange tube slots. The fin body 20 of the fin 2 may have a substantially flat shape. Each column of heat exchange tube slots of the plurality of columns of heat exchange tube slots includes a plurality of heat exchange tube slots 21 arranged in a first direction D1, the plurality of fins 2 being arranged in a second direction D2 perpendicular to the first direction D 1, and the plurality of columns of heat

exchange tube slots of each fin of the plurality of fins 2 being arranged in the third direction D3 perpendicular to the first direction D1 and the second direction D2. At least two heat exchange tube slots 21 of the heat exchange tube slots 21 of the plurality of columns of heat exchange tube slots of at least one fin 2 of the plurality of fins 2 have different lengths in the third direction D3.

[0056] Referring to Figs. 7, 8, 9, 12, 14, 16 and 17, in some embodiments of the present invention, at least two heat exchange tube slots 21 of the plurality of heat exchange tube slots 21 of at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of at least one fin 2 of the plurality of fins 2 have different lengths in the third direction D3.

[0057] Referring to Figs. 10, 11, 18 and 19, in some other embodiments of the present invention, at least one heat exchange tube slots 21 of the plurality of heat exchange tube slots 21 of at least one column of heat exchange tube slots, positioned on the first side S1 of the heat exchanger 100 in the third direction D3, of the plurality of columns of heat exchange tube slots of at least one fin 2 of the plurality of fins 2 and at least one heat exchange tube slots 21 of the plurality of heat exchange tube slots 21 of at least another column of heat exchange tube slots, positioned on the second side S2 of the heat exchanger 100 opposite to the first side S1 in the third direction D3, of the plurality of columns of heat exchange tube slots of the at least one fin 2 of the plurality of fins 2 have different lengths in the third direction D3. For example, a length of at least one heat exchange tube slot 21 of the plurality of heat exchange tube slots 21 of at least one column of heat exchange tube slots, positioned on the first side S1 of the heat exchanger 100 in the third direction D3, of the plurality of columns of heat exchange tube slots of at least one fin 2 of the plurality of fins 2 in the third direction D3 is less than that of at least one heat exchange tube slot 21 of the plurality of heat exchange tube slots 21 of at least another column of heat exchange tube slots, positioned on the second side S2 of the heat exchanger 100 opposite to the first side S1 in the third direction D3, of the plurality of columns of heat exchange tube slots of the at least one fin 2 of the plurality of fins 2 in the third direction D3.

[0058] Referring to Figs. 10, 11, 18 and 19, in the embodiments of the present invention, the heat exchange tube slot 21 of the column of heat exchange tube slots of the fin 2 has a first slot edge 211 and a second slot edge 212, the first slot edge 211 and the second slot edge 212 being positioned on outermost sides of the heat exchange tube slot 21 in the third direction D3, respectively, and the first slot edge 211 of the heat exchange tube slot 21 of the fin 2 being closer to the first side S1 of the heat exchanger 100 in the third direction D3 than the second slot edge 212 of the heat exchange tube slot 21 of the fin 2 in the third direction D3. The first slot edges 211 of the plurality of heat exchange tube slots 21 of at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of the plurality of fins 2 are substantially aligned with each other in the third direction D3, and/or the second slot edges 212 of the plurality of heat exchange tube slots 21 of the at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of the plurality of fins 2 are substantially aligned with each other in the third direction D3. The plurality of heat exchange tube slots 21 of at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of the plurality of fins 2 may have substantially the same size in the third direction D3.

[0059] Referring to Figs. 16-19, in the embodiments of the present invention, the heat exchanger 100 further includes a row of heat exchange tubes provided in each heat exchange tube slot 21 of the plurality of heat exchange tube slots 21 of each column of heat exchange tube slots of the plurality of columns of heat exchange tube slots, the row of heat exchange tubes being composed of one heat exchange tube 1 or a plurality of heat exchange tubes 1. Referring to Figs. 16, 18 and 19, a length of at least one heat exchange tube slot 21 of the plurality of heat exchange tube slots 21 of at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of at least one fin 2 of the plurality of fins 2 in the third direction D3 is greater than a heat exchange tube size of the row of heat exchange tubes inserted in the at least one heat exchange tube slot in the third direction D3. In the case that the row of heat exchange tubes is composed of the one heat exchange tube 1, the heat exchange tube size is a size of the one heat exchange tube 1 in the third direction D3, and in the case that the row of heat exchange tubes is composed of the plurality of heat exchange tubes 1, the heat exchange tube size is a sum of sizes of the plurality of heat exchange tubes 1 in the third direction D3. According to the embodiments of the present invention, a temperature field in different regions of the heat exchanger in the third direction may be flexibly controlled, which is convenient to optimize the heat exchange efficiency. In addition, it is also possible to adjust an amount of the generated condensate water in different regions of the heat exchanger in the third direction. Furthermore, a gap 5 for passage of water may be formed in the heat exchange tube slot 21. For example, the gap 5 forms a drainage passage through which defrosting water may quickly flow away, thereby improving the performance of the heat exchanger under frosting conditions.

[0060] The heat exchange efficiency refers to a measurement of efficiency of the heat exchange between air and other fluid media after the air flows through the heat exchanger. Given the same atmospheric environment, the same dry bulb temperature, the same wet bulb temperature, the same atmospheric pressure, the same fluid, the same inlet temperature, and the same flow rate, the average temperatures at the air outlet are compared to obtain the difference of temperature change before and after the air flows through the heat exchanger. Greater temperature change means higher heat exchange effi-

ciency.

[0061] Referring to Figs. 7-9, 12, 14, 16 and 17, in the embodiments of the present invention, the plurality of heat exchange tube slots 21 of at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of at least one fin 2 of the plurality of fins 2 include a plurality of first heat exchange tube slots 21S and a plurality of second heat exchange tube slots 21L (references "21S" and "21L" are showed only in Fig. 7). A length SL1 of the first heat exchange tube slot 21S and a length SL2 of the second heat exchange tube slot 21L satisfy the following relationship of: $SL2 \geq n*SL1$, where n is a positive integer. The n may be greater than or equal to 2. In one example of the present invention, the plurality of first heat exchange tube slots 21 include a plurality of sets of first heat exchange tube slots, each set of first heat exchange tube slots including at least one first heat exchange tube slot 21S; the plurality of second heat exchange tube slots 21 include a plurality of sets of second heat exchange tube slots, each set of second heat exchange tube slots including at least one second heat exchange tube slot 21L; and the plurality of sets of first heat exchange tube slots and the plurality of sets of second heat exchange tube slots are arranged alternately in the first direction D1. For example, each set of first heat exchange tube slots includes one first heat exchange tube slot 21S, and each set of second heat exchange tube slots includes one second heat exchange tube slot 21L. Referring to Figs. 16, 18 and 19, in the embodiments of the present invention, the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots 21 of at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of at least one fin 2 of the plurality of fins 2 have the same number and/or size of the heat exchange tubes 1. According to the examples of the present invention, the size of the heat exchange tube 1 in the third direction D3 is greater than or equal to 6 millimeters and less than or equal to 20 millimeters. According to the embodiments of the present invention, in the case that the heat exchange tubes 1 with the same width are adopted, the complexity of the production process may be reduced and the occurrence of errors may also be reduced. In addition, the temperature field of the different regions of the heat exchanger in the third direction may be flexibly controlled.

[0062] Referring to Figs. 7-12, 14 and 16-19, in some embodiments of the present invention, spacing between the plurality of heat exchange tube slots 21 of at least one column of heat exchange tube slots, positioned on the first side S1 of the heat exchanger 100 in the third direction D3, of the plurality of columns of heat exchange tube slots of the plurality of fins 2 is substantially the same as spacing between the plurality of heat exchange tube slots 21 of at least another column of heat exchange tube slots, positioned on the second side S2 of the heat exchanger 100 opposite to the first side S 1 in the third direction D3, of the plurality of columns of heat exchange tube slots of the plurality of fins 2. Referring to Figs. 18 and 19, the heat exchange tube size of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots 21 of the at least one column of heat exchange tube slots, positioned on the first side S1 of the heat exchanger 100 in the third direction D3, of the plurality of columns of heat exchange tube slots of the plurality of fins 2 may be different from the heat exchange tube size of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots 21 of the at least another column of heat exchange tube slots, positioned on the second side S2 of the heat exchanger 100 opposite to the first side S1 in the third direction D3, of the plurality of columns of heat exchange tube slots of the plurality of fins 2. For example, the heat exchange tube size of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots 21 of the at least one column of heat exchange tube slots, positioned on the first side S 1 of the heat exchanger 100 in the third direction D3, of the plurality of columns of heat exchange tube slots of the plurality of fins 2 is less than the heat exchange tube size of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots 21 of the at least another column of heat exchange tube slots, positioned on the second side S2 of the heat exchanger 100 opposite to the first side S 1 in the third direction D3, of the plurality of columns of heat exchange tube slots of the plurality of fins 2. By adopting the heat exchange tube slots with the same spacing and the rows of heat exchange tubes with the different heat exchange tube sizes, the temperature field of the different regions of the heat exchanger in the third direction may be flexibly controlled. In addition, the spacing between the plurality of heat exchange tube slots 21 of at least one column of heat exchange tube slots, positioned on the first side S1 of the heat exchanger 100 in the third direction D3, of the plurality of columns of heat exchange tube slots of the plurality of fins 2 may also be different from the spacing between the plurality of heat exchange tube slots 21 of at least another column of heat exchange tube slots, positioned on the second side S2 of the heat exchanger 100 opposite to the first side S1 in the third direction D3, of the plurality of columns of heat exchange tube slots of the plurality of fins 2. For example, the spacing between the plurality of heat exchange tube slots 21 of at least one column of heat exchange tube slots, positioned on the first side S1 of the heat exchanger 100 in the third direction D3, of the plurality of columns of heat exchange tube slots of the plurality of fins 2 is greater than the spacing between the plurality of heat exchange tube slots 21 of at least another column of heat exchange tube slots, positioned on the second side S2 of the heat exchanger 100 opposite to the first side S1 in the third direction D3, of the plurality of columns of heat exchange tube slots of the plurality of fins 2. By provision of the heat

exchange tube slots 21 with the different spacings, the temperature field of the different regions of the heat exchanger in the third direction may be flexibly controlled.

[0063] Referring to Figs. 1, 3 and 5, in the embodiments of the present invention, the plurality of fins 2 and the heat exchange tubes 1 of the rows of heat exchange tubes provided in the heat exchange tube slots 21 of the plurality of columns of heat exchange tube slots of the plurality of fins 2 constitute a heat exchanger core 8, the heat exchanger core 8 including a first core portion 81 and a second core portion 82. The first core portion 81 and the second core portion 82 are positioned on both sides of a plane passing through a geometric center of the fin bodies 20 and perpendicular to the third direction D3, respectively, the first core portion 81 being positioned on the first side S1 of the heat exchanger 100 in the third direction D3, and the second core portion 82 being positioned on the second side S2 of the heat exchanger 100 opposite to the first side S1 in the third direction D3, wherein the heat exchange efficiency of the first core portion 81 is lower than that of the second core portion 82. According to the embodiments of the present invention, in the case that the first core portion 81 is positioned on a windward side of the heat exchanger and the second core portion 82 is positioned on a leeward side of the heat exchanger, the utilization efficiency of the first core portion 81 may be balanced and the second core portion 82 may be fully utilized by adjusting the heat exchange efficiencies of the first core portion 81 and the second core portion 82. In addition, it may potentially reduce an amount of the generated condensate water at the first core portion 81, reduce the heat transfer resistance caused by the condensate water, and instead improve the overall heat exchange efficiency of the heat exchanger.

[0064] Referring to Figs. 1, 3, 5 and 16-19, in the embodiments of the present invention, the heat transfer efficiency between the one heat exchange tube 1 (, or at least one heat exchange tube 1 of the plurality of heat exchange tubes 1,) of at least one row of heat exchange tubes 1 of the plurality of rows heat exchange tubes provided in the plurality of heat exchange tube slots 21 of at least one column of heat exchange tube slots, positioned on the first side S1 of the heat exchanger 100 in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins 2 and at least one fin of the plurality of fins 2 is lower than the heat transfer efficiency between the one heat exchange tube 1 (, or at least one heat exchange tube 1 of the plurality of heat exchange tubes 1,) of at least one row of heat exchange tubes 1 of the plurality of rows heat exchange tubes provided in the plurality of heat exchange tube slots 21 of at least another column of heat exchange tube slots, positioned on the second side S2 of the heat exchanger 100 opposite to the first side S1 in the third direction D3, of the plurality of columns of heat exchange tube slots of the plurality of fins 2 and at least one fin of the plurality of fins 2. According to an example of the present invention, referring to Figs. 14 and 15, the fin body 20 of the plurality of fins 2 includes a first fin body portion 20A positioned on the first side S 1 of the heat exchanger 100 in the third direction D3 and a second fin body portion 20B positioned on the second side S2 of the heat exchanger 100 opposite to the first side S 1 in the third direction D3, the first fin body portion 20A and the second fin body portion 20B having a substantially flat shape. The fin 2 includes first louver(s) 22A provided in the first fin body portion 20A, and second louver(s) 22B provided in the second fin body portion 20B, the heat exchange efficiency of the first louver(s) 22A being lower than that of the second louver(s) 22B. The number of the first louver(s) 22A is smaller than that of the second louver(s) 22B, and/or an inclination angle of the first louver(s) 22A relative to the first fin body portion 20A is smaller than that of the second louver(s) 22B relative to the second fin body portion 20B. For example, referring to Fig. 15, the spacing between the adjacent first louvers 22A is 3 millimeters, the inclination angle of the first louver(s) 22A relative to the first fin body portion 20A is 25 degrees, the spacing between the adjacent second louvers 22B is 2 millimeters, and the inclination angle of the second louver(s) 22B relative to the second fin body portion 20B is 30 degrees. According to another example of the present invention, referring to Figs. 12 and 13, the fin body 20 of the plurality of fins 2 includes a first fin body portion 20A positioned on the first side S 1 of the heat exchanger 100 in the third direction D3 and a second fin body portion 20B positioned on the second side S2 of the heat exchanger 100 opposite to the first side S1 in the third direction D3, the fin 2 includes the second louver(s) 22B provided on the second fin body portion 20B, and there is no louver on the first fin body portion 20A. According to the embodiments of the present invention, the temperature field of the different regions of the heat exchanger in the third direction may be flexibly controlled.

[0065] Referring to Figs. 17 and 19, in the embodiments of the present invention, structure parameters of the one heat exchange tube 1 (, or structure parameters of at least one heat exchange tube of the plurality of heat exchange tubes,) of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots 21 of at least one column of heat exchange tube slots, positioned on the first side S1 of the heat exchanger 100 in the third direction D3, of the plurality of columns of heat exchange tube slots of the plurality of fins 2 are different from structure parameters of the one heat exchange tube 1 (, or structure parameters of at least one heat exchange tube 1 of the plurality of heat exchange tubes 1,) of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots 21 of at least another column of heat exchange tube slots, positioned on second side S2 of the heat exchanger 100 opposite to the first side S1 in the third direction D3, of the plurality of columns of heat exchange tube slots of the plurality of fins 2. The

structural parameters may include at least one of, a size of the heat exchange tube 1 in the first direction D1, the number of holes of the heat exchange tube 1, an aperture of the hole of the heat exchange tube 1, and a thickness of a wall between the adjacent holes of the heat exchange tube 1.

[0066] Referring to Figs. 7, 8, 10-12, 14 and 16-19, in the embodiments of the present invention, the plurality of heat exchange tube slots 21 of at least one column of heat exchange tube slots, positioned on the first side S1 of the heat exchanger 100 in the third direction D3, of the plurality of columns of heat exchange tube slots of at least one fin 2 of the plurality of fins 2 and the plurality of heat exchange tube slots 21 of at least another column of heat exchange tube slots, positioned on the second side S2 of the heat exchanger 100 opposite to the first side S1 in the third direction D3, of the plurality of columns of heat exchange tube slots of the at least one fin 2 of the plurality of fins 2 are arranged alternately in the first direction D1. Referring to Fig 11, according to the examples of the present invention, at least one heat exchange tube slot 21 of the plurality of heat exchange tube slots 21 of at least one column of heat exchange tube slots, positioned on the first side S1 of the heat exchanger 100 in the third direction D3, of the plurality of columns of heat exchange tube slots of the plurality of fins 2 and at least one heat exchange tube slot 21 of the plurality of heat exchange tube slots 21 of at least another column of heat exchange tube slots, positioned on the second side S2 of the heat exchanger 100 opposite to the first side S1 in the third direction D3, of the plurality of columns of heat exchange tube slots of the plurality of fins 2 are displaced from each other in the first direction D1 and, when viewed in the first direction D1, overlap with each other.

[0067] Referring to Figs. 7-12, 14 and 16-19, in the embodiments of the present invention, the plurality of columns of heat exchange tube slots of the plurality of fins 2 include a first column of heat exchange tube slots and a second column of heat exchange tube slots positioned on the first side S1 and the second side S2 of the heat exchanger 100 opposite to each other in the third direction D3, respectively. The plurality of heat exchange tube slots 21A of the first column of heat exchange tube slots of the plurality of fins 2 have an opening towards the first side S1 of the heat exchanger 100, and the plurality of heat exchange tube slots 21B of the second column of heat exchange tube slots of the plurality of fins 2 have an opening towards the second side S2 of the heat exchanger 100. The heat exchange tube slots 21 of the plurality of fins 2 may have no opening and are closed heat exchange tube slots.

[0068] Referring to Figs. 7-9, 12, 14, 16 and 17, in the embodiments of the present invention, the second slot edges 212 of at least two heat exchange tube slots 21A of the plurality of heat exchange tube slots 21A of the first column of heat exchange tube slots of the plurality of fins 2 are displaced from each other in the third direction D3, and/or the first slot edges 211 of at least two heat exchange tube slots 21B of the plurality of heat exchange tube slots 21B of the second column of heat exchange tube slots of the plurality of fins 2 are displaced from each other in the third direction D3. Referring to Figs. 7, 8, 10-12, 14 and 16-19, at least one heat exchange tube slot of the plurality of heat exchange tube slots 21A of the first column of heat exchange tube slots of the plurality of fins 2 and at least one heat exchange tube slot of the plurality of heat exchange tube slots 21B of the second column of heat exchange tube slots of the plurality of fins 2 are displaced from each other in the first direction D1. Referring to Fig. 9, at least one heat exchange tube slot of the plurality of heat exchange tube slots 21A of the first column of heat exchange tube slots of the plurality of fins 2 and at least one heat exchange tube slot of the plurality of heat exchange tube slots 21B of the second column of heat exchange tube slots of the plurality of fins 2 are substantially aligned with each other in the first direction D1. According to the embodiments of the present invention, a flow path for the discharge of the condensate water may be shortened by displacing the slot edges of the heat exchange tube slots in the third direction D3 and by displacing the heat exchange tube slots in the first direction D1, which is beneficial to rapid discharge of the condensate water and reduce the resistance to wind, and can also adjust the amount of the condensate water at the same time.

[0069] Referring to Fig. 7, in the examples of the present invention, the plurality of heat exchange tube slots 21 of the first column of heat exchange tube slots of the plurality of fins 2 include a plurality of first heat exchange tube slots 21S and a plurality of second heat exchange tube slots 21L, a length of the first heat exchange tube slot 21S of the first column of heat exchange tube slots is less than that of the second heat exchange tube slot 21L of the second column of heat exchange tube slots; the plurality of heat exchange tube slots 21B of the second column of first heat exchange tube slots of the plurality of fins 2 include a plurality of first heat exchange tube slots 21S and a plurality of second heat exchange tube slots 21L, a length of the first heat exchange tube slot 21S of the second column of heat exchange tube slots is less than that of the second heat exchange tube slot 21L of the second column of heat exchange tube slots; and at least one first heat exchange tube slot of the plurality of first heat exchange tube slots 21S of the first column of heat exchange tubes of the plurality of fins 2 and at least one second heat exchange tube slot of the plurality of second heat exchange tube slots 21L of the second column of heat exchange tubes of the plurality of fins 2 are substantially aligned with each other in the first direction D1.

[0070] Referring to Figs. 10, 11, 18 and 19, in the embodiments of the present invention, the plurality of heat exchange tube slots 21A of the first column of heat exchange tube slots of the plurality of fins 2 are substantially aligned with each other in the third direction D3, and/or the plurality of heat exchange tube slots 21B of the second column of heat exchange tube slots of the plur-

ality of fins 2 are substantially aligned with each other in the third direction D3. For example, the second slot edges 212 of the plurality of heat exchange tube slots 21A of the first column of heat exchange tube slots of the plurality of fins 2 are substantially aligned with each other in the third direction D3, and/or the first slot edges 211 of the plurality of heat exchange tube slots 21B of the second column of heat exchange tube slots of the plurality of fins 2 are substantially aligned with each other in the third direction D3.

[0071] Referring to Figs. 16, 18 and 19, in the embodiments of the present invention, a length of at least one heat exchange tube slot 21 of the plurality of heat exchange tube slots 21A of the first column of heat exchange tube slots of at least one fin 2 of the plurality of fins 2 in the third direction D3 is greater than the heat exchange tube size of the row of heat exchange tubes inserted in the at least one heat exchange tube slot 2 in the third direction D3, and/or a length of at least one heat exchange tube slot 21 of the plurality of heat exchange tube slots 21B of the second column of heat exchange tube slots of the at least one fin 2 of the plurality of fins 2 in the third direction D3 is greater than the heat exchange tube size of the row of heat exchange tubes inserted in the at least one heat exchange tube slot 21 in the third direction D3. Referring to Figs. 17, 18 and 19, in the embodiments of the present invention, a length of at least one heat exchange tube slot 21 of the plurality of heat exchange tube slots 21A of the first column of heat exchange tube slots of at least one fin 2 of the plurality of fins 2 in the third direction D3 is substantially equal to the heat exchange tube size of the row of heat exchange tubes inserted in the at least one heat exchange tube slot 21 in the third direction D3, and/or a length of at least one heat exchange tube slot 21 of the plurality of heat exchange tube slots 21B of the second column of heat exchange tube slots of the at least one fin 2 of the plurality of fins 2 in the third direction D3 is substantially greater than or equal to the heat exchange tube size of the row of heat exchange tubes inserted in the at least one heat exchange tube slot 21 in the third direction D3.

[0072] Referring to Figs. 1, 3, 5 and 16-19, in the embodiments of the present invention, the heat exchange tubes 1 of the row of heat exchange tubes arranged in the heat exchange tube slot 21 of the plurality of columns of heat exchange tube slots of the plurality of fins 2 includes a plurality of columns of heat exchange tubes arranged in the third direction D3, each column of heat exchange tubes of the plurality of columns of heat exchange tubes includes a plurality of heat exchange tubes 1 arranged in the first direction D1. For example, a first column of heat exchange tubes include a plurality of heat exchange tubes 1A, a second column of heat exchange tubes include a plurality of heat exchange tubes 1B, a third column of heat exchange tubes include a plurality of heat exchange tubes 1C, a forth column of heat exchange tubes include a plurality of heat exchange tubes 1D, and so on. Referring to Figs. 1, 3 and 5, in the embodiments of the present invention, the heat exchange tube 1 of the plurality of columns of heat exchange tubes includes a first end 18 positioned on one side of the heat exchange tube 1 in the second direction D2 and a second end 19 positioned on the other side of the heat exchange tube 1 in the second direction D2. In one example, the heat exchanger 100 further includes: a first header 31 connected and fluid communicated with the first ends 18 of the heat exchange tubes 1; and a second header 32 connected and fluid communicated with the second ends 19 of the heat exchange tubes 1. In another example, the heat exchanger 100 further includes: a first header 31 connected and fluid communicated with the first ends 18 of the heat exchange tubes 1 of the plurality of columns of heat exchange tubes; and two second headers 32, one of the two second headers 32 being connected and fluid communicated with the second ends 19 of the heat exchange tubes 1 of at least one column of heat exchange tubes of the plurality of columns of heat exchange tubes, and the other of the two second headers 32 being connected and fluid communicated with the second ends 19 of the heat exchange tubes 1 of at least another column of heat exchange tubes of the plurality of columns of heat exchange tubes. In further another example, referring to Figs. 5 and 6, the heat exchanger 100 further includes a connecting portion 6, by which the first ends 18 of the heat exchange tubes 1 of one column of heat exchange tubes of the plurality of columns of heat exchange tubes are connected and fluid communicated with the first ends 18 of the heat exchange tubes 1 of another column of heat exchange tubes of the plurality of columns of heat exchange tubes; and two second headers 32, one of the two second headers 32 being connected and fluid communicated with the second ends 19 of the heat exchange tubes 1 of the one column of heat exchange tubes, and the other of the two second headers 32 being connected and fluid communicated with the second ends 19 of the heat exchange tubes 1 of the another column of heat exchange tubes. The connection portion 6 may be a plurality of connection tubes 60, by which the first ends 18 of the heat exchange tubes 1 of the one column of heat exchange tubes are connected and fluidly communicated with the first ends 18 of the heat exchange tubes 1 of the another column of heat exchange tubes, respectively. The connection portion 6 may also enable the first ends 18 of the heat exchange tubes 1 of the one column of heat exchange tubes to be connected and fluidly communicated with the first ends 18 of the heat exchange tubes 1 of the another column of heat exchange tubes, but not being in one-to-one correspondence relationship. The heat exchange tube 1 of the one column of heat exchange tubes, the connection tube 60, and the heat exchange tube 1 of the another column of heat exchange tubes, which are connected with each other, may be formed by bending one tube. In the examples shown in Figs. 5 and 6, the first ends 18 of the heat exchange tubes 1 of two columns of heat exchange tubes of the plurality columns of heat

exchange tubes are connected and fluidly communicated with the first ends 18 of the heat exchange tubes 1 of another two columns of heat exchange tubes of the plurality columns of heat exchange tubes, respectively, one of the two second headers 32 is connected and fluidly communicated with the second ends 19 of the heat exchange tubes 1 of the two columns of heat exchange tubes, and the other of the two second headers 32 is connected and fluidly communicated with the second ends 19 of the heat exchange tubes 1 of the another two columns of heat exchange tubes. In further examples, referring to Figs. 1 and 3, the heat exchanger 100 further includes: two first headers 31 and two second headers 32, one of the two first headers 31 and one of the two second headers 32 being connected and fluidly communicated with the first ends 18 and the second ends 19 of the heat exchange tubes 1 of at least one column of the heat exchange tubes of the plurality of columns of heat exchange tubes, respectively, and the other of the two first headers 31 and the other of the two second headers 32 being connected and fluidly communicated with the first ends 18 and the second ends 19 of the heat exchange tubes 1 of at least another column of the heat exchange tubes of the plurality of columns of heat exchange tubes, respectively. In the examples shown in Figs. 1 and 3, each first header 31 is connected and fluidly communicated with the first ends 18 of the heat exchange tubes 1 of two columns of heat exchange tubes of the plurality of columns of heat exchange tubes, and each second header 32 is connected and fluidly communicated with the second ends 19 of the heat exchange tubes 1 of two columns of heat exchange tubes of the plurality of columns of heat exchange tubes.

[0073] Referring to Figs. 1 to 6, in the embodiments of the present invention, in use, at least a portion of the heat exchange tube 1 extends substantially vertically. For example, the heat exchange tube 1 extends substantially vertically. In addition, at least a portion of the heat exchange tube 1 may also extend substantially horizontally or obliquely, for example, the heat exchange tube 1 may extend substantially horizontally or obliquely. Referring to Figs. 1-19, in the embodiments of the present invention, each of at least some fins 2 is formed by one plate. For example, the fin 2 is formed by one plate. The fin body 20 of the fin 2 may be inclined with respect to a plane defined by the first direction D1 and the third direction D3. An angle between the fin body 20 of the fin 2 and the plane defined by the first direction D1 and the third direction D3 may be less than or equal to 45 degrees. When the heat exchanger is used as an evaporator, the condensate water will be generated, inclination of the fin body 20 of the fin 2 facilitates the smooth discharge of the condensate water and reduces the resistance to wind.

[0074] In the example shown in Fig. 7, the plurality of heat exchange tube slots 21A of the first column of heat exchange tube slots have an opening towards the first side S1 of the heat exchanger 100, and the plurality of heat exchange tube slots 21B of the second column of heat exchange tube slots have an opening towards the second side S2 of the heat exchanger 100. The column of heat exchange tube slots includes the heat exchange tube slots 21 with different lengths. The plurality of heat exchange tube slots 21A of the first column of heat exchange tube slots and the plurality of heat exchange tube slots 21B of the second column of heat exchange tube slots are displaced from each other in the first direction D1. Spacing between the plurality of heat exchange tube slots 21A of the first column of heat exchange tube slots is substantially the same as spacing between the plurality of heat exchange tube slots 21B of the second column of heat exchange tube slots.

[0075] In the examples shown in Figs. 7, 8, and 9, the plurality of first heat exchange tube slots 21 include a plurality of sets of first heat exchange tube slots, each set of first heat exchange tube slots includes at least one first heat exchange tube slot 21S (see Fig. 7); the plurality of second heat exchange tube slots 21 include a plurality of sets of second heat exchange tube slots, each set of second heat exchange tube slots includes at least one second heat exchange tube slot 21L (see Fig. 7); and the plurality of sets of first heat exchange tube slots and the plurality of sets of second heat exchange tube slots are alternately arranged in the first direction D 1. Therefore, the shorter first heat exchange tube slots 21S and the longer second heat exchange tube slots 21L are flexibly arranged according to specific heat exchange requirements.

[0076] In the examples shown in Figs. 10 and 11, the plurality of heat exchange tube slots 21A of the first column of heat exchange tube slots have the same length, and the plurality of heat exchange tube slots 21B of the second column of heat exchange tube slots have the same length, but the length of the heat exchange tube slot 21A is different from that of the heat exchange tube slot 21B. In addition, the heat exchange tube slot 21A and the heat exchange tube slot 21B may partially overlap.

[0077] In the example shown in Fig. 16, the heat exchange tubes 1 have the same size (i.e., width Tw) in the third direction D3, the plurality of heat exchange tube slots 21A of the first column of heat exchange tube slots and the plurality of heat exchange tube slots 21B of the second column of heat exchange tube slots are displaced from each other in the first direction D1 , and the lengths of some heat exchange tube slots 21 are greater than sizes (i.e., width Tw) of the heat exchange tubes inserted in the some heat exchange tube slots 21 in the third direction D3.

[0078] In the example shown in Fig. 17, the length of the heat exchange tube slot 21 is equal to the size (i.e. width Tw) of the heat exchange tube inserted in the heat exchange tube slot 21 in the third direction D3 or the heat exchange tube size of the row of heat exchange tubes in the third direction D3.

[0079] In the examples shown in Figs. 18 and 19, the lengths of the plurality of heat exchange tube slots 21A of

the first column of heat exchange tube slots are equal to the sizes (i.e., width Tw) of the heat exchange tube inserted in the plurality of heat exchange tube slots 21A in the third direction D3, and the lengths of the plurality of heat exchange tube slots 21B of the second column of heat exchange tubes are greater than the heat exchange tube sizes of the rows of heat exchange tubes inserted in the plurality of heat exchange tube slots 21B in the third direction D3. Some rows of heat exchange tubes include a plurality of heat exchange tubes separated from each other. In the example shown in Fig. 18, the heat exchange tubes in the plurality of heat exchange tube slots 21B of the second column of heat exchange tube slots have the same size in the third direction D3, and in the example shown in Fig. 19, the heat exchange tubes in the plurality of heat exchange tube slots 21B of the second column of heat exchange tube slots have different sizes in the third direction D3.

[0080] In the embodiments of the present invention, the heat exchange tube 1 may be a flat tube or any heat exchange tube having two planes which are substantially parallel to each other.

[0081] An air conditioning system according to an embodiment of the present invention includes: the above-mentioned heat exchanger 100. More specifically, the air conditioning system includes: a compressor, a condenser, an evaporator, an expansion valve, etc.. At least one of the condenser and the evaporator may be the above-mentioned heat exchanger 100.

[0082] With the heat exchanger and the air conditioning system having the same according to the embodiments of the present invention, for example, the performance of the heat exchanger and the air conditioning system can be improved.

[0083] According to the embodiments of the present invention, the temperature of the various regions of the heat exchanger in the third direction may be flexibly controlled, thereby avoiding the phenomenon of the condensation water being concentrated on the windward side due to overly efficient heat exchange on the windward side of the heat exchanger, furthermore, the leeward side of the heat exchanger may also be fully utilized, this not only effectively reduces wind resistance (due to the accumulation of the less condensation water), but also balances the heat exchange efficiency on the windward and leeward sides of the heat exchanger, thereby achieving the overall improvement of the heat exchanger efficiency.

[0084] In addition, according to the embodiments of the present invention, by adopting the heat exchange tube slots with different lengths and the heat exchange tubes with different widths, the heat exchange efficiency of the heat exchange tubes on the windward and leeward sides of the heat exchanger may be flexibly controlled, thereby achieving the overall improvement of the heat exchange performance. When the heat exchanger is used as the evaporator, an amount of the condensate water generated in different heat exchange regions can also be controlled by adjusting the heat exchange, which is beneficial to the uniform distribution of the condensate water on the overall heat exchange surface, reducing the resistance to wind, and reducing the probability of the condensate water being blown out of the heat exchanger. The overall heat transfer performance is improved.

[0085] Although the above embodiments are described, some features of the above embodiments and/or some of the above embodiments may be combined to form new embodiments.

Claims

1. A heat exchanger comprising:

a plurality of fins, each of the plurality of fins comprising a fin body and a plurality of columns of heat exchange tube slots formed in the fin body, each of the plurality of columns of heat exchange tube slots comprising a plurality of heat exchange tube slots arranged in a first direction, the plurality of fins being arranged in a second direction perpendicular to the first direction, and the plurality of columns of heat exchange tube slots of each of the plurality of fins being arranged in a third direction perpendicular to the first direction and the second direction;

wherein at least two heat exchange tube slots of the plurality of heat exchange tube slots of the plurality of columns of heat exchange tube slots of at least one fin of the plurality of fins have different sizes in the third direction.

2. The heat exchanger according to claim 1, wherein at least two heat exchange tube slots of the plurality of heat exchange tube slots of at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of at least one fin of the plurality of fins have different sizes in the third direction.

3. The heat exchanger according to claim 1, wherein at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least one column of heat exchange tube slots, positioned on a first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of at least one fin of the plurality of fins and at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least another column of heat exchange tube slots, positioned on a second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the at least one fin of the plurality of fins have different sizes in the third direction.

4. The heat exchanger according to claim 1, further comprising:

a row of heat exchange tubes provided in each heat exchange tube slot of the plurality of heat exchange tube slots of each column of heat exchange tube slots of the plurality of columns of heat exchange tube slots, the row of heat exchange tubes comprising one heat exchange tube or a plurality of heat exchange tubes,
wherein
a length of at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of at least one fin of the plurality of fins in the third direction is greater than a heat exchange tube size of the row of heat exchange tubes inserted in the at least one heat exchange tube slot in the third direction, in the case that the row of heat exchange tubes comprises the one heat exchange tube, the heat exchange tube size is a size of the one heat exchange tube in the third direction, and in the case that the row of heat exchange tubes comprises the plurality of heat exchange tubes, the heat exchange tube size is a sum of sizes of the plurality of heat exchange tubes in the third direction.

5. The heat exchanger according to claim 1, wherein the fin body of the fin is inclined relative to a plane defined by the first direction and the second direction.

6. The heat exchanger according to claim 4, wherein

the plurality of heat exchange tube slots of at least one column of heat exchange tube slots of the plurality of columns of heat exchange tube slots of at least one fin of the plurality of fins comprise a plurality of first heat exchange tube slots and a plurality of second heat exchange tube slots, a length SL1 of the first heat exchange tube slot and a length SL2 of the second heat exchange tube slot satisfy the following relationship of:

$$SL2 \geqslant n*SL1,$$

where, n is a positive integer.

7. The heat exchanger according to claim 6, wherein n is greater than or equal to 2.

8. The heat exchanger according to claim 6 or 7, wherein

the plurality of first heat exchange tube slots comprises a plurality of sets of first heat exchange tube slots, each set of first heat exchange tube slots comprising at least one first heat exchange tube slot;
the plurality of second heat exchange tube slots comprises a plurality of sets of second heat exchange tube slots, each set of second heat exchange tube slots comprising at least one second heat exchange tube slot; and
the plurality of sets of first heat exchange tube slots and the plurality of sets of second heat exchange tube slots are alternately arranged in the first direction.

9. The heat exchanger according to claim 1 or 4, wherein
spacing between the plurality of heat exchange tube slots of at least one column of heat exchange tube slots, positioned on a first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins is different from or substantially equal to spacing between the plurality of heat exchange tube slots of at least another column of heat exchange tube slots, positioned on a second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins.

10. The heat exchanger according to claim 9, wherein
the heat exchange tube size of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes in the plurality of heat exchange tube slots of the at least one column of heat exchange tube slots, positioned on the first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins is different from that of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes in the plurality of heat exchange tube slots of the at least another column of heat exchange tube slots, positioned on the second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins.

11. The heat exchanger according to claim 4, wherein
a heat transfer efficiency between the one heat exchange tube of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots of at least one column of heat exchange tube slots, positioned on a first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins and at least one fin of the plurality of fins, or a heat transfer efficiency between at least one heat exchange tube

of the plurality of heat exchange tubes of the at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots of the at least one column of heat exchange tube slots, positioned on the first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins and the at least one fin of the plurality of fins, is less than a heat transfer efficiency between the one heat exchange tube of at least one row of heat exchange tubes of a plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots of at least another column of heat exchange tube slots, positioned on a second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins and at least one fin of the plurality of fins, or a heat transfer efficiency between at least one heat exchange tube of the plurality of heat exchange tubes of the at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots of the at least another column of heat exchange tube slots, positioned on the second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins and the at least one fin of the plurality of fins.

12. The heat exchanger according to claim 1 or 4, wherein
the fin body of the plurality of fins comprises a first fin body portion positioned on a first side of the heat exchanger in the third direction and a second fin body portion positioned on a second side of the heat exchanger opposite to the first side in the third direction, and the fin comprises a first louver provided on the first fin body portion, and a second louver provided on the second fin body portion, wherein the heat exchange efficiency of the first louver is lower than that of the second louver.

13. The heat exchanger according to claim 12, wherein

the number of the first louver is less than that of the second louver; and/or
an inclination angle of the first louver relative to the first fin body portion is less than that of the second louver relative to the second fin body portion.

14. The heat exchanger according to claim 1 or 5, wherein
the fin body of the plurality of fins comprises a first fin body portion positioned on a first side of the heat exchanger in the third direction and a second fin body portion positioned on a second side of the heat exchanger opposite to the first side in the third direction, and the fin comprises a second louver provided on the second fin body portion, and there is no louver provided on the first fin body portion.

15. The heat exchanger according to claim 4, wherein
structure parameters of the one heat exchange tube, or structure parameters of at least one heat exchange tube of the plurality of heat exchange tubes, of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots of at least one column of heat exchange tube slots, positioned on a first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins are different from structure parameters of the one heat exchange tube, or structure parameters of at least one heat exchange tube of the plurality of heat exchange tubes, of at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes provided in the plurality of heat exchange tube slots of at least another column of heat exchange tube slots, positioned on a second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins, wherein the structural parameters comprise at least one of: a size of the heat exchange tube in the first direction, the number of holes of the heat exchange tube, an aperture of the hole of the heat exchange tube, and a thickness of a wall between adjacent holes of the heat exchange tube.

16. The heat exchanger according to claim 1, wherein
the plurality of heat exchange tube slots of at least one column of heat exchange tube slots, positioned on a first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of at least one fin of the plurality of fins and the plurality of heat exchange tube slots of at least another column of heat exchange tube slots, positioned on a second side of the heat exchanger opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the at least one fin of the plurality of fins are alternately arranged in the first direction.

17. The heat exchanger according to claim 1, wherein
at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least one column of heat exchange tube slots, positioned on a first side of the heat exchanger in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins and at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least another column of heat exchange tube slots, positioned on a second side of the heat ex-

changer opposite to the first side in the third direction, of the plurality of columns of heat exchange tube slots of the plurality of fins are displaced from each other in the first direction and, when viewed in the first direction, partially overlap.

18. The heat exchanger according to claim 1, wherein the plurality of columns of heat exchange tube slots of the plurality of fins comprise a first column of heat exchange tube slots and a second column of heat exchange tube slots positioned on a first side and a second side of the heat exchanger opposite to each other in the third direction, respectively.

19. The heat exchanger according to claim 18, wherein the plurality of heat exchange tube slots of the first column of heat exchange tube slots of the plurality of fins has an opening towards the first side of the heat exchanger, and the plurality of heat exchange tube slots of the second column of heat exchange tube slots of the plurality of fins has an opening towards the second side of the heat exchanger.

20. The heat exchanger according to claim 18, wherein the heat exchange tube slot of the column of heat exchange tube slots of the fin has a first slot edge and a second slot edge, the first slot edge and the second slot edge being respectively positioned on outermost sides of the heat exchange tube slot in the third direction, and the first slot edge of the heat exchange tube slot of the fin being closer to the first side of the heat exchanger in the third direction than the second slot edge of the heat exchange tube slot of the fin; wherein the fin has at least one of the following features:

the second slot edges of at least two heat exchange tube slots of the plurality of heat exchange tube slots of a first column of heat exchange tube slots of the plurality of fins are displaced from each other in the third direction;
the first slot edges of at least two heat exchange tube slots of the plurality of heat exchange tube slots of a second column of heat exchange tube slots of the plurality of fins are displaced from each other in the third direction;
the second slot edges of the plurality of heat exchange tube slots of the first column of heat exchange tube slots of the plurality of fins are substantially aligned with each other in the third direction;
the first slot edges of the plurality of heat exchange tube slots of the second column of heat exchange tube slots of the plurality of fins are substantially aligned with each other in the third direction.

21. The heat exchanger according to claim 18, wherein at least one heat exchange tube slot of the plurality of heat exchange tube slots of the first column of heat exchange tube slots of the plurality of fins and at least one heat exchange tube slot of the plurality of heat exchange tube slots of the second column of heat exchange tube slots of the plurality of fins are displaced from each other in the first direction.

22. The heat exchanger according to claim 18, wherein

the plurality of heat exchange tube slots of the first column of heat exchange tube slots of the plurality of fins comprises a plurality of first heat exchange tube slots and a plurality of second heat exchange tube slots, a length of the first heat exchange tube slot of the first column of heat exchange tube slots is less than that of the second heat exchange tube slot of the first column of heat exchange tube slots;
the plurality of heat exchange tube slots of the second column of heat exchange tube slots of the plurality of fins comprises a plurality of first heat exchange tube slots and a plurality of second heat exchange tube slots, a length of the first heat exchange tube slot of the second column of heat exchange tube slots is less than that of the second heat exchange tube slot of the second column of heat exchange tube slots; and
at least one first heat exchange tube slot of the plurality of first heat exchange tube slots of the first column of heat exchange tube slots of the plurality of fins and at least one second heat exchange tube slot of the plurality of second heat exchange tube slots of the second column of heat exchange tube slots of the plurality of fins are substantially aligned with each other in the first direction.

23. The heat exchanger according to claim 18, further comprising:

a row of heat exchange tubes provided in each heat exchange tube slot of the plurality of heat exchange tube slots of each column of heat exchange tube slots of the plurality of columns of heat exchange tube slots, the row of heat exchange tubes comprising one heat exchange tube or a plurality of heat exchange tubes, wherein
a length of at least one heat exchange tube slot of the plurality of heat exchange tube slots of the first column of heat exchange tube slots of at least one fin of the plurality of fins in the third direction is greater than or substantially equal to a heat exchange tube size of the row of heat exchange tubes inserted in the at least one heat exchange tube slot in the third direction, in the case that the row of heat exchange tubes com-

prises the one heat exchange tube, the heat exchange tube size is a size of the one heat exchange tube in the third direction, and in the case that the row of heat exchange tubes comprises the plurality of heat exchange tubes, the heat exchange tube size is a sum of sizes of the plurality of heat exchange tubes in the third direction; and/or

a length of at least one heat exchange tube slot of the plurality of heat exchange tube slots of the second column of heat exchange tube slots of the at least one fin of the plurality of fins in the third direction is greater than or substantially equal to the heat exchange tube size of the row of heat exchange tubes inserted in the at least one heat exchange tube slot in the third direction.

24. The heat exchanger according to claim 4, wherein the heat exchange tubes of the rows of heat exchange tubes provided in the heat exchange tube slots of the plurality of columns of heat exchange tube slots of the plurality of fins comprise a plurality of columns of heat exchange tubes arranged in the third direction, each column of heat exchange tubes of the plurality of columns of heat exchange tubes comprising a plurality of heat exchange tubes arranged in the first direction.

25. The heat exchanger according to claim 24, wherein

the heat exchange tube of the plurality of columns of heat exchange tubes comprises a first end positioned on one side of the heat exchange tube in the second direction and a second end positioned on the other side of the heat exchange tube in the second direction; and

the heat exchanger further comprises: a first header connected and fluidly communicated with the first ends of the heat exchange tubes; and a second header connected and fluidly communicated with the second ends of the heat exchange tubes.

26. The heat exchanger according to claim 24, wherein

the heat exchange tube of the plurality of columns of heat exchange tubes comprises a first end positioned on one side of the heat exchange tube in the second direction and a second end positioned on the other side of the heat exchange tube in the second direction; and

the heat exchanger further comprises: a first header connected and fluidly communicated with the first ends of the heat exchange tubes of the plurality columns of heat exchange tubes; and two second headers, one of the two second headers being connected and fluidly communicated with the second ends of the heat exchange tubes of at least one column of heat exchange tubes of the plurality of columns of heat exchange tubes, and the other of the two second headers being connected and fluidly communicated with the second ends of the heat exchange tubes of at least another column of heat exchange tubes of the plurality of columns of heat exchange tubes.

27. The heat exchanger according to claim 24, wherein

the heat exchange tube of the plurality of columns of heat exchange tubes comprises a first end positioned on one side of the heat exchange tube in the second direction and a second end positioned on the other side of the heat exchange tube in the second direction; and

the heat exchanger further comprises: a connection portion, by which the first ends of the heat exchange tubes of one column of heat exchange tubes of the plurality columns of heat exchange tubes and the first ends of the heat exchange tubes of another column of heat exchange tubes of the plurality columns of heat exchange tubes are connected and fluidly communicated with each other; and two second headers, one of the two second headers being connected and fluidly communicated with the second ends of the heat exchange tubes of the one column of heat exchange tubes, and the other of the two second headers being connected and fluidly communicated with the second ends of the heat exchange tubes of the another column of heat exchange tubes.

28. The heat exchanger according to claim 27, wherein the connection portion comprises a plurality of connection tubes, by which the first ends of the heat exchange tubes of the one column of heat exchange tubes are connected and fluidly communicated with the first ends of the heat exchange tubes of the another column of heat exchange tubes of the plurality of connection tubes, respectively.

29. The heat exchanger according to claim 28, wherein the heat exchange tube of the one column of heat exchange tubes, the connection tube, and the heat exchange tube of the another column of heat exchange tubes, which are connected with each other, are formed by bending one tube.

30. The heat exchanger according to claim 24, wherein

the heat exchange tube of the plurality of columns of heat exchange tubes comprises a first end positioned on one side of the heat exchange tube in the second direction and a second end

positioned on the other side of the heat exchange tube in the second direction; and
the heat exchanger further comprises: two first headers and two second headers, one of the two first headers and one of the two second headers being connected and fluidly communicated with the first ends and the second ends of the heat exchange tubes of at least one column of heat exchange tubes of the plurality of columns of heat exchange tubes, respectively, and the other of the two first headers and the other of the two second headers being connected and fluidly communicated with the first ends and the second ends of the heat exchange tubes of at least another column of heat exchange tubes of the plurality of columns of heat exchange tubes, respectively.

31. An air conditioning system comprising:
the heat exchanger according to any one of claims 1 to 30.

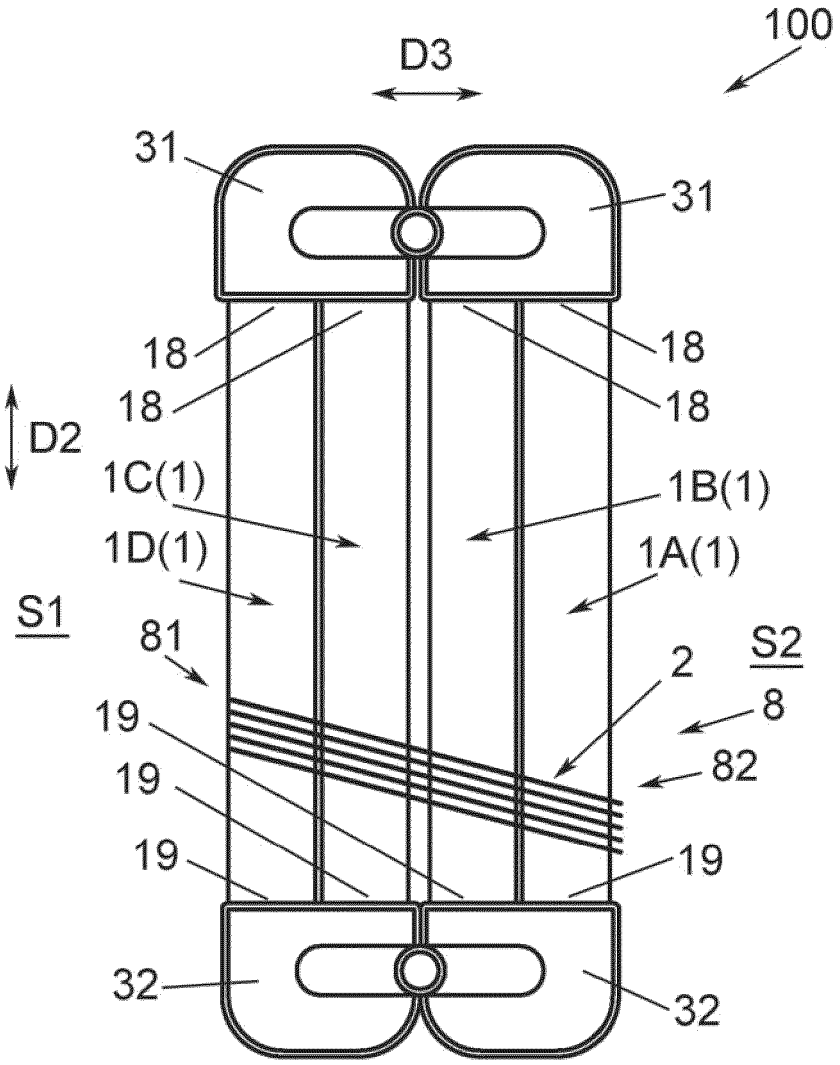

100
D3
31
31
18
18
18
18
D2
1C(1)
1B(1)
1D(1)
1A(1)
S1
81
S2
2
8
82
19
19
19
19
32
32

Fig. 1

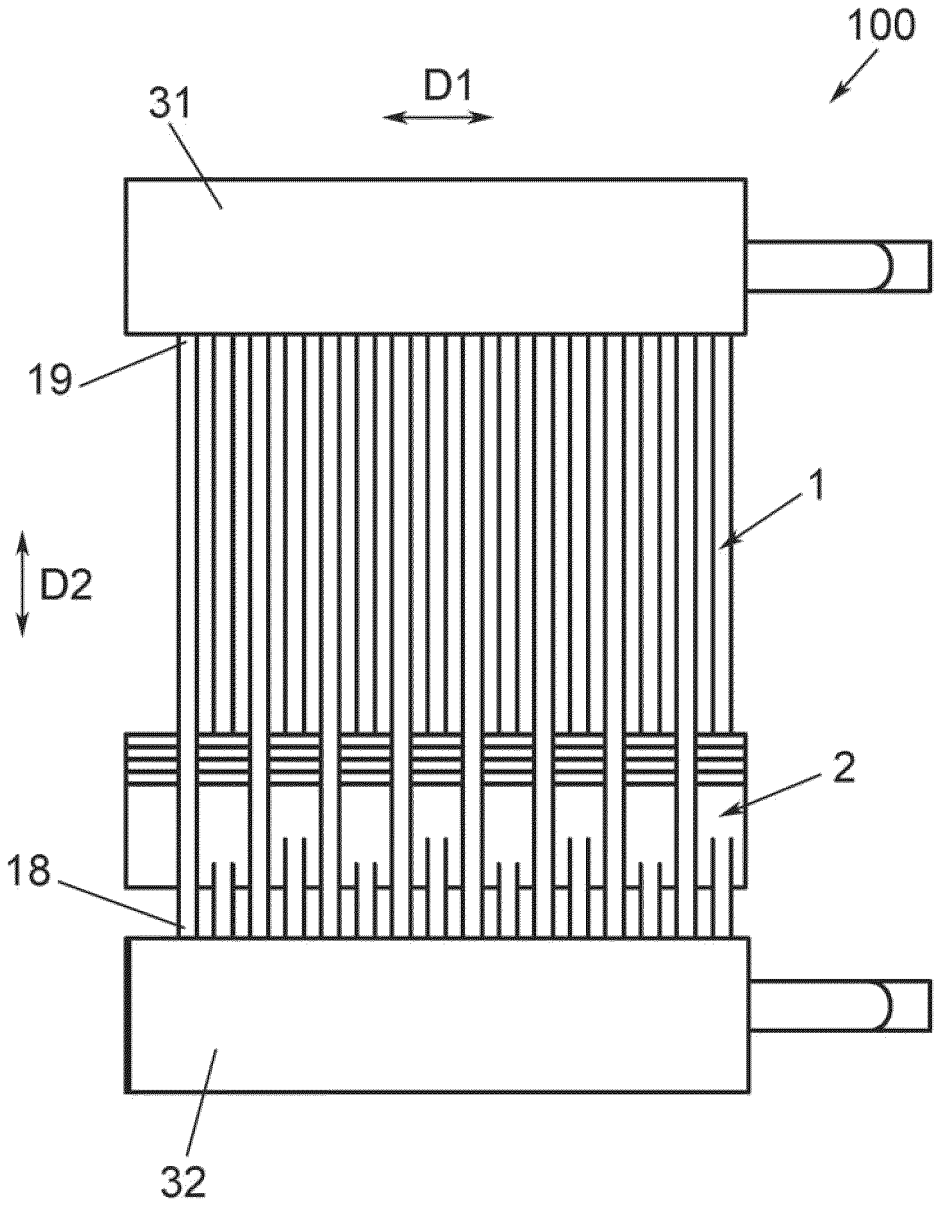


Fig. 2

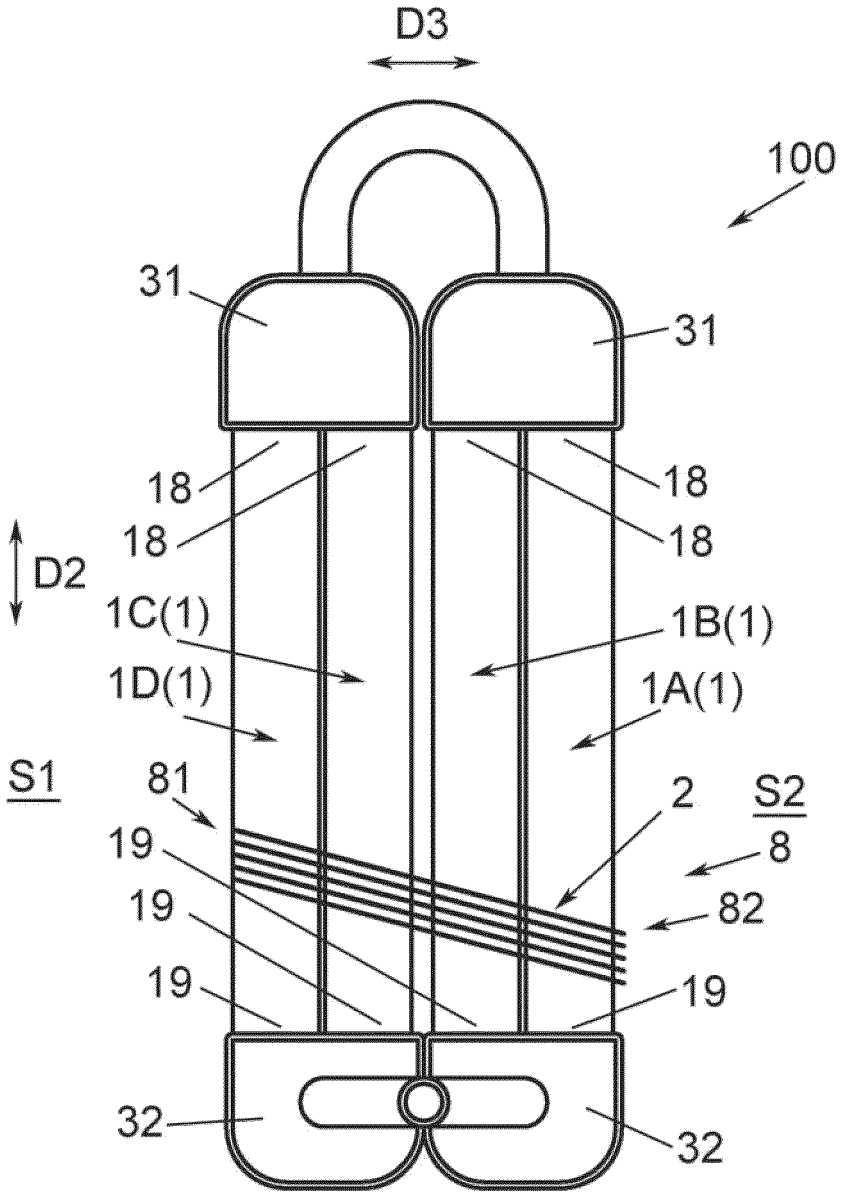

D3
100
31
31
18
18
18
18
D2
1C(1)
1B(1)
1D(1)
1A(1)
S1
81
2
S2
8
19
19
82
19
19
32
32

Fig. 3

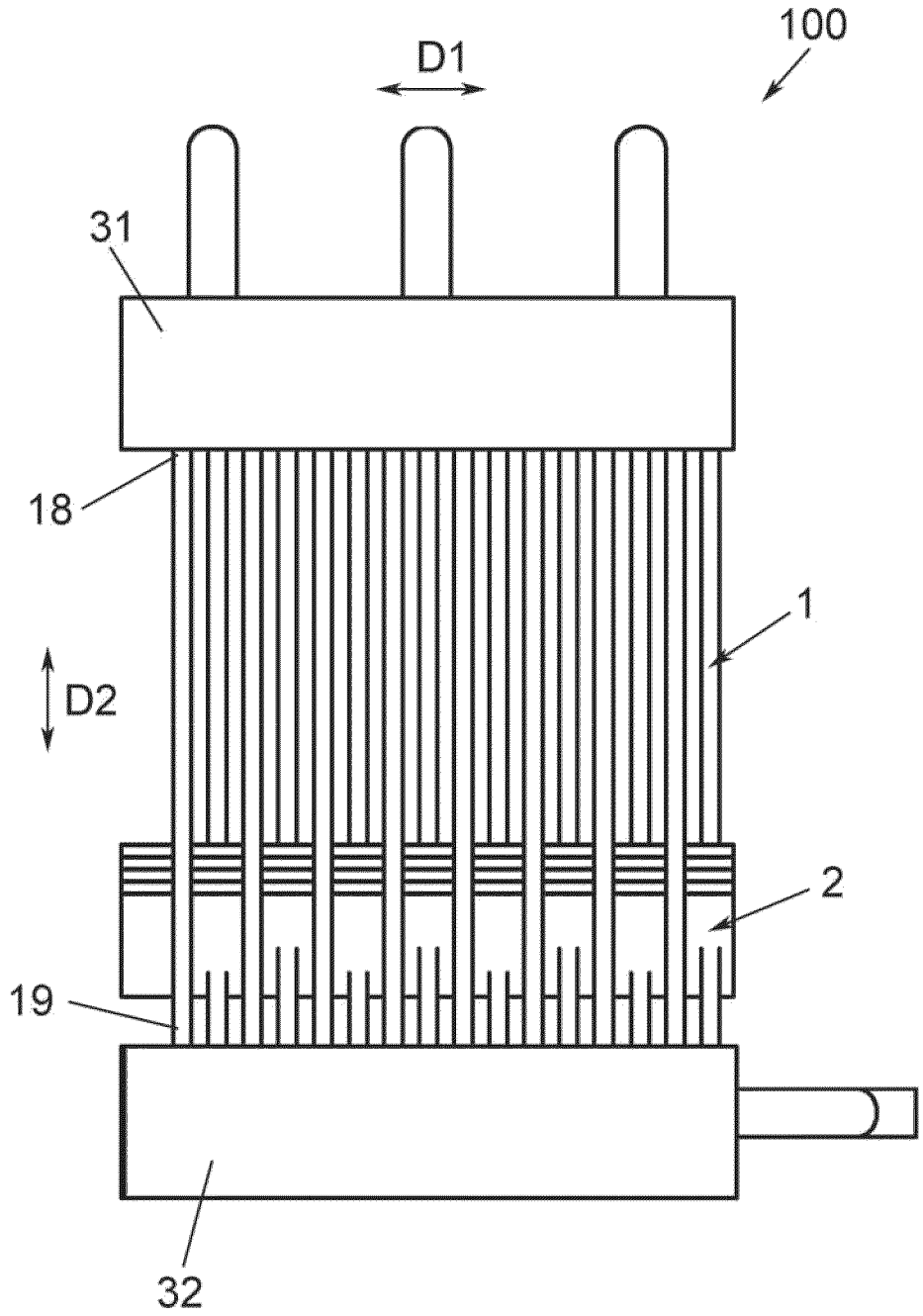


Fig. 4

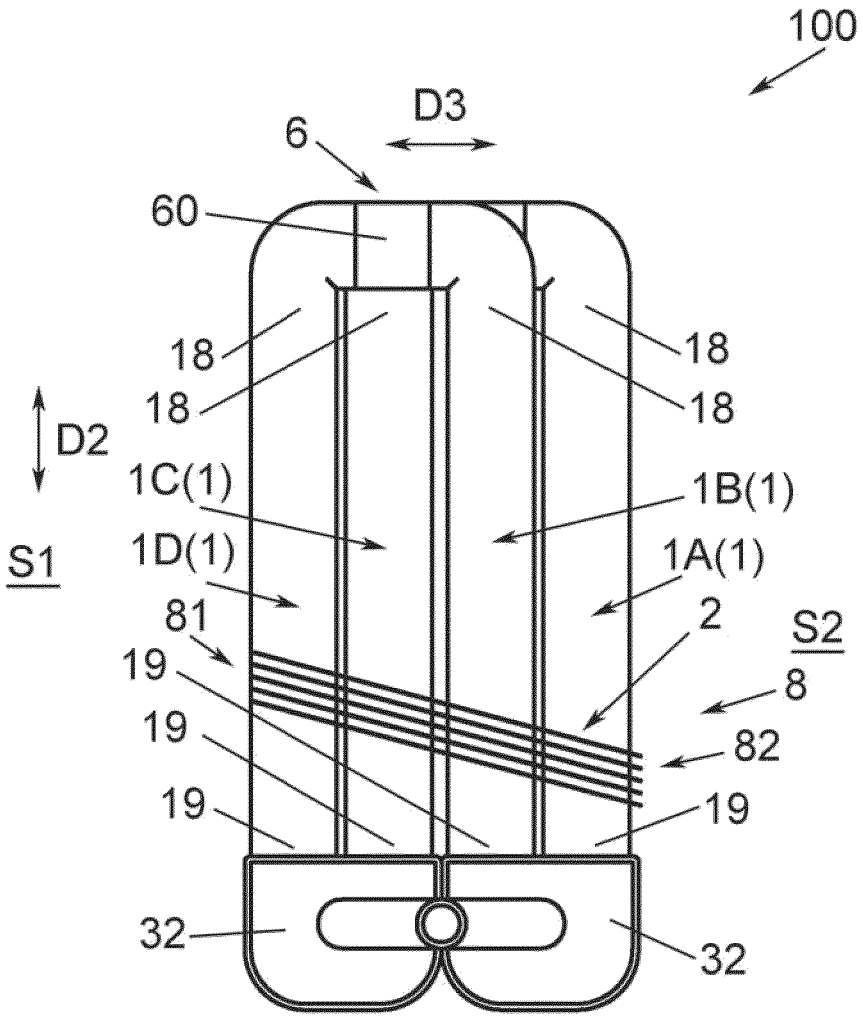

100
D3
6
60
18
18
18
18
D2
1C(1)
1B(1)
S1
1D(1)
1A(1)
81
2
S2
19
8
19
82
19
19
32
32

Fig. 5

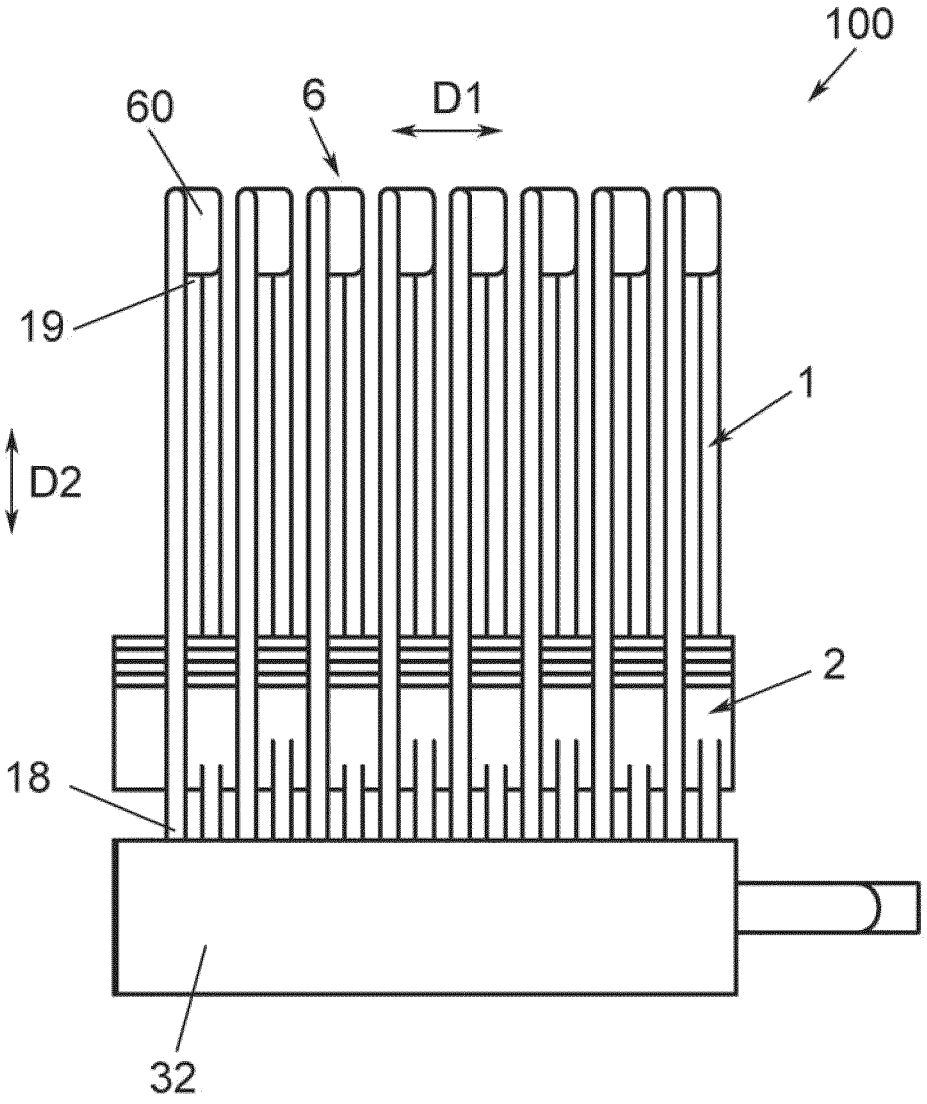


Fig. 6

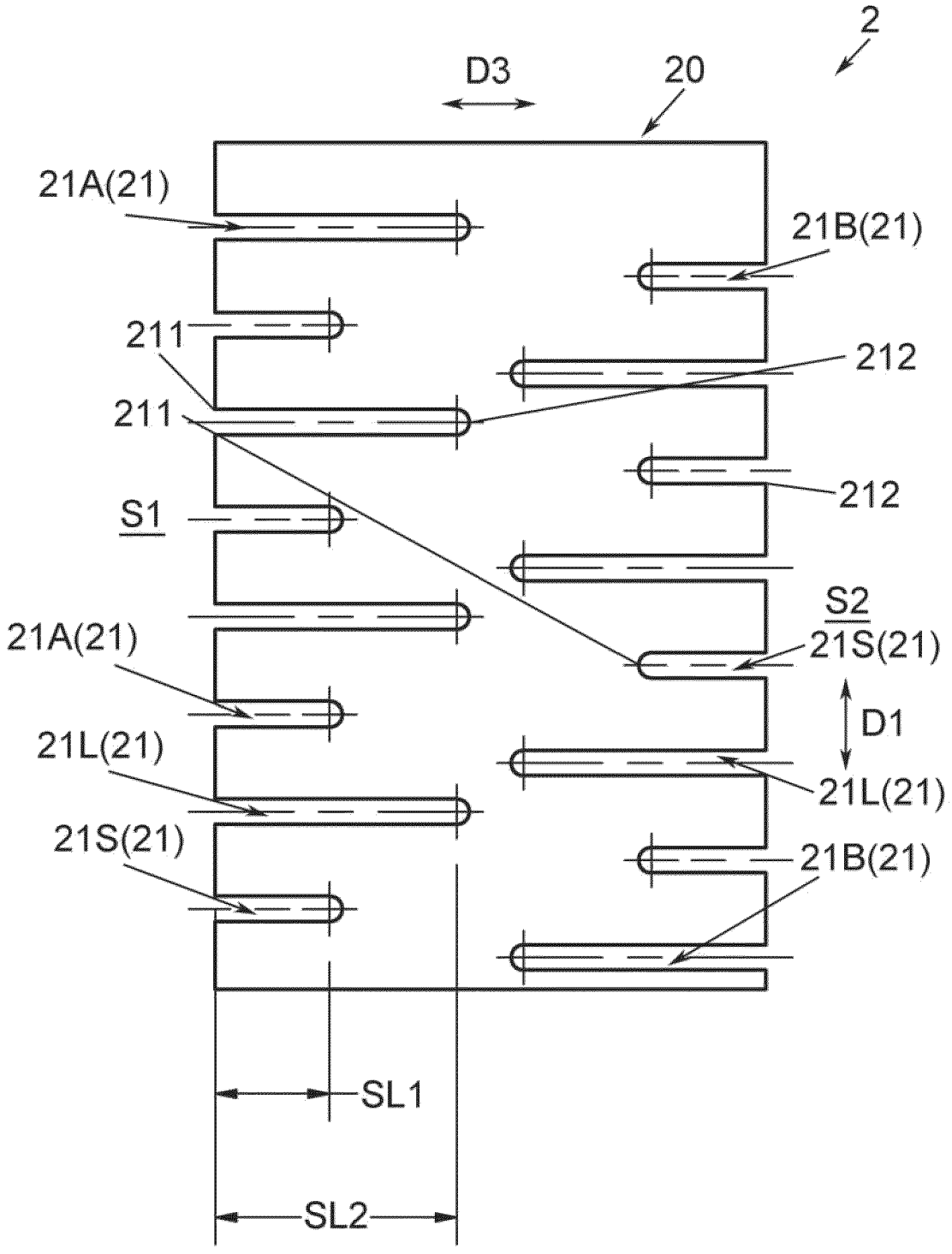

2
D3
20
21A(21)
21B(21)
211
212
211
212
S1
S2
21A(21)
21S(21)
D1
21L(21)
21L(21)
21S(21)
21B(21)
SL1
SL2

Fig. 7

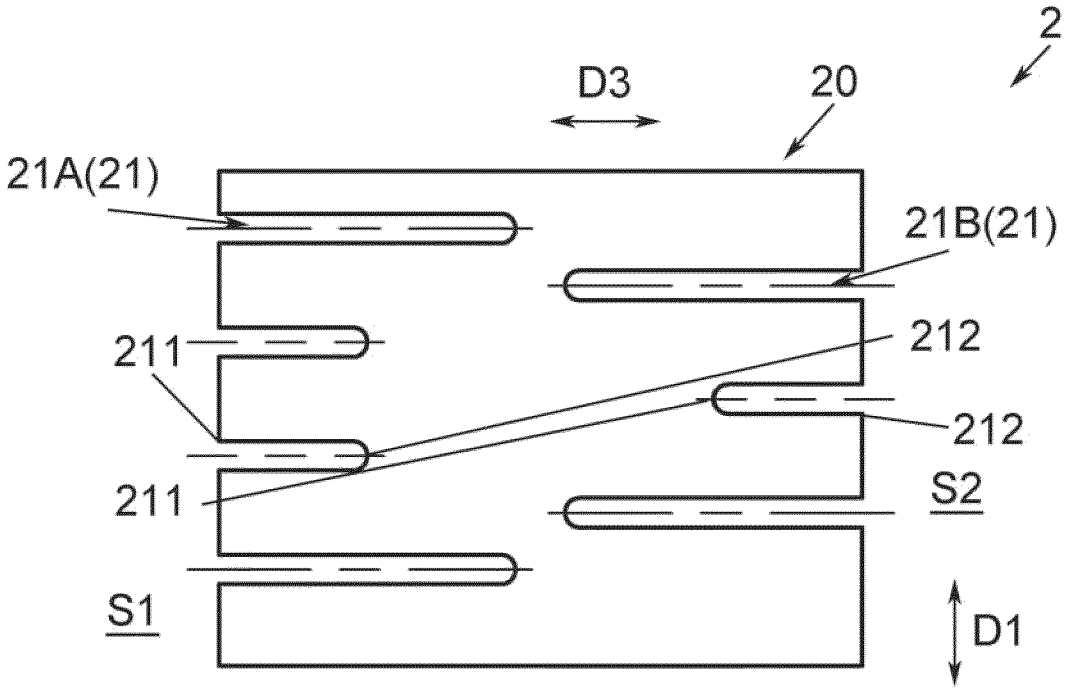


Fig. 8

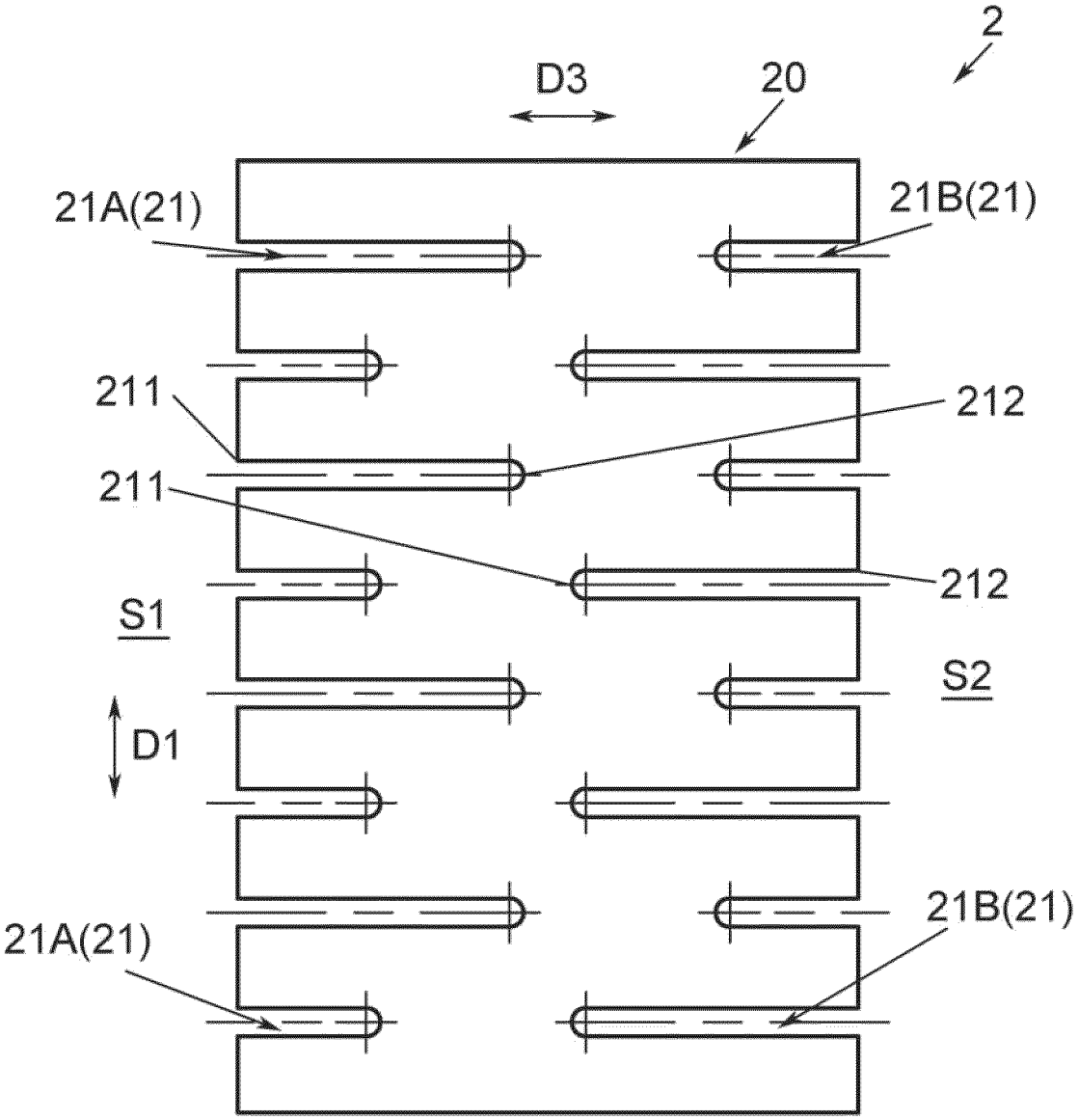


Fig. 9

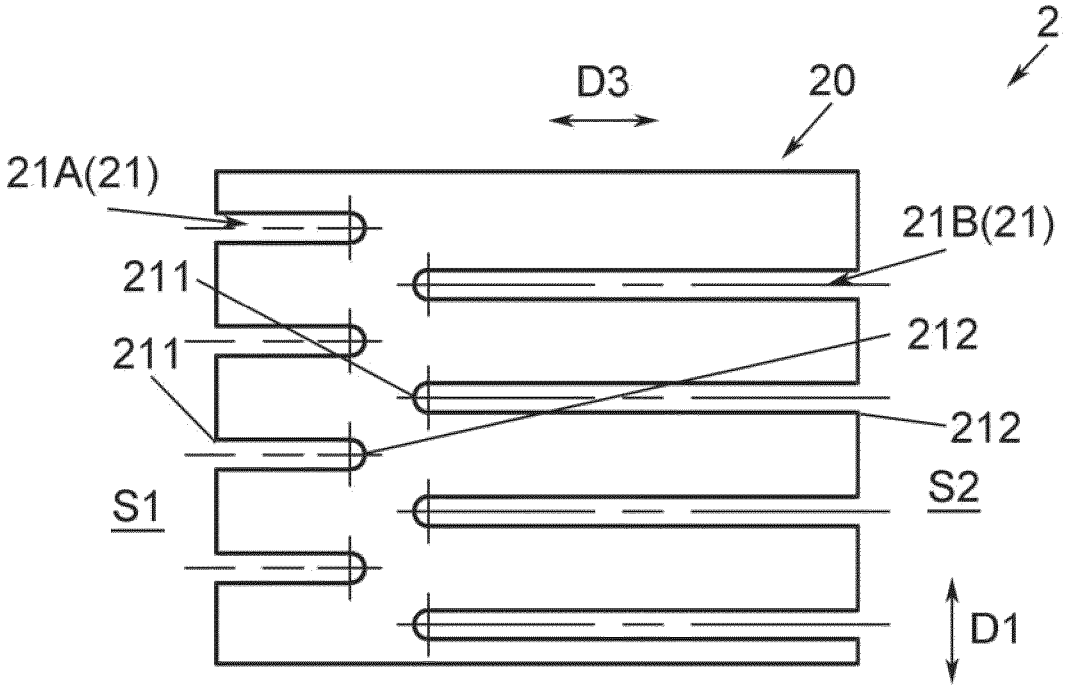


Fig. 10

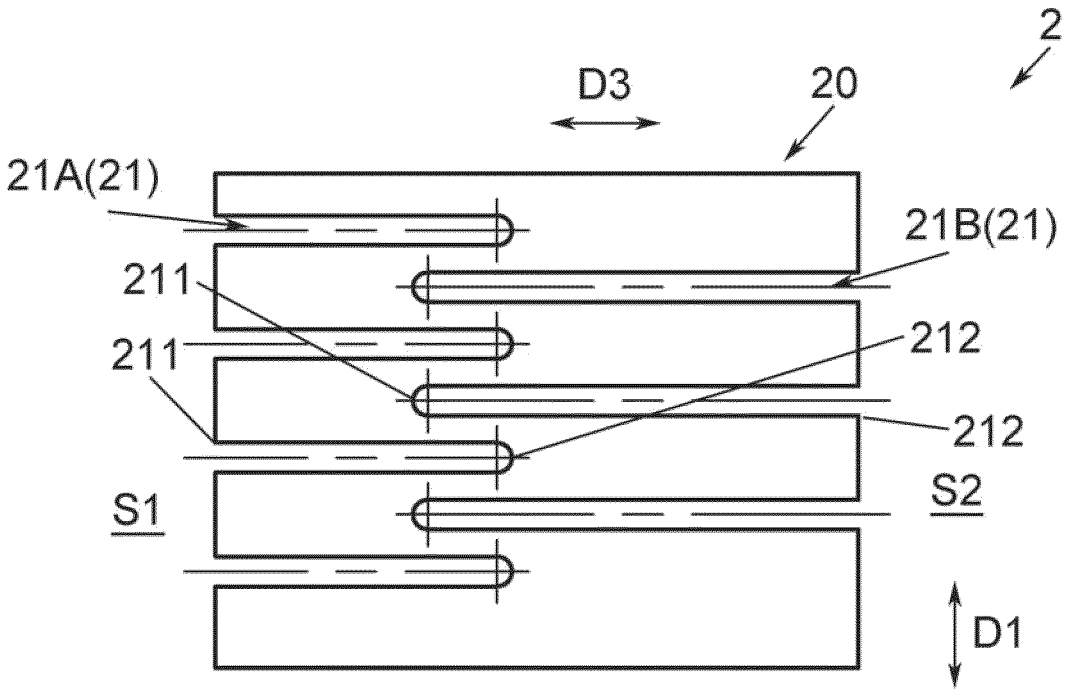


Fig. 11

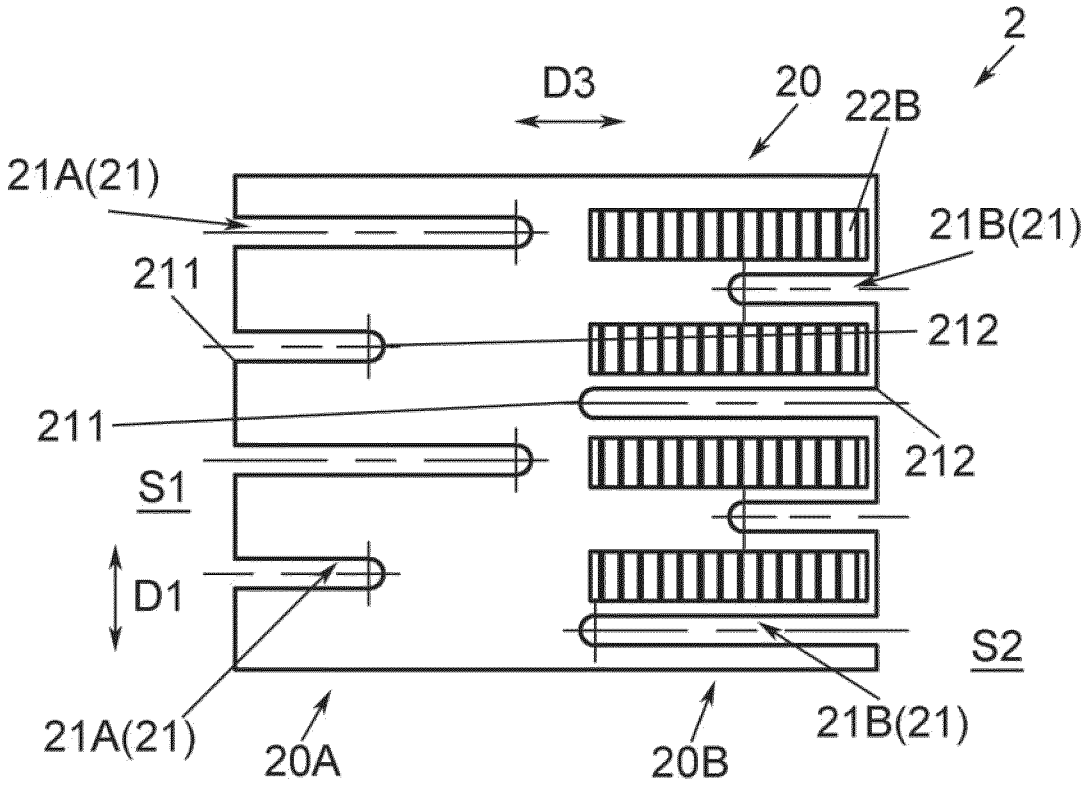

2
D3
20
22B
21A(21)
21B(21)
211
212
211
212
S1
D1
S2
21A(21)
20A
20B
21B(21)

Fig. 12

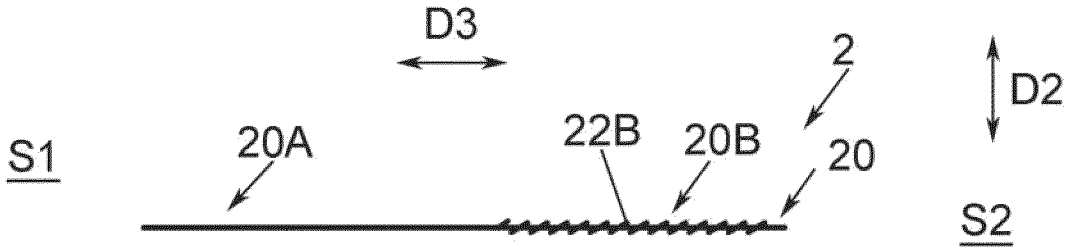

D3
2
D2
S1
20A
22B
20B
20
S2

Fig. 13

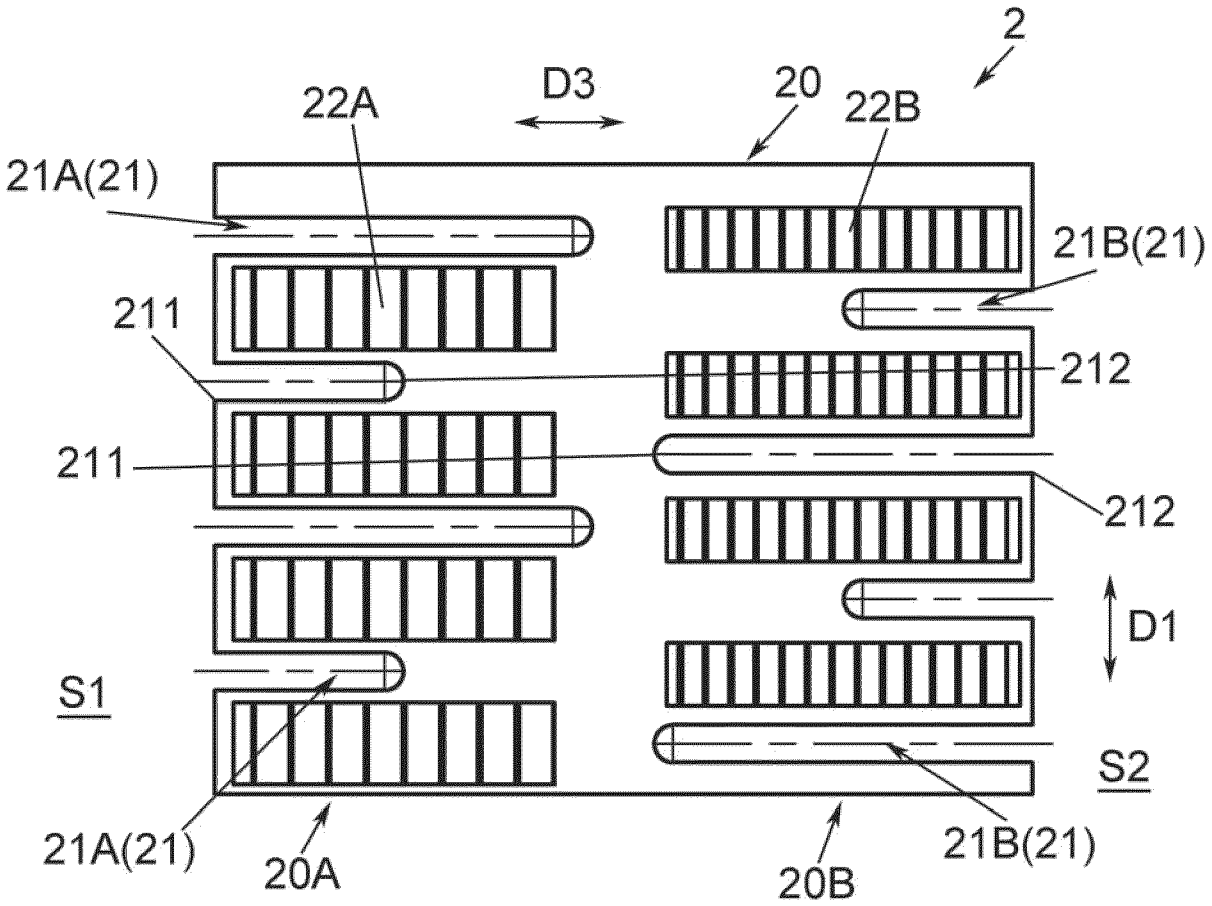

2
D3
22A
20
22B
21A(21)
21B(21)
211
212
211
212
D1
S1
S2
21A(21)
20A
20B
21B(21)

Fig. 14

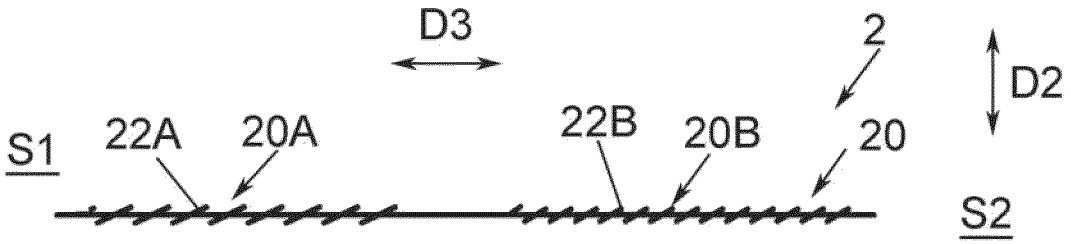

D3
2
D2
S1
22A
20A
22B
20B
20
S2

Fig. 15

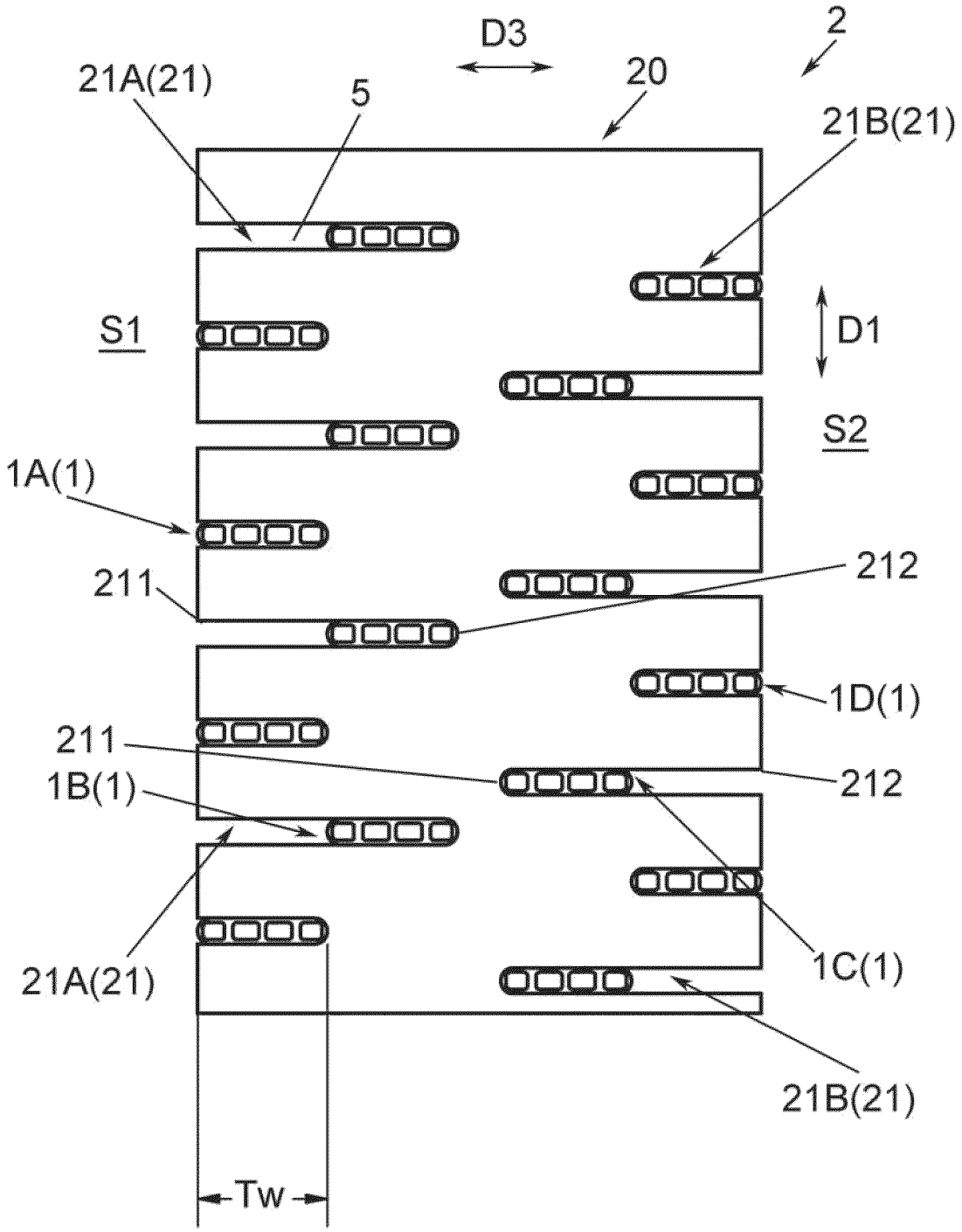

D3
2
21A(21)
5
20
21B(21)
S1
D1
S2
1A(1)
211
212
1D(1)
211
212
1B(1)
1C(1)
21A(21)
21B(21)
Tw

Fig. 16

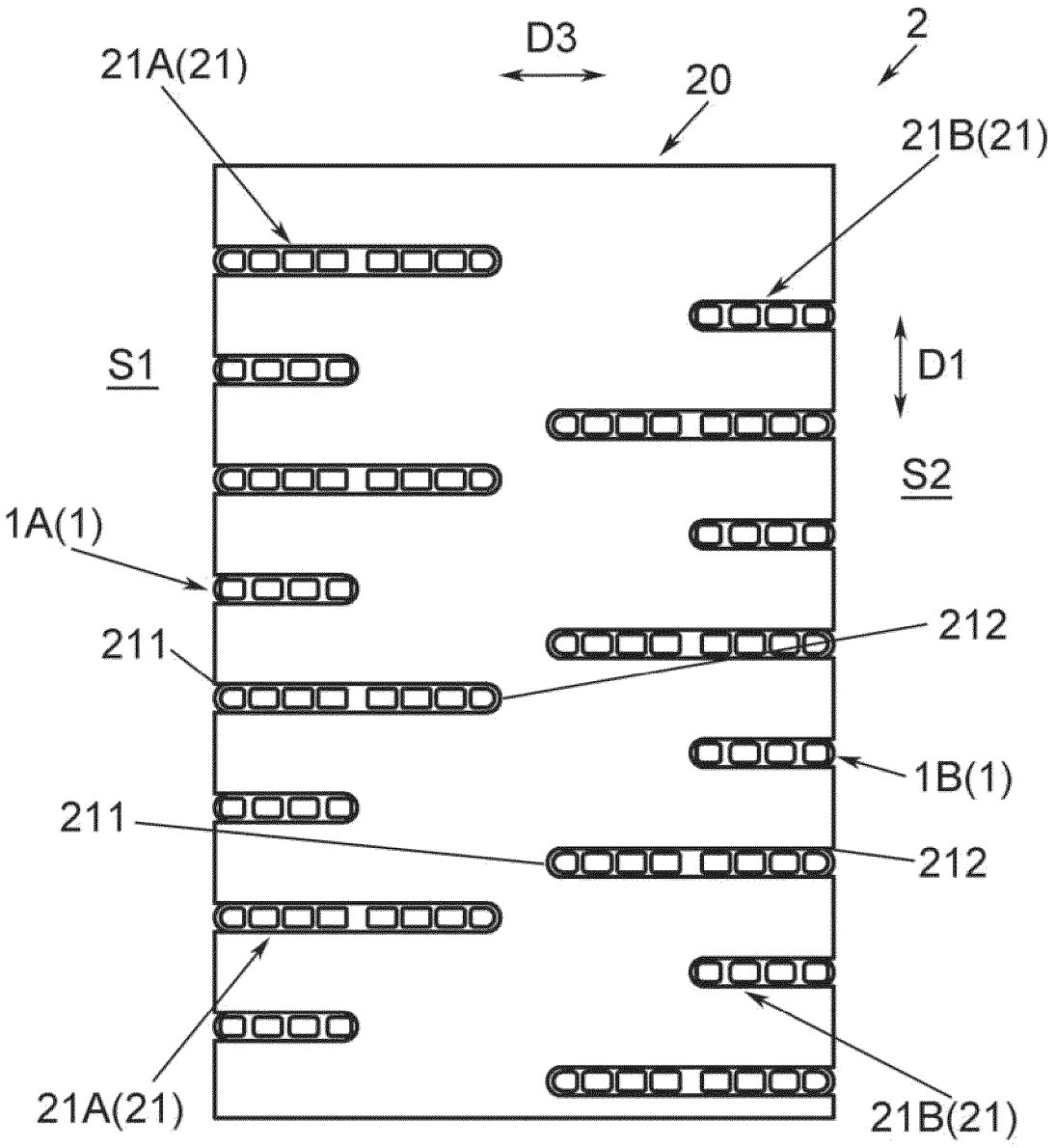
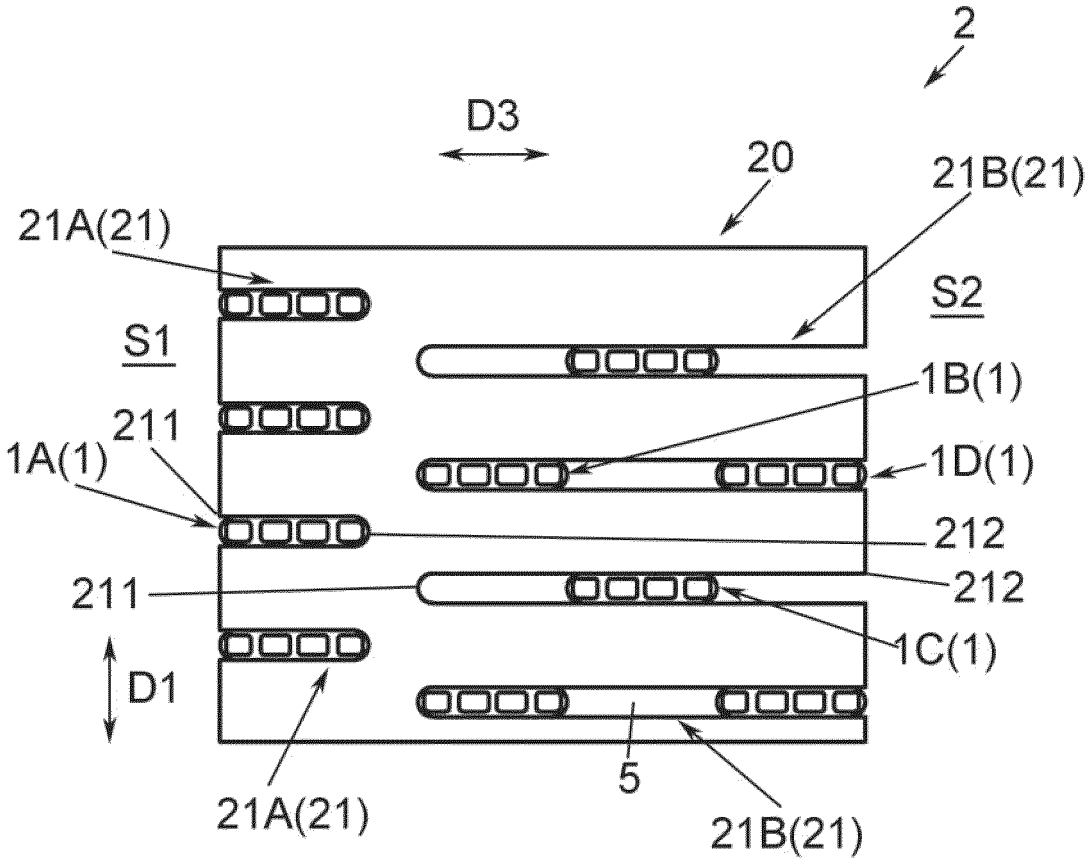


Fig. 17


2
D3
20
21B(21)
21A(21)
S2
S1
1B(1)
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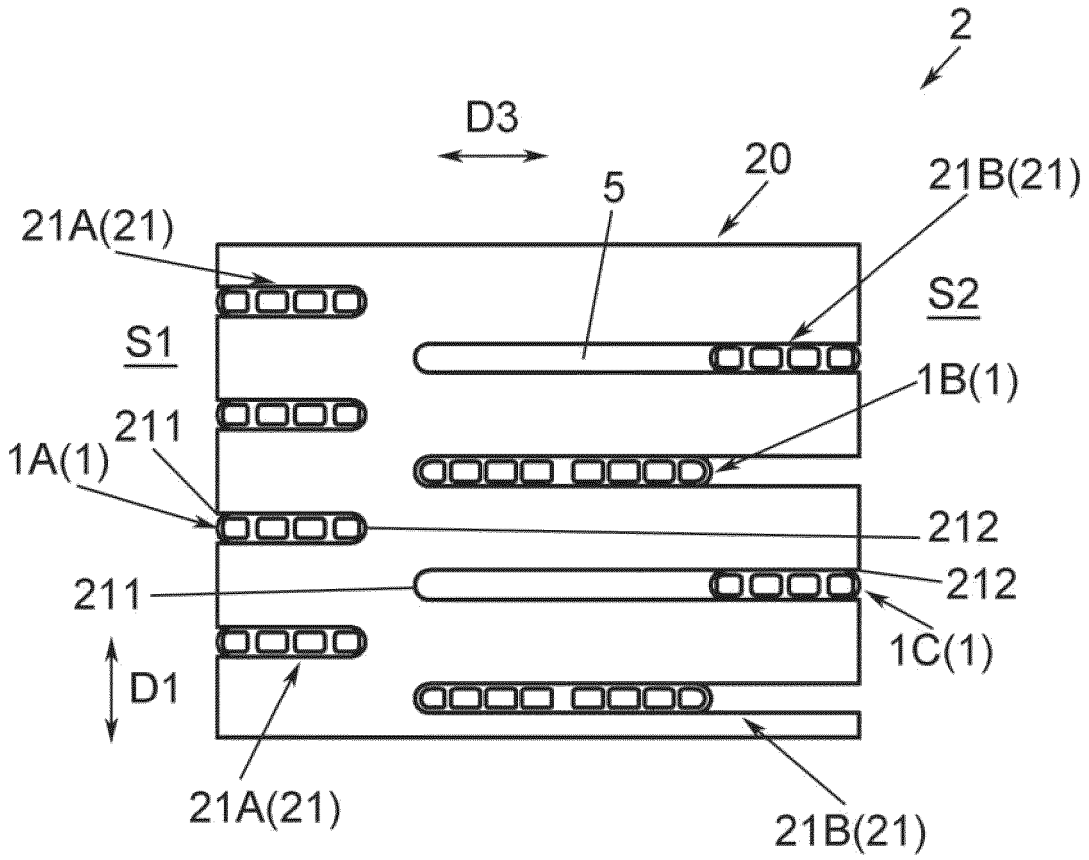
1D(1)
212
211
212
1C(1)
D1
5
21A(21)
21B(21)

Fig. 18


2
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21A(21)
S2
S1
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1A(1)
212
212
211
1C(1)
D1
21A(21)
21B(21)

Fig. 19

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Place of search	Date of completion of the search	Examiner
Munich	24 January 2025	Vassoille, Bruno

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