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(54) **HEAT EXCHANGER, BENT HEAT EXCHANGER AND AIR CONDITIONING SYSTEM**

(57) The present invention discloses a heat exchanger, a bent heat exchanger formed by bending the heat exchanger, and an air conditioning system having the heat exchanger or the bent heat exchanger. The heat exchanger includes: a plurality of rows of heat exchange tubes arranged in a first direction; and a plurality of fins arranged in a second direction perpendicular to the first direction. Each of the plurality of fins includes a fin body and a plurality of heat exchange tube slots formed in the fin body, one or more heat exchange tubes of each row of heat exchange tubes of the plurality of rows of heat exchange tubes being inserted into one heat exchange tube slot of the plurality of heat exchange tube slots; and a length of at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least one fin of the plurality of fins in a third direction perpendicular to the first direction and the second direction is greater than a heat exchange tube size of the row of heat exchange tubes inserted into the at least one heat exchange tube slot in the third direction to form a gap for passage of water in the at least one heat exchange tube slot, thereby improving the performance of the heat exchanger, bent heat exchanger and air conditioning system.

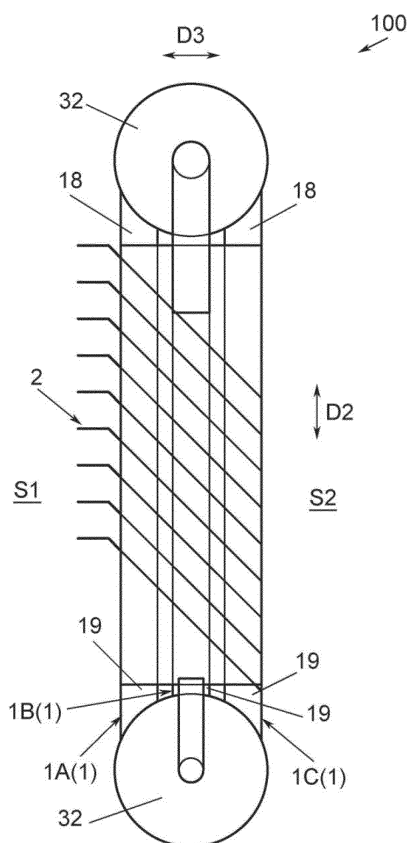


Fig. 15

Description**TECHNICAL FIELD**

- 5 **[0001]** Embodiments of the present invention relate to a heat exchanger, a bent heat exchanger formed by bending the heat exchanger, and an air conditioning system having the heat exchanger or the bent heat exchanger.

BACKGROUND

- 10 **[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

- 15 **[0003]** An object of embodiments of the present invention is to provide a heat exchanger, a bent heat exchanger formed by bending the heat exchanger, and an air conditioning system having the heat exchanger or the bent heat exchanger, thereby, for example, improving the performance of the heat exchanger, the bent heat exchanger and the air conditioning system.
- 20 **[0004]** Embodiments of the present invention provide a heat exchanger including: a heat exchanger a plurality of rows of heat exchange tubes arranged in a first direction, each row of heat exchange tubes includes one heat exchange tube or a plurality of heat exchange tubes; and a plurality of fins arranged in a second direction perpendicular to the first direction, wherein each of the plurality of fins includes a fin body and a plurality of heat exchange tube slots formed in the fin body, the one heat exchange tube of each row of heat exchange tubes of the plurality of rows of heat exchange tubes being inserted
- 25 into one heat exchange tube slot of the plurality of heat exchange tube slots, or, the plurality of heat exchange tubes of each row of heat exchange tubes of the plurality of rows of heat exchange tubes being inserted into one heat exchange tube slot of the plurality of heat exchange tube slots; and a length of at least one heat exchange tube slot, in a third direction perpendicular to the first direction and the second direction, of the plurality of heat exchange tube slots of at least one fin of the plurality of fins is greater than a heat exchange tube size of the row of heat exchange tubes inserted into the at least one
- 30 heat exchange tube slot in the third direction to form a gap for passage of water in the at least one heat exchange tube slot, 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.
- 35 **[0005]** According to embodiments of the present invention, the fins and the heat exchange tubes of the heat exchanger satisfy the following relationship of:

$$40 \frac{(W_f \times L_f - \sum W_{si} T_{si}) \times (P_f - T_f)}{[\sum W_{si} T_{si} - \sum (T_{si} \times \sum W_{tij})] \times P_f} \leq R$$

- where, W_f is a width of the fin in the third direction, L_f is a length of the fin in the first direction, W_{si} is a length of the i^{th} heat exchange tube slot from one side to the other side of the heat exchanger in the first direction, T_{si} is a width of an i^{th} heat exchange tube slot from one side to the other side of the heat exchanger in the first direction, P_f is a spacing between adjacent fins, T_f is a thickness of the fin body of the fin, W_{tij} is a size of a j^{th} heat exchange tube, of the row of heat exchange tubes in the i^{th} heat exchange tube slot, from one side to the other side of the heat exchanger in the first direction from a first side to a second side of the heat exchanger in the third direction; when the row of heat exchange tubes includes the one heat exchange tube, $j=1$, and R is a predetermined value.

- 50 **[0006]** According to embodiments of the present invention, the predetermined value R is equal to 150.

- [0007]** According to embodiments of the present invention, at least one row of heat exchange tubes includes the plurality of heat exchange tubes, and there is a gap between at least two adjacent heat exchange tubes of the plurality of heat exchange tubes.

- 55 **[0008]** According to embodiments of the present invention, the heat exchange tube includes a first tube edge and a second tube edge, the first tube edge and the second tube edge of the heat exchange tube being respectively positioned on the outermost sides of the heat exchange tube in the third direction, and the heat exchanger has a first side and a second side opposite to each other in the third direction, the first tube edge of the heat exchange tube being closer to the first side of the heat exchanger than the second tube edge of the heat exchange tube in the third direction; the heat exchange tube slot

of the fin has a first slot edge and a second slot edge, the first slot edge and the second slot edge of the heat exchange tube slot of the fin 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 than the second slot edge of the heat exchange tube slot of the fin in the third direction; and there is a gap in the third direction between the first slot edge of at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least one fin of the plurality of fins and the first tube edge of the one heat exchange tube of the row of heat exchange tubes inserted into the at least one heat exchange tube slot, or, there is a gap in the third direction between the first slot edge of the at least one heat exchange tube slot of the plurality of heat exchange tube slots of the at least one fin of the plurality of fins and the first tube edge of one heat exchange tube, of the plurality of heat exchange tubes closest to the first slot edge, of the row of heat exchange tubes inserted into the at least one heat exchange tube slot; and/or there is a gap in the third direction between the second slot edge of the at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least one fin of the plurality of fins and the second tube edge of the one heat exchange tube of the row of heat exchange tubes inserted into the at least one heat exchange tube slot, or, there is a gap in the third direction between the second slot edge of the at least one heat exchange tube slot of the plurality of heat exchange tube slots of the at least one fin of the plurality of fins and the second tube edge of one heat exchange tube, of the plurality of heat exchange tubes closest to the second slot edge, of the row of heat exchange tubes inserted into the at least one heat exchange tube slot.

[0009] According to embodiments of the present invention, at least in the middle of the gap in the third direction, a size of the gap in the first direction is equal to a width of the heat exchange tube slot; and/or, a size of the gap in at least one heat exchange tube slot of the plurality of heat exchange tube slots in the third direction is greater than or equal to that of the one heat exchange tube of the row of heat exchange tubes in the at least one heat exchange tube slot in the third direction, or, the size of the gap in the at least one heat exchange tube slot of the plurality of heat exchange tube slots in the third direction is greater than or equal to that of one heat exchange tube of the plurality of heat exchange tubes of the row of heat exchange tubes in the at least one heat exchange tube slot in the third direction.

[0010] According to embodiments of the present invention, the heat exchange tube includes a first tube edge and a second tube edge, the first tube edge and the second tube edge of the heat exchange tube being respectively positioned on the outermost sides of the heat exchange tube in the third direction, and the heat exchanger has a first side and a second side opposite to each other in the third direction, the first tube edge of the heat exchange tube being closer to the first side of the heat exchanger than the second tube edge of the heat exchange tube in the third direction; the heat exchange tube slot of the fin has a first slot edge and a second slot edge, the first slot edge and the second slot edge of the heat exchange tube slot of the fin 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 than the second slot edge of the heat exchange tube slot of the fin in the third direction; and the heat exchange tubes of the plurality of rows of heat exchange tubes 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.

[0011] According to embodiments of the present invention, orthogonal projections of the heat exchange tubes of two adjacent rows of heat exchange tubes in a plane perpendicular to the first direction are separated from each other in the third direction.

[0012] According to embodiments of the present invention, the heat exchange tubes of two adjacent rows of heat exchange tubes are displaced from each other in the third direction.

[0013] According to embodiments of the present invention, a plurality of gaps for the drainage of water are formed between at least some heat exchange tube slots of at least some fins of the plurality of fins and the heat exchange tubes of the rows of heat exchange tubes inserted into the at least some heat exchange tube slots, the plurality of gaps including a plurality of columns of gaps arranged in the third direction, each column of gaps of the plurality of columns of gaps including a plurality of gaps arranged in the first direction.

[0014] According to embodiments of the present invention, the gaps in at least two adjacent heat exchange tube slots are displaced from each other in the third direction.

[0015] According to embodiments of the present invention, the plurality of columns of heat exchange tubes are arranged sequentially from the first side to the second side of the heat exchanger in the third direction; and there are gaps between the first slot edges of the heat exchange tube slots and the first tube edges of the heat exchange tubes of a second column of heat exchange tubes of the plurality of columns of heat exchange tubes inserted into the heat exchange tube slots in the third direction.

[0016] According to embodiments of the present invention, the first slot edges of the heat exchange tube slots and the first tube edges of the heat exchange tubes of a first column of heat exchange tubes of the plurality of columns of heat exchange tubes inserted into the heat exchange tube slots are substantially aligned with each other in the third direction.

[0017] According to embodiments of the present invention, the plurality of columns of heat exchange tubes are arranged sequentially from the second side to the first side of the heat exchanger in the third direction; and there are gaps between the second slot edges of the heat exchange tube slots and the second tube edges of the heat exchange tubes of a second

column of heat exchange tubes of the plurality of columns of heat exchange tubes inserted into the heat exchange tube slots in the third direction.

[0018] According to embodiments of the present invention, the second slot edges of the heat exchange tube slots and the second tube edges of the heat exchange tubes of a first column of heat exchange tubes of the plurality of columns of heat exchange tubes inserted into the heat exchange tube slots are substantially aligned with in the third direction.

[0019] According to embodiments of the present invention, the plurality of columns of heat exchange tubes are arranged sequentially from the first side to the second side of the heat exchanger in the third direction; and the first slot edges of some heat exchange tube slots, into which the heat exchange tubes of the second column of heat exchange tubes of the plurality of columns of heat exchange tubes are inserted, are closer to the second side of the heat exchanger than the first slot edges of some other heat exchange tube slots, into which the heat exchange tubes of the first column of heat exchange tubes of the plurality of columns of heat exchange tubes are inserted.

[0020] According to embodiments of the present invention, the plurality of columns of gaps are arranged sequentially from the second side to the first side of the heat exchanger in the third direction; the gaps of odd numbered columns of gaps of the plurality of columns of gaps are formed in some heat exchange tube slots of the plurality of heat exchange tube slots, and the gaps of even numbered columns of gaps of the plurality of columns of gaps are formed in some other heat exchange tube slots of the plurality of heat exchange tube slots; and the some heat exchange tube slots and the some other heat exchange tube slots are arranged alternately in the first direction.

[0021] According to embodiments of the present invention, the heat exchange tubes of odd numbered columns of heat exchange tubes of the plurality of columns of heat exchange tubes are provided in some heat exchange tube slots of the plurality of heat exchange tube slots, and the heat exchange tubes of even numbered columns of heat exchange tubes of the plurality of columns of heat exchange tubes are formed in some other heat exchange tube slots of the plurality of heat exchange tube slots; and the some heat exchange tube slots and the some other heat exchange tube slots are arranged alternately in the first direction.

[0022] According to embodiments of the present invention, the first tube edges of the heat exchange tubes of at least one column of heat exchange tubes of the plurality of columns of heat exchange tubes are substantially aligned with each other in the third direction, and/or the second tube edges of the heat exchange tubes of the at least one column of heat exchange tubes of the plurality of columns of heat exchange tubes are substantially aligned with each other in the third direction.

[0023] According to embodiments of the present invention, the heat exchange tubes of at least one column of heat exchange tubes of the plurality of columns of heat exchange tubes have substantially the same size in the third direction.

[0024] According to embodiments of the present invention, the heat exchange tube includes a first tube edge and a second tube edge, the first tube edge and the second tube edge of the heat exchange tube being respectively positioned on the outermost sides of the heat exchange tube in the third direction, and the heat exchanger has a first side and a second side opposite to each other in the third direction, the first tube edge of the heat exchange tube being closer to the first side of the heat exchanger than the second tube edge of the heat exchange tube in the third direction; and the first tube edge of the one heat exchange tube (, or the first tube edge 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 and the first tube edge of the one heat exchange tube (, or the first tube edge of at least one heat exchange tube of the plurality of heat exchange tubes,) of at least another row of heat exchange tubes of the plurality of rows of heat exchange tubes are displaced from each other in the third direction; and/or, the second tube edge of the one heat exchange tube (, or the second tube edge of the 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 and the second tube edge of the one heat exchange tube (, or the second tube edge of the at least one heat exchange tube of the plurality of heat exchange tubes,) of the at least another row of heat exchange tubes of the plurality of rows of heat exchange tubes are displaced from each other in the third direction.

[0025] According to embodiments of the present invention, the heat exchange tube slot of the fin has a first slot edge and a second slot edge, the first slot edge and the second slot edge of the heat exchange tube slot of the fin 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 than the second slot edge of the heat exchange tube slot of the fin in the third direction; and the first slot edge of at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least one fin of the plurality of fins and the first slot edge of at least another heat exchange tube slot of the plurality of heat exchange tube slots of the at least one fin of the plurality of fins are displaced from each other in the third direction.

[0026] According to embodiments of the present invention, the second slot edge of the at least one heat exchange tube slot of the plurality of heat exchange tube slots of the at least one fin of the plurality of fins and the second slot edge of the at least another heat exchange tube slot of the plurality of heat exchange tube slots of the at least one fin of the plurality of fins are displaced from each other in the third direction.

[0027] According to embodiments of the present invention, the second slot edge of the at least one heat exchange tube slot of the plurality of heat exchange tube slots of the at least one fin of the plurality of fins and the second slot edge of the at least another heat exchange tube slot of the plurality of heat exchange tube slots of the at least one fin of the plurality of fins

are substantially aligned with each other.

[0028] According to embodiments of the present invention, the first slot edges of the heat exchange tube slots of the plurality of fins are substantially aligned with each other in the third direction, and the second slot edges of the heat exchange tube slots of the plurality of fins are substantially aligned with each other in the third direction.

[0029] According to embodiments of the present invention, the heat exchange tube slots of the plurality of fins have substantially the same size in the third direction.

[0030] According to embodiments of the present invention, the heat exchange tube of the plurality of rows 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 of rows of heat exchange tubes; and a second header connected and fluidly communicated with the second ends of the heat exchange tubes of the plurality of rows of heat exchange tubes.

[0031] According to embodiments of the present invention, the heat exchange tube of the plurality of rows 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 of 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.

[0032] According to embodiments of the present invention, the heat exchange tube of the plurality of rows 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 connecting portion, the first ends of the heat exchange tubes of one column of heat exchange tubes of the plurality of columns of heat exchange tubes being connected and fluidly communicated with the first ends of the heat exchange tubes of another column of heat exchange tubes of the plurality of columns of heat exchange tubes by the connecting portion; 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.

[0033] According to embodiments of the present invention, the connection portion includes a plurality of connection tubes, the first ends of the heat exchange tubes of the one column of heat exchange tubes being connected and fluidly communicated with the first ends of the heat exchange tubes of the another column of heat exchange tubes by the plurality of connection tubes, respectively.

[0034] 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 interconnected, are formed by bending one tube.

[0035] According to embodiments of the present invention, the heat exchange tube of the plurality of rows 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.

[0036] According to embodiments of the present invention, the heat exchange tubes of each column of heat exchange tubes of the plurality of columns of heat exchange tubes and the heat exchange tubes of the adjacent column of heat exchange tubes of the plurality of columns of heat exchange tubes are separated from each other in the third direction.

[0037] According to embodiments of the present invention, when viewed in the first direction, the fin bodies of the plurality of fins are inclined relative to the third direction.

[0038] According to embodiments of the present invention, when viewed in the first direction, an angle between the fin bodies of the plurality of fins and the third direction is less than or equal to 45 degrees.

[0039] According to embodiments of the present invention, the heat exchange tube slot of the fin has a first slot edge and a second slot edge, the first slot edge and the second slot edge of the heat exchange tube slot of the fin 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 than the second slot edge of the heat

exchange tube slot of the fin in the third direction; and each of the plurality of fins further includes: a fin segment extending from an edge of on the fin body on the first side of the heat exchanger in the third direction.

[0040] 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 fin of the plurality of fins have substantially the same size in the third direction, and the heat exchange tubes of the rows of exchange tubes inserted into the at least two heat exchange tube slots have substantially the same size in the third direction.

[0041] 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 fin of the plurality of fins have substantially the same size in the third direction, and the heat exchange tubes of the rows of exchange tubes inserted into the at least two heat exchange tube slots have different sizes in the third direction.

[0042] 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 fin of the plurality of fins have different sizes in the third direction, and the heat exchange tubes of the rows of exchange tubes inserted into the at least two heat exchange tube slots have substantially the same size in the third direction.

[0043] 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 fin of the plurality of fins have different sizes in the third direction, and the heat exchange tubes of the rows of exchange tubes inserted into the at least two heat exchange tube slots have different sizes in the third direction.

[0044] According to embodiments of the present invention, the heat exchange tube slot of the fin has a first slot edge and a second slot edge, the first slot edge and the second slot edge of the heat exchange tube slot of the fin 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 than the second slot edge of the heat exchange tube slot of the fin in the third direction; and the heat exchange tube slot of the plurality of fins has an opening towards the second side of the heat exchanger.

[0045] According to embodiments of the present invention, in use, at least a portion of the heat exchange tube extends substantially vertically.

[0046] According to embodiments of the present invention, each of at least some fins is formed by one plate.

[0047] Embodiments of the present invention further provide a bent heat exchanger, the bent heat exchanger being formed by bending the above-mentioned heat exchanger.

[0048] Embodiments of the present invention further provide an air conditioning system including the above-mentioned heater exchanger or bent heater exchanger.

[0049] With the heat exchanger, the bent heater exchanger and the air conditioning system having the heat exchanger or the bent heater exchanger according to the embodiments of the present invention, for example, the performance of the heat exchanger, the bent heater exchanger and the air conditioning system may be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0050]

Fig. 1 is a schematic perspective view of a heat exchanger according to an embodiment of the present invention;
 Fig. 2 is a schematic front view of the heat exchanger shown in Fig. 1;
 Fig. 3 is a schematic right view of the heat exchanger shown in Fig. 1;
 Fig. 4 is a schematic left view of the heat exchanger shown in Fig. 1;
 Fig. 5 is a schematic perspective view of a heat exchanger according to an embodiment of the present invention;
 Fig. 6 is a schematic front view of the heat exchanger shown in Fig. 5;
 Fig. 7 is a schematic right view of the heat exchanger shown in Fig. 5;
 Fig. 8 is a schematic left view of the heat exchanger shown in Fig. 5;
 Fig. 9 is a schematic perspective view of a heat exchanger according to an embodiment of the present invention;
 Fig. 10 is a schematic front view of the heat exchanger shown in Fig. 9;
 Fig. 11 is a schematic right view of the heat exchanger shown in Fig. 9;
 Fig. 12 is a schematic left view of the heat exchanger shown in Fig. 9;
 Fig. 13 is a schematic perspective view of a heat exchanger according to an embodiment of the present invention;
 Fig. 14 is a schematic front view of the heat exchanger shown in Fig. 13;
 Fig. 15 is a schematic right view of the heat exchanger shown in Fig. 13;
 Fig. 16 is a schematic left view of the heat exchanger shown in Fig. 13;
 Fig. 17 is a schematic perspective view of a heat exchanger according to an embodiment of the present invention;
 Fig. 18 is a schematic front view of the heat exchanger shown in Fig. 17;
 Fig. 19 is a schematic right view of the heat exchanger shown in Fig. 17;

Fig. 20 is a schematic left view of the heat exchanger shown in Fig. 17;
 Fig. 21 is a schematic perspective view of a heat exchanger according to an embodiment of the present invention;
 Fig. 22 is a schematic front view of the heat exchanger shown in Fig. 21;
 Fig. 23 is a schematic right view of the heat exchanger shown in Fig. 21;
 5 Fig. 24 is a schematic left view of the heat exchanger shown in Fig. 21;
 Fig. 25 is a schematic perspective view of a heat exchanger according to an embodiment of the present invention;
 Fig. 26 is a schematic front view of the heat exchanger shown in Fig. 25;
 Fig. 27 is a schematic right view of the heat exchanger shown in Fig. 25;
 Fig. 28 is a schematic left view of the heat exchanger shown in Fig. 25;
 10 Fig. 29 is a schematic right view of a fin of the heat exchanger shown in Figs. 1, 5, 9, 13, 17, 21 and 25;
 Fig. 30 is a schematic top view of the fin of the heat exchanger shown in Fig. 29;
 Fig. 31 is a schematic right view of a heat exchanger, wherein only a portion of the heat exchange tubes and one fin are
 remained, according to an embodiment of the present invention;
 Fig. 32 is a schematic cross-sectional bottom view of the heat exchanger shown in Fig. 31 taken along line A-A of Fig.
 15 31;
 Fig. 33 is a schematic right view of a heat exchanger, wherein only a portion of the heat exchange tubes and one fin are
 remained, according to an embodiment of the present invention;
 Fig. 34 is a schematic cross-sectional bottom view of the heat exchanger shown in Fig. 33 taken along line B-B of Fig.
 20 33;
 Fig. 35 is a schematic right view of a heat exchanger, wherein only a portion of the heat exchange tubes and one fin are
 remained, according to an embodiment of the present invention;
 Fig. 36 is a schematic cross-sectional bottom view of the heat exchanger shown in Fig. 35 taken along line C-C of Fig.
 25 35;
 Fig. 37 is a schematic right view of a heat exchanger, wherein only a portion of the heat exchange tubes and one fin are
 remained, according to an embodiment of the present invention;
 Fig. 38 is a schematic cross-sectional bottom view of the heat exchanger shown in Fig. 37 taken along line D-D of Fig.
 30 37;
 Fig. 39 is a schematic right view of a heat exchanger, wherein only a portion of the heat exchange tubes and one fin are
 remained, according to an embodiment of the present invention;
 Fig. 40 is a schematic cross-sectional bottom view of the heat exchanger shown in Fig. 39 taken along line E-E of Fig.
 35 39;
 Fig. 41 is a schematic right view of a heat exchanger, wherein only a portion of the heat exchange tubes and one fin are
 remained, according to an embodiment of the present invention;
 Fig. 42 is a schematic cross-sectional bottom view of the heat exchanger shown in Fig. 41 taken along line F-F of Fig.
 40 41;
 Fig. 43 is a schematic right view of a heat exchanger, wherein only a portion of the heat exchange tubes and one fin are
 remained, according to an embodiment of the present invention;
 Fig. 44 is a schematic cross-sectional bottom view of the heat exchanger shown in Fig. 43, taken along line G-G in Fig.
 45 43;
 Fig. 45 is a schematic right view of a heat exchanger, wherein only a portion of the heat exchange tubes and one fin are
 remained, according to an embodiment of the present invention;
 Fig. 46 is a schematic cross-sectional bottom view of the heat exchanger shown in Fig. 45, taken along line H-H in Fig.
 50 45;
 Fig. 47 is a schematic right view of a heat exchanger, wherein only a portion of the heat exchange tubes and one fin are
 remained, according to an embodiment of the present invention;
 Fig. 48 is a schematic cross-sectional bottom view of the heat exchanger shown in Fig. 47, taken along line I-I in Fig.
 55 47;
 Fig. 49 is a schematic right view of a heat exchanger, wherein only a portion of the heat exchange tubes and one fin are
 remained, according to an embodiment of the present invention;
 Fig. 50 is a schematic cross-sectional bottom view of the heat exchanger shown in Fig. 49, taken along line J-J in Fig.
 49;
 Fig. 51 is a schematic perspective view of a bent heat exchanger according to an embodiment of the present invention;
 and
 Fig. 52 is a schematic top view of a portion of the bent heat exchanger shown in Fig. 51.

DETAILED DESCRIPTION OF EMBODIMENTS

[0051] The present invention is further explained below by means of specific embodiments in conjunction with the

drawings.

[0052] Referring to Figs. 1-50, a heat exchanger 100 according to an embodiment of the present invention includes: a plurality of rows of heat exchange tubes arranged in a first direction D1, each row of heat exchange tubes being composed of one heat exchange tube 1 or a plurality of heat exchange tubes 1; and a plurality of fins 2 arranged in a second direction D2 perpendicular to the first direction D1. Each of the plurality of fins 2 includes a fin body 20 and a plurality of heat exchange tube slots 21 formed in the fin body 20, the one heat exchange tube 1 or the plurality of heat exchange tubes 1 of each row of heat exchange tubes of the plurality of rows of heat exchange tubes being inserted into one heat exchange tube slot 21 of the plurality of heat exchange tube slots 21; and a length of at least one heat exchange tube slot 21 of the plurality of heat exchange tube slots 21 of at least one fin 2 of the plurality of fins 2 in a third direction D3 perpendicular to the first direction D1 and the second direction D2 being greater than a heat exchange tube size of the row of heat exchange tubes inserted into the at least one heat exchange tube slot 21 in the third direction D3 to form a gap 5 for passage of water in the at least one heat exchange tube slot 21. 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 the sum of the sizes of the plurality of heat exchange tubes 1 in the third direction D3. 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.

[0053] Referring to Figs. 1-50, in the embodiments of the present invention, a volume V_g of the defrosting water generated by the heat exchanger 100 and a volume V_p of the drainage passage of the heat exchanger 100 may be calculated as follows:

$$V_g = \left(W_f \times L_f - \sum W_{si} T_{si} \right) \times (P_f - T_f) \times \frac{h}{P_f} \times \frac{1}{\cos \theta}$$

$$V_p = \left[\sum W_{si} T_{si} - \sum \left(T_{si} \times \sum W_{tij} \right) \right] \times \frac{h}{\cos \theta}$$

where

W_f is a width of the fin 2 in the third direction D3,

L_f is a length of the fin 2 in the first direction D1,

W_{si} is a length of an i^{th} heat exchange tube slot 21 from one side to the other side of the heat exchanger 100 in the first direction D1,

T_{si} is a width of the i^{th} heat exchange tube slot 21 from one side to the other side of the heat exchanger 100 in the first direction D1,

P_f is spacing between adjacent fins 2,

T_f is a thickness of the fin body 20 of the fin 2,

W_{tij} is a size of a j^{th} heat exchange tube 1, of the row of heat exchange tubes in the i^{th} heat exchange tube slot 21 from one side to the other side of the heat exchanger 100 in the first direction D1, from a first side S1 to a second side S2 of the heat exchanger 100 in the third direction D3, when the row of heat exchange tubes is composed of one heat exchange tube 1, $j=1$,

H is a size of a range of the plurality of fins 2 arranged in the second direction D2, and θ is an angle between the fin body 20 of the fin 2 and the third direction D3.

[0054] According to the embodiments of the present invention, a ratio of the volume V_g of the defrosting water generated by the heat exchanger 100 to the volume V_p of the drainage passage of the heat exchanger 100 may satisfy the following relationship of:

$$\frac{V_g}{V_p} \leq R$$

where R is a predetermined value, for example, R may be equal to 90, 110, 130, 150, 170, 190, 210, etc., or may be within a certain range, for example, within a range of 80 to 260.

[0055] The following relationship may be obtained by substituting the volume V_g of the defrosting water generated by the

heat exchanger 100 and the volume V_p of the drainage passage of the heat exchanger 100 into the above relationship:

$$\frac{(W_f \times L_f - \sum W_{si} T_{si}) \times (P_f - T_f)}{[\sum W_{si} T_{si} - \sum (T_{si} \times \sum W_{tij})] \times P_f} \leq R$$

[0056] The fins 2 and the heat exchange tubes 1 of the heat exchanger 100 may satisfy this relationship to ensure an appropriate flow rate for discharging the defrosting water. In case the heat exchanger 100 is used, when the volume of the generated defrosting water is larger and the volume of the drainage passage is smaller, the defrosting water is discharged more slowly; and when the volume of the generated defrosting water is smaller and the volume of the drainage passage is larger, the defrosting water is discharged more quickly. According to the embodiments of the present invention, the ratio of the volume of the generated defrosting water to the volume of the drainage passage is less than the predetermined value, thereby ensuring the appropriate flow rate for discharging the defrosting water.

[0057] Referring to Figs. 1-50, in use, at least a portion of the heat exchange tube 1 may extend substantially vertically, for example, the heat exchange tube 1 may extend 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. In the embodiments of the present invention, at least one row of heat exchange tubes is composed of a plurality of heat exchange tubes 1, and there may be a gap 5 between at least two adjacent heat exchange tubes 1 of the plurality of heat exchange tubes 1. In the embodiments of the present invention, a size of the gap 5 in the first direction D1 is equal to a width of the heat exchange tube slot 21 at least in the middle of the gap 5 in the third direction D3. That is, the gap 5 occupies the entire width of the heat exchange tube slot 21 at least in the middle of the gap 5, thereby ensuring that water can pass through the gap 5, and the gap 5 will not be blocked or partially blocked by solder during welding process, and preventing water from being not able to flow quickly through the gap 5 in the case that the gap 5 is too small or there is solder in gap 5. In the embodiments of the present invention, a size of the gap 5 in at least one heat exchange tube slot 21 of the plurality of heat exchange tube slots 21 in the third direction D3 is greater than or equal to that of the one heat exchange tube 1 or one heat exchange tube 1 of the plurality of heat exchange tubes 1 of the row of heat exchange tubes in the at least one heat exchange tube slot 21 in the third direction D3.

[0058] Referring to Figs. 1-50, in the embodiments of the present invention, the heat exchange tube 1 includes a first tube edge 11 and a second tube edge 12, the first tube edge 11 and the second tube edge 12 of the heat exchange tube 1 being respectively positioned on the outermost sides of the heat exchange tube 1 in the third direction D3, and the heat exchanger 100 has a first side S1 and a second side S2 opposite to each other in the third direction D3, the first tube edge 11 of the heat exchange tube 1 being closer to the first side S1 of the heat exchanger 100 than the second tube edge 12 of the heat exchange tube 1 in the third direction D3. The heat exchange tube slot 21 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 of the heat exchange tube slot 21 of the fin 2 being respectively positioned on the outermost sides of the heat exchange tube slot 21 in the third direction D3, 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 than the second slot edge 212 of the heat exchange tube slot 21 of the fin 2 in the third direction D3. The heat exchange tube slot 21 of the plurality of fins 2 may have an opening towards the second side S2 of the heat exchanger 100, or the heat exchange tube slot 21 of the plurality of fins 2 has no opening and is a closed heat exchange tube slot. Each of at least some fins 2 may be formed by one plate. For example, all fins 2 may be formed from one plate.

[0059] Referring to Figs. 31-50, in the embodiments of the present invention, the one heat exchange tube 1 or the plurality of heat exchange tubes 1 of the row of the heat exchange tubes may be positioned between the first slot edge 211 and the second slot edge 212 of the heat exchange tube slot 21 of the fin 2 in the third direction D3. There is a gap 5 between the first slot edge 211 of at least one heat exchange tube slot 21 of the plurality of heat transfer tube slots 21 of at least one fin 2 of the plurality of fins 2 and the first tube edge 11 of the one heat exchange tube 1 (or the first tube edge 11 of one heat exchange tube 1 of the plurality of heat exchange tubes 1 closest to the first slot edge 211) of the row of heat exchange tubes inserted into the at least one heat exchange tube slot 21 in the third direction D3; and/or there is a gap 5 between the second slot edge 212 of the at least one heat exchange tube slot 21 of the plurality of heat transfer tube slots 21 of the at least one fin 2 of the plurality of fins 2 and the second tube edge 12 of the one heat exchange tube 1 (or the second tube edge 12 of one heat exchange tube 1 of the plurality of heat exchange tubes 1 closest to the second slot edge 212) of the row of heat exchange tubes inserted into the at least one heat exchange tube slot 21 in the third direction D3.

[0060] Referring to Figs. 1-34 and 41-50, in the embodiments of the present invention, the one heat exchange tube 1 or the plurality of heat exchange tubes 1 of the row of heat exchange tubes may be positioned between the first slot edge 211 and the second slot edge 212 of the heat exchange tube slot 21 of the fin 2 in the third direction D3. The heat exchange tubes 1 of the plurality of rows of heat exchange tubes include 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

includes a plurality of heat exchange tubes 1A, a second column of heat exchange tubes includes a plurality of heat exchange tubes 1B, a third column of heat exchange tubes includes a plurality of heat exchange tubes 1C, a fourth column of heat exchange tubes includes a plurality of heat exchange tubes 1D, and so on. According to one example of the present invention, orthographic projections of the heat exchange tubes 1 of two adjacent rows of heat exchange tubes in a plane perpendicular to the first direction D1 are separated from each other in the third direction D3. According to another example of the present invention, the heat exchange tubes 1 of two adjacent rows of heat exchange tubes are displaced from each other in the third direction D3. The heat exchange tubes 1 of at least one column of heat exchange tubes 1 of the plurality of columns of heat exchange tubes may have substantially the same size in the third direction D3. The heat exchange tubes 1 of each column of heat exchange tubes of the plurality of columns of heat exchange tubes and the heat exchange tubes 1 of the adjacent column of heat exchange tubes 1 of the plurality of columns of heat exchange tubes may be separated from each other in the third direction D3.

[0061] Referring to Figs. 31-36 and 41-50, in the embodiments of the present invention, there are a plurality of gaps for drainage of water between at least some heat exchange tube slots 21 of at least some fins 2 of the plurality of fins 2 and the heat exchange tubes 1 of the rows of heat exchange tubes inserted into the at least some heat exchange tube slots 21. The plurality of gaps 5 include a plurality of columns of gaps arranged in the third direction D3, each column of gaps of the plurality of columns of gaps including a plurality of gaps arranged in the first direction D1. According to the examples of the present invention, the gaps 5 in at least two adjacent heat exchange tube slots 21 are displaced from each other in the third direction D3.

[0062] Referring to Figs. 31-34, 41-44 and 47-48, in the embodiments of the present invention, the plurality of columns of heat exchange tubes are arranged sequentially from the first side S1 to the second side S2 of the heat exchanger 100 in a third direction D3; and there are gaps 5 between the first slot edges 211 of the heat exchange tube slots 21 and the first tube edge 11 of the heat exchange tubes 1 of the second column of heat exchange tubes of the plurality of columns of heat exchange tubes inserted into the heat exchange tube slots 21 in the third direction D3. According to the examples of the present invention, the first slot edges 211 of the heat exchange tube slots 21 and the first tube edges 11 of the heat exchange tubes 1 of the first column of heat exchange tubes of the plurality of columns of heat exchange tubes inserted into the heat exchange tube slots 21 are substantially aligned with each other in the third direction D3. For example, the first column of heat exchange tubes includes the plurality of heat exchange tubes 1A, the second column of heat exchange tubes includes the plurality of heat exchange tubes 1B, the third column of heat exchange tubes includes the plurality of heat exchange tubes 1C, the fourth column of heat exchange tubes includes the plurality of heat exchange tubes 1D, and so on.

[0063] Referring to Figs. 31-34 and 41-50, in the embodiments of the present invention, the plurality of columns of heat exchange tubes are arranged sequentially from the second side S2 to the first side S1 of the heat exchanger 100 in the third direction D3; and there are gaps 5 between the second slot edges 212 of the heat exchange tube slots 21 and the second tube edges 12 of the heat exchange tubes 1 of the second column of heat exchange tubes of the plurality of columns of heat exchange tubes inserted into the heat exchange tube slots 21 in the third direction D3. According to the examples of the present invention, the second slot edges 212 of the heat exchange tube slots 21 and the second tube edges 12 of the heat exchange tubes 1 of the first column of heat exchange tubes of the plurality of columns of heat exchange tubes inserted into the heat exchange tube slots 21 are substantially aligned with in the third direction D3. For example, the first column of heat exchange tubes includes the plurality of heat exchange tubes 1D, the second column of heat exchange tubes includes the plurality of heat exchange tubes 1C, the third column of heat exchange tubes includes the plurality of heat exchange tubes 1B, the fourth column of heat exchange tubes includes the plurality of heat exchange tubes 1A, and so on.

[0064] Referring to Figs. 31-34 and 41-50, in the embodiments of the present invention, a plurality of columns of gaps are arranged sequentially from the second side S2 to the first side S1 of the heat exchanger 100 in the third direction D3; the gaps 5 of odd numbered columns of gaps of the plurality of columns of gaps are formed in some heat exchange tube slots 21 of the plurality of heat exchange tube slots 21, and the gaps 5 of even numbered columns of gaps of the plurality of columns of gaps are formed in some other heat exchange tube slots 21 of the plurality of heat exchange tube slots 21; and the some heat exchange tube slots 21 and the some other heat exchange tube slots 21 are alternately arranged in the first direction D1.

[0065] Referring to Figs. 45-46 and 49-50, in the embodiments of the present invention, the plurality of columns of heat exchange tubes are arranged sequentially from the first side S1 to the second side S2 of the heat exchanger 100 in the third direction D3; and the first slot edges 211 of some heat exchange tube slots 21, into which the heat exchange tubes 1 of the second column of heat exchange tubes of the plurality of columns of heat exchange tubes are inserted, are closer to the second side S2 of the heat exchanger 100 than the first slot edges 211 of some other heat exchange tube slots 21, into which the heat exchange tubes 1 of the first column of heat exchange tubes of the plurality of columns of heat exchange tubes are inserted. For example, the first column of heat exchange tubes includes the plurality of heat exchange tubes 1A, the second column of heat exchange tubes includes the plurality of heat exchange tubes 1B, the third column of heat exchange tubes includes the plurality of heat exchange tubes 1C, the fourth column of heat exchange tubes includes the plurality of heat exchange tubes 1D, and so on. According to the embodiments of the present invention, a larger plane is

provided locally for the flowing of the defrosting water, and the surface tension of this continuous plane can promote the faster flowing of the defrosting water, improving the performance of the heat exchanger under the frosting conditions.

[0066] Referring to Figs. 31-36 and 41-50, in the embodiments of the present invention, the heat exchange tubes 1 of odd numbered columns of heat exchange tubes of the plurality columns of heat exchange tubes are provided in some heat exchange tube slots 21 of the plurality of heat exchange tube slots 21, and the heat exchange tubes 1 of even numbered columns of heat exchange tubes of the plurality columns of heat exchange tubes are provided in some other heat exchange tube slots 21 of the plurality of heat exchange tube slots 21; and the some heat exchange tube slots 21 and the some other heat exchange tube slots 21 are alternately arranged in the first direction D1. For example, the first column of heat exchange tubes includes the plurality of heat exchange tubes 1A, the second column of heat exchange tubes includes the plurality of heat exchange tubes 1B, the third column of heat exchange tubes includes the plurality of heat exchange tubes 1C, the fourth column of heat exchange tubes includes the plurality of heat exchange tubes 1D, and so on. Alternatively, for example, the first column of heat exchange tubes includes the plurality of heat exchange tubes 1D, the second column of heat exchange tubes includes the plurality of heat exchange tubes 1C, the third column of heat exchange tubes includes the plurality of heat exchange tubes 1B, the fourth column of heat exchange tubes includes the plurality of heat exchange tubes 1A, and so on.

[0067] Referring to Figs. 31-34 and 41-50, in the embodiments of the present invention, the first tube edges 11 of the heat exchange tubes 1 of at least one column of heat exchange tubes of the plurality of columns of heat exchange tubes are substantially aligned with each other in the third direction D3, and/or, the second tube edges 12 of the heat exchange tubes 1 of the at least one column of heat exchange tubes of the plurality of columns of heat exchange tubes are substantially aligned with each other in the third direction D3.

[0068] Referring to Figs. 1-50, in the embodiments of the present invention, the first tube edge 11 of the one heat exchange tube 1 (or the first tube edge 11 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 and the first tube edge 11 of the one heat exchange tube 1 (or the first tube edge 11 of at least one heat exchange tube 1 of the plurality of heat exchange tubes 1) of at least another row of heat exchange tubes of the plurality of rows of heat exchange tubes are displaced from each other in the third direction D3; and/or, the second tube edge 12 of the one heat exchange tube 1 (or the second tube edge 12 of the at least one heat exchange tube 1 of the plurality of heat exchange tubes 1) of the at least one row of heat exchange tubes of the plurality of rows of heat exchange tubes and the second tube edge 12 of the one heat exchange tube 1 (or the second tube edge 12 of the at least one heat exchange tube 1 of the plurality of heat exchange tubes 1) of the at least another row of heat exchange tubes of the plurality of rows of heat exchange tubes are displaced from each other in the third direction D3. For example, the first tube edges 11 of at least some heat exchange tubes 1 of at least some rows of heat exchange tubes of the plurality of rows of heat exchange tubes and the first tube edges 11 of at least some heat exchange tubes 1 of at least some other rows of heat exchange tubes of the plurality of rows of heat exchange tubes are displaced from each other in the third direction D3; and/or, the second tube edges 12 of the at least some heat exchange tubes 1 of the at least some rows of heat exchange tubes of the plurality of rows of heat exchange tubes and the second tube edges 12 of the at least some heat exchange tubes 1 of the at least some other rows of heat exchange tubes of the plurality of rows of heat exchange tubes are displaced from each other in the third direction D3.

[0069] Referring to Figs. 37-40, 45-46 and 49-50, in the embodiments of the present invention, the first slot edge 211 of at least one heat exchanger slot 21 of the plurality of heat exchange tube slots 21 of at least one fin 2 of the plurality of fins 2 and the first slot edge 211 of at least another heat exchanger slot 21 of the plurality of heat exchange tube slots 21 of the at least one fin 2 of the plurality of fins 2 are displaced from each other in the third direction D3. The second slot edge 212 of the at least one heat exchanger slot 21 of the plurality of heat exchange tube slots 21 of the at least one fin 2 of the plurality of fins 2 and the second slot edge 212 of the at least another heat exchanger slot 21 of the plurality of heat exchange tube slots 21 of the at least one fin 2 of the plurality of fins 2 are substantially aligned with each other in the third direction. For example, in the case that the heat exchange tube slot 21 of the plurality of fins 2 has no opening towards the second side S2 of the heat exchanger 100, i.e., in the case that the heat exchange tube slot 21 is a closed heat exchange tube slot, the second slot edge 212 of the at least one heat exchange tube slot 21 of the plurality of heat exchange tube slots 21 of the at least one fin 2 of the plurality of fins 2 and the second slot edge 212 of the at least another heat exchange tube slot 21 of the plurality of heat exchange tube slots 21 of the at least one fin 2 of the plurality of fins 2 may also be displaced from each other in the third direction D3. Referring to Figs. 31-36, 41-44 and 47-50, in the embodiments of the present invention, the first slot edges 211 of the heat exchange tube slots 21 of the plurality of fins 2 are substantially aligned with each other in the third direction D3, and the second slot edges 212 of the heat exchange tube slots 21 of the plurality of fins 2 are substantially aligned with each other in the third direction D3. The heat exchange tube slots 21 of the plurality of fins 2 may have approximately the same size in the third direction D3.

[0070] Referring to Figs. 1-28, in the embodiments of the present invention, the heat exchange tube 1 of the plurality of rows 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 the embodiments shown in Figs. 1-4 and 13-20, the heat exchanger 100 further includes: a first header 31 connected and

fluidly communicated with the first ends 18 of the heat exchange tubes 1 of the plurality of rows of heat exchange tubes; and a second header 32 connected and fluidly communicated with the second ends 19 of the heat exchange tubes 1 of the plurality of rows of heat exchange tubes. The heat exchange tubes 1 of the plurality of rows of heat exchange tubes may be arranged into one, two, three, four or more columns of the heat exchange tubes. In the embodiments shown in Figs. 5-8, the heat exchanger 100 further includes: a first header 31 connected and fluidly 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 fluidly communicated with the second ends 19 of the heat exchange tubes 1 of at least one column of the heat exchange tubes 1 of the plurality of columns of heat exchange tubes, and the other of the two second headers 32 being connected and fluidly communicated with 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. In the embodiments shown in Figs. 21-28, 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. Referring to Figs. 21-24, the two first headers 31 may be connected with a refrigerant inlet pipe or a refrigerant outlet pipe, and the two second headers 32 may be connected with a refrigerant outlet pipe or a refrigerant inlet pipe. Referring to Figs. 25-28, the two first headers 31 may be connected with each other by a connection pipe 7, and the two second headers 32 may be connected with the refrigerant inlet pipe and the refrigerant outlet pipe, respectively. In the embodiment shown in Figs. 9-12, the heat exchanger 100 further includes: a connection 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 fluidly 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 fluidly 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 fluidly 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. The two second headers 32 may be connected to the refrigerant inlet pipe and the refrigerant outlet pipe, respectively.

[0071] Referring to Figs. 1-50, in the embodiments of the present invention, when viewed in the first direction D1, the fin bodies 20 of the plurality of fins 2 are inclined relative to the third direction D3. The fin bodies 20 of the fins 2 may be parallel to the first direction D1. For example, when viewed in the first direction D1, an angle between the fin bodies 20 of the plurality of fins 2 and the third direction D3 is less than or equal to 45 degrees. Each of the plurality of fins 2 also includes a fin segment 29 extending from an edge of the fin body 20 on the first side S1 of the heat exchanger 100 in the third direction D3. The fin segment 29 may be parallel to the first direction D1. When viewed in the first direction D1, the fin bodies 20 of the plurality of fins 2 may also be parallel to the third direction D3. In the embodiments of the present invention, the fin bodies 20 of the plurality of fins 2 are inclined relative to the third direction D3, therefore, the inclined fin bodies 20 may further promote the rapid discharge of the defrosting water and improve the performance of the heat exchanger under the frosting conditions.

[0072] Referring to Figs. 1-32 and 21-50, in the 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 fin 2 of the plurality of fins 2 have substantially the same size in the third direction D3 and the heat exchange tubes 1 of the rows of heat exchange tubes inserted into the at least two heat exchange tube slots 21 has substantially the same size in the third direction D3. For example, the heat exchange tube slots 21 of the plurality of fins 2 have substantially the same size in the third direction D3, and the heat exchange tubes of the plurality of rows of heat exchange tubes have substantially the same size in the third direction D3. According to the embodiments of the present invention, the heat exchange tube slot 21 of the plurality of fins 2 has an opening towards the second side S2 of the heat exchanger 100, thereby making assembly simple. In addition, the gap forms a drainage passage through which the defrosting water may quickly flow away, improving the performance under the frosting conditions. Furthermore, the fin bodies 20 of the plurality of fins 2 are inclined relative to the third direction D3, therefore, the inclined fin bodies 20 may further promote the rapid discharge of the defrosting water and improve the performance of the heat exchanger under the frosting conditions.

[0073] Referring to Figs. 33-36, in the 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 fin 2 of the plurality of fins 2 have substantially the same size in the third direction D3, and the heat exchange tubes 1 of the rows of heat exchange tubes inserted into the at least two heat exchange tube slots 21 has different sizes in the third direction D3. For example, the heat exchange tube slots 21 of the plurality of fins 2 have substantially the same size in the third direction D3, and the heat exchange tubes 1 of the plurality of rows of heat exchange tubes has different sizes in the third direction D3. In the embodiments of the present invention, the gap forms a drainage passage through which the defrosting water may quickly flow away, improving the performance under the frosting conditions. In addition, with the use of the heat exchange tubes with different widths, the gaps with different sizes are formed, thereby forming the drainage passages with different sizes, therefore, the discharge path of the defrosting water are more flexibly and effectively managed, improving the performance of the heat exchanger under the frosting conditions. In addition, the fin bodies 20 of the plurality of fins 2 are inclined relative to the third direction D3, therefore, the inclined fin bodies 20 may further promote the rapid discharge of the defrosting water and improve the performance of the heat exchanger under the frosting conditions.

[0074] Referring to Figs. 37-38, in the 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 fin 2 of the plurality of fins 2 have different sizes in the third direction D3, and the heat exchange tubes 1 of the rows of heat exchange tubes inserted into the at least two heat exchange tube slots 21 have substantially the same size in the third direction D3. For example, the heat exchange tube slots 21 of the plurality of fins 2 have different sizes in the third direction D3, and the heat exchange tubes 1 of the plurality of rows of heat exchange tubes have substantially the same size in the third direction D3. The first slot edges 211 of the heat exchange tube slots are displaced from each other in the third direction D3, providing a larger plane for the flowing of the defrosting water locally. The surface tension of this continuous plane can promote the faster flowing of the defrosting water, improving the performance of the heat exchanger under the frosting conditions. With the use of the heat exchange tube slots with different lengths, the gaps with different sizes are formed, thereby forming the drainage passages with different sizes, therefore, the discharge path of the defrosting water are more flexibly and effectively managed, improving the performance of the heat exchanger under the frosting conditions. In addition, the fin bodies 20 of the plurality of fins 2 are inclined relative to the third direction D3, therefore, the inclined fin bodies 20 may further promote the rapid discharge of the defrosting water and improve the performance of the heat exchanger under the frosting conditions.

[0075] Referring to Figs. 39-40, in the 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 fin 2 of the plurality of fins 2 have different sizes in the third direction D3, and the heat exchange tubes 1 of the rows of heat exchange tubes inserted into the at least two heat exchange tube slots 21 have different sizes in the third direction D3. For example, the heat exchange tube slots 21 of the plurality of fins 2 have different sizes in the third direction D3, and the heat exchange tubes 1 of the plurality of rows of heat exchange tubes have different sizes in the third direction D3. The first slot edges 211 of the heat exchange tube slots are displaced from each other in the third direction D3, and the first tube edges 11 of the heat exchange tubes 1 are displaced from each other in the third direction D3, providing a larger plane for the flowing of the defrosting water locally. The surface tension of this continuous plane can promote the faster flowing of the defrosting water, improving the performance of the heat exchanger under the frosting conditions. With the use of the heat exchange tube slots with different lengths and the heat exchange tubes with different widths, the gaps with different sizes are formed, thereby forming the drainage passages with different sizes, therefore, the discharge path of the defrosting water are more flexibly and effectively managed, improving the performance of the heat exchanger under the frosting conditions. In addition, the fin bodies 20 of the plurality of fins 2 are inclined relative to the third direction D3, therefore, the inclined fin bodies 20 may further promote the rapid discharge of the defrosting water and improve the performance of the heat exchanger under frosting conditions.

[0076] 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. A width of the heat exchange tube 1 or a size of the heat exchange tube 1 in the third direction is greater than a thickness of the heat exchange tube 1 or a size of the heat exchange tube 1 in the first direction. A length of the heat exchange tube slot 21 or a size of the heat exchange tube slot 21 in the third direction is greater than a width of the heat exchange tube slot 21 or a size of the heat exchange tube slot 21 in the first direction. The thickness of the heat exchange tube 1 may be less than or equal to the width of the heat exchange tube slot 21.

[0077] Referring to Figs. 51 and 52, a bent heat exchanger 100' according to an embodiment of the present invention is formed by bending the above-mentioned heat exchanger 100. For example, the heat exchanger 100 is bent along a bending line of the heat exchanger 100 in the middle of the first direction D1 and parallel to the second direction, so that at least one portion of the two portions of the heat exchanger 100 on both sides of the bending line is towards the second side S2 of the heat exchanger 100, i.e., one side on which the opening of the heat exchange tube slot 21 is positioned. An angle between the two portions of the heat exchanger 100 may be any appropriate angle.

[0078] Referring to Fig. 1, an air conditioning system according to an embodiment of the present invention includes: the above-mentioned heat exchanger 100 or bent 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 or bent heat exchanger 100'.

[0079] With the heat exchanger, the bent heat exchanger and the air conditioning system having the heat exchanger or the bent heat exchanger according to the embodiments of the present invention, for example, the performance of the heat exchanger and the air conditioning system can be improved.

[0080] With the heat exchanger or the bent heat exchanger according to the embodiments of the present invention, by displacing the tube edges of the heat exchange tubes in the third direction, or by displacing the slot edges of the heat exchange tube slots of the fin in the third direction, or by displacing the tube edges of the heat exchange tubes in the third direction and by displacing the slot edges of the heat exchange tube slots of the fin in the third direction, the flow path of the defrosting water can be flexibly managed, at the same time, combined with the inclined structure of the fin, the flowing of the defrosting water is accelerated, further enhancing the discharge of the defrosting water, and improving the performance of the heat exchanger and the air conditioning system under the frosting conditions.

[0081] 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 rows of heat exchange tubes arranged in a first direction, each row of heat exchange tubes comprising one heat exchange tube or a plurality of heat exchange tubes; and
a plurality of fins arranged in a second direction perpendicular to the first direction,
wherein
each of the plurality of fins comprises a fin body and a plurality of heat exchange tube slots formed in the fin body,
the one heat exchange tube of each row of heat exchange tubes of the plurality of rows of heat exchange tubes being inserted into one heat exchange tube slot of the plurality of heat exchange tube slots, or, the plurality of heat exchange tubes of each row of heat exchange tubes of the plurality of rows of heat exchange tubes being inserted into one heat exchange tube slot of the plurality of heat exchange tube slots; and
a length of at least one heat exchange tube slot, in a third direction perpendicular to the first direction and the second direction, of the plurality of heat exchange tube slots of at least one fin of the plurality of fins is greater than a heat exchange tube size of the row of heat exchange tubes inserted into the at least one heat exchange tube slot in the third direction to form a gap for passage of water in the at least one heat exchange tube slot; 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.

2. The heat exchanger according to claim 1, wherein

the fins and the heat exchange tubes of the heat exchanger satisfy the following relationship of:

$$\frac{(W_f \times L_f - \sum W_{si} T_{si}) \times (P_f - T_f)}{[\sum W_{si} T_{si} - \sum (T_{si} \times \sum W_{tij})] \times P_f} \leq R$$

where, W_f is a width of the fin in the third direction, L_f is a length of the fin in the first direction, W_{si} is a length of an i^{th} heat exchange tube slot from one side to the other side of the heat exchanger in the first direction, T_{si} is a width of the i^{th} heat exchange tube slot from one side to the other side of the heat exchanger in the first direction, P_f is a spacing between adjacent fins, T_f is a thickness of the fin body of the fin, W_{tij} is a size of a j^{th} heat exchange tube, of the row of heat exchange tubes in the i^{th} heat exchange tube slot from one side to the other side of the heat exchanger in the first direction, from a first side to a second side of the heat exchanger in the third direction; when the row of heat exchange tubes comprises the one heat exchange tube, $j=1$, and R is equal to 150.3. The heat exchanger according to claim 1, wherein

at least one row of heat exchange tubes comprises the plurality of heat exchange tubes, and there is a gap between at least two adjacent heat exchange tubes of the plurality of heat exchange tubes.

4. The heat exchanger according to claim 1, wherein

the heat exchange tube comprises a first tube edge and a second tube edge, the first tube edge and the second tube edge of the heat exchange tube being respectively positioned on outermost sides of the heat exchange tube in the third direction, and the heat exchanger has a first side and a second side opposite to each other in the third direction, the first tube edge of the heat exchange tube being closer to the first side of the heat exchanger than the second tube edge of the heat exchange tube in the third direction;

the heat exchange tube slot of the fin has a first slot edge and a second slot edge, the first slot edge and the second slot edge of the heat exchange tube slot of the fin 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 than the second slot edge of the heat exchange tube slot of the fin in the third direction; and

there is a gap in the third direction between the first slot edge of at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least one fin of the plurality of fins and the first tube edge of the one heat exchange tube of the row of heat exchange tubes inserted into the at least one heat exchange tube slot, or, there is a gap in the third direction between the first slot edge of the at least one heat exchange tube slot of the plurality of heat exchange tube slots of the at least one fin of the plurality of fins and the first tube edge of one heat exchange tube, of the plurality of heat exchange tubes closest to the first slot edge, of the row of heat exchange tubes inserted into the at least one heat exchange tube slot; and/or, there is a gap in the third direction between the second slot edge of the at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least one fin of the plurality of fins and the second tube edge of the one heat exchange tube of the row of heat exchange tubes inserted into the at least one heat exchange tube slot, or, there is a gap in the third direction between the second slot edge of the at least one heat exchange tube slot of the plurality of heat exchange tube slots of the at least one fin of the plurality of fins and the second tube edge of one heat exchange tube, of the plurality of heat exchange tubes closest to the second slot edge, of the row of heat exchange tubes inserted into the at least one heat exchange tube slot.

5. The heat exchanger according to claim 1, wherein

the heat exchange tube comprises a first tube edge and a second tube edge, the first tube edge and the second tube edge of the heat exchange tube being respectively positioned on outermost sides of the heat exchange tube in the third direction, and the heat exchanger has a first side and a second side opposite to each other in the third direction, the first tube edge of the heat exchange tube being closer to the first side of the heat exchanger than the second tube edge of the heat exchange tube in the third direction;

the heat exchange tube slot of the fin has a first slot edge and a second slot edge, the first slot edge and the second slot edge of the heat exchange tube slot of the fin 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 than the second slot edge of the heat exchange tube slot of the fin in the third direction; and

the heat exchange tubes of the plurality of rows of heat exchange tubes 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.

6. The heat exchanger according to claim 5, wherein

orthogonal projections of the heat exchange tubes of two adjacent rows of heat exchange tubes in a plane perpendicular to the first direction are separated from each other in the third direction.

7. The heat exchanger according to claim 5, wherein

a plurality of gaps for the drainage of water are formed between at least some heat exchange tube slots of at least some fins of the plurality of fins and the heat exchange tubes of the rows of heat exchange tubes inserted into the at least some heat exchange tube slots, the plurality of gaps comprising a plurality of columns of gaps arranged in the third direction, each column of gaps of the plurality of columns of gaps comprising a plurality of gaps arranged in the first direction.

8. The heat exchanger according to claim 7, wherein

the gaps in at least two adjacent heat exchange tube slots are displaced from each other in the third direction.

9. The heat exchanger according to claim 5, wherein

the plurality of columns of heat exchange tubes are arranged sequentially from the first side to the second side of

the heat exchanger in the third direction; and
there are gaps between the first slot edges of the heat exchange tube slots and the first tube edges of the heat exchange tubes of a second column of heat exchange tubes of the plurality of columns of heat exchange tubes inserted into the heat exchange tube slots in the third direction.

10. The heat exchanger according to claim 9, wherein
the first slot edges of the heat exchange tube slots and the first tube edges of the heat exchange tubes of a first column of heat exchange tubes of the plurality of columns of heat exchange tubes inserted into the heat exchange tube slots are substantially aligned with each other in the third direction.

11. The heat exchanger according to claim 5, wherein

the plurality of columns of heat exchange tubes are arranged sequentially from the first side to the second side of the heat exchanger in the third direction; and
the first slot edges of some heat exchange tube slots, into which the heat exchange tubes of a second column of heat exchange tubes of the plurality of columns of heat exchange tubes are inserted, are closer to the second side of the heat exchanger than the first slot edges of some other heat exchange tube slots, into which the heat exchange tubes of a first column of heat exchange tubes of the plurality of columns of heat exchange tubes are inserted.

12. The heat exchanger according to claim 7, wherein

the plurality of columns of gaps are arranged sequentially from the second side to the first side of the heat exchanger in the third direction;
the gaps of odd numbered columns of gaps of the plurality of columns of gaps are formed in some heat exchange tube slots of the plurality of heat exchange tube slots, and the gaps of even numbered columns of gaps of the plurality of columns of gaps are formed in some other heat exchange tube slots of the plurality of heat exchange tube slots; and
the some heat exchange tube slots and the some other heat exchange tube slots are arranged alternately in the first direction.

13. The heat exchanger according to any one of claims 9 to 11, wherein

the heat exchange tubes of odd numbered columns of heat exchange tubes of the plurality of columns of heat exchange tubes are provided in some heat exchange tube slots of the plurality of heat exchange tube slots, and the heat exchange tubes of even numbered columns of heat exchange tubes of the plurality of columns of heat exchange tubes are formed in some other heat exchange tube slots of the plurality of heat exchange tube slots; and
the some heat exchange tube slots and the some other heat exchange tube slots are arranged alternately in the first direction.

14. The heat exchanger according to any one of claims 5 to 12, wherein

the first tube edges of the heat exchange tubes of at least one column of heat exchange tubes of the plurality of columns of heat exchange tubes are substantially aligned with each other in the third direction, and/or, the second tube edges of the heat exchange tubes of the at least one column of heat exchange tubes of the plurality of columns of heat exchange tubes are substantially aligned with each other in the third direction.

15. The heat exchanger according to claim 1, wherein

the heat exchange tube comprises a first tube edge and a second tube edge, the first tube edge and the second tube edge of the heat exchange tube being respectively positioned on outermost sides of the heat exchange tube in the third direction, and the heat exchanger has a first side and a second side opposite to each other in the third direction, the first tube edge of the heat exchange tube being closer to the first side of the heat exchanger than the second tube edge of the heat exchange tube in the third direction; and
the first tube edge of the one heat exchange tube, or the first tube edge 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 and the first tube edge of the one heat exchange tube, or the first tube edge of at least one heat exchange tube of the plurality of heat exchange tubes, of at least another row of heat exchange tubes of the plurality of rows of heat exchange tubes are displaced from each other in the third direction; and/or, the second

tube edge of the one heat exchange tube, or the second tube edge of the 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 and the second tube edge of the one heat exchange tube, or the second tube edge of the at least one heat exchange tube of the plurality of heat exchange tubes, of the at least another row of heat exchange tubes of the plurality of rows of heat exchange tubes are displaced from each other in the third direction.

16. The heat exchanger according to claim 1, wherein

the heat exchange tube slot of the fin has a first slot edge and a second slot edge, the first slot edge and the second slot edge of the heat exchange tube slot of the fin 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 than the second slot edge of the heat exchange tube slot of the fin in the third direction; and

the first slot edge of at least one heat exchange tube slot of the plurality of heat exchange tube slots of at least one fin of the plurality of fins and the first slot edge of at least another heat exchange tube slot of the plurality of heat exchange tube slots of the at least one fin of the plurality of fins are displaced from each other in the third direction.

17. The heat exchanger according to claim 5, wherein

the first slot edges of the heat exchange tube slots of the plurality of fins are substantially aligned with each other in the third direction, and the second slot edges of the heat exchange tube slots of the plurality of fins are substantially aligned with each other in the third direction.

18. The heat exchanger according to claim 1 or 5, wherein

the heat exchange tube of the plurality of rows 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 of rows of heat exchange tubes; and a second header connected and fluidly communicated with the second ends of the heat exchange tubes of the plurality of rows of heat exchange tubes.

19. The heat exchanger according to claim 5, wherein

the heat exchange tube of the plurality of rows 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 of 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.

20. The heat exchanger according to claim 5, wherein

the heat exchange tube of the plurality of rows 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 connecting portion, the first ends of the heat exchange tubes of one column of heat exchange tubes of the plurality of columns of heat exchange tubes being connected and fluidly communicated with the first ends of the heat exchange tubes of another column of heat exchange tubes of the plurality of columns of heat exchange tubes by the connecting portion; 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.

21. The heat exchanger according to claim 20, wherein

the connection portion comprises a plurality of connection tubes, the first ends of the heat exchange tubes of the one

column of heat exchange tubes being connected and fluidly communicated with the first ends of the heat exchange tubes of the another column of heat exchange tubes by the plurality of connection tubes, respectively.

22. The heat exchanger according to claim 21, 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 interconnected, are formed by bending one tube.

23. The heat exchanger according to claim 5, wherein

the heat exchange tube of the plurality of rows 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.

24. The heat exchanger according to claim 5, wherein

the heat exchange tubes of each column of heat exchange tubes of the plurality of columns of heat exchange tubes and the heat exchange tubes of the adjacent column of heat exchange tubes of the plurality of columns of heat exchange tubes are separated from each other in the third direction.

25. The heat exchanger according to claim 1, wherein

when viewed in the first direction, the fin bodies of the plurality of fins are inclined relative to the third direction.

26. The heat exchanger according to claim 25, wherein

the heat exchange tube slot of the fin has a first slot edge and a second slot edge, the first slot edge and the second slot edge of the heat exchange tube slot of the fin 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 than the second slot edge of the heat exchange tube slot of the fin in the third direction; and

each of the plurality of fins further comprises: a fin segment extending from an edge of on the fin body on the first side of the heat exchanger in the third direction.

27. 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 fin of the plurality of fins have substantially the same size in the third direction, and the heat exchange tubes of the rows of exchange tubes inserted into the at least two heat exchange tube slots have substantially the same size in the third direction.

28. The heat exchanger according to claim 1, wherein

the heat exchange tube slot of the fin has a first slot edge and a second slot edge, the first slot edge and the second slot edge of the heat exchange tube slot of the fin 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 than the second slot edge of the heat exchange tube slot of the fin in the third direction; and

the heat exchange tube slot of the plurality of fins has an opening towards the second side of the heat exchanger.

29. A bent heat exchanger, wherein

the bent heat exchanger is formed by bending the heat exchanger according to claim 1.

30. An air conditioning system comprising:

the heat exchanger according to any one of claims 1 to 28 or the bent heat exchanger according to claim 29.

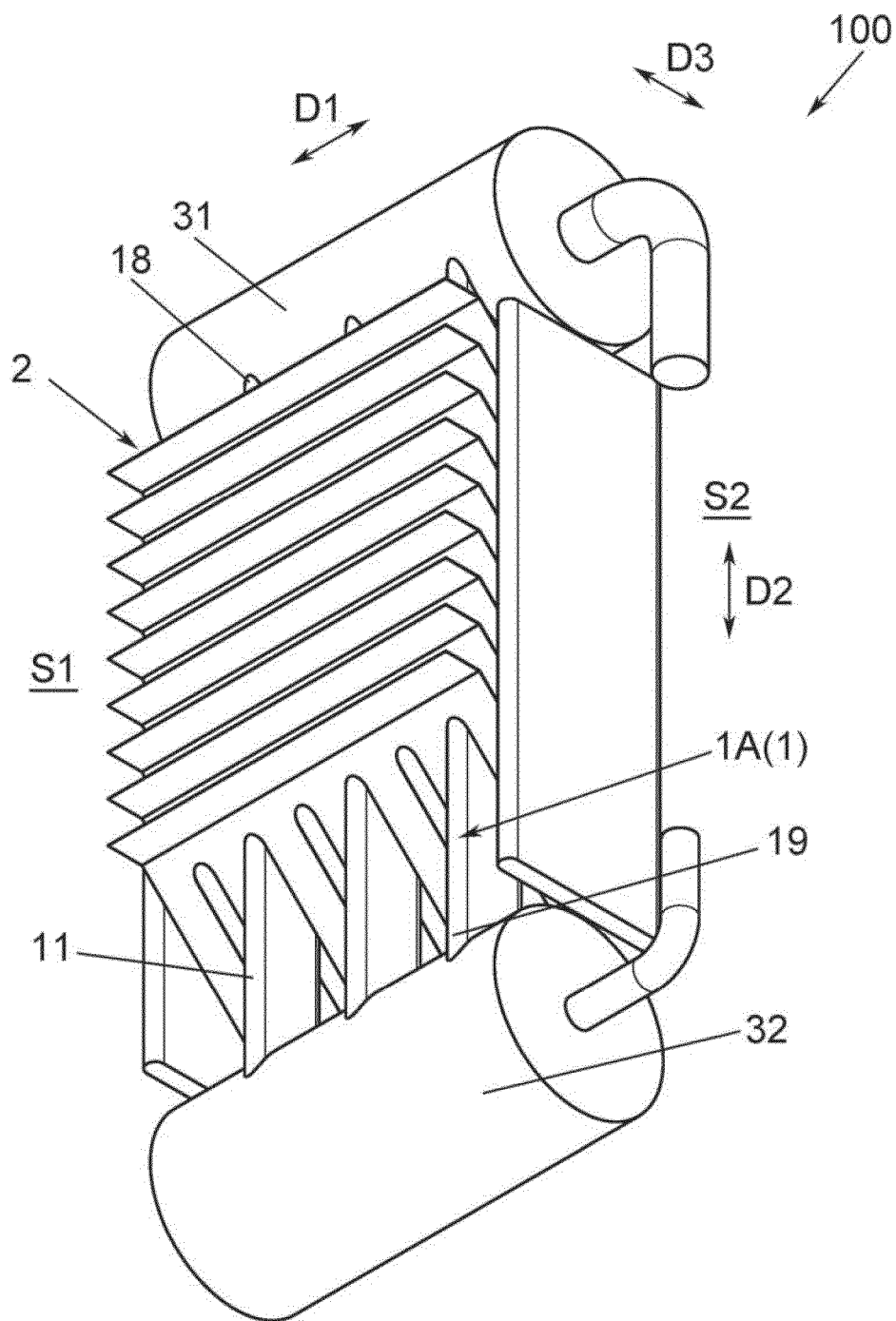


Fig. 1

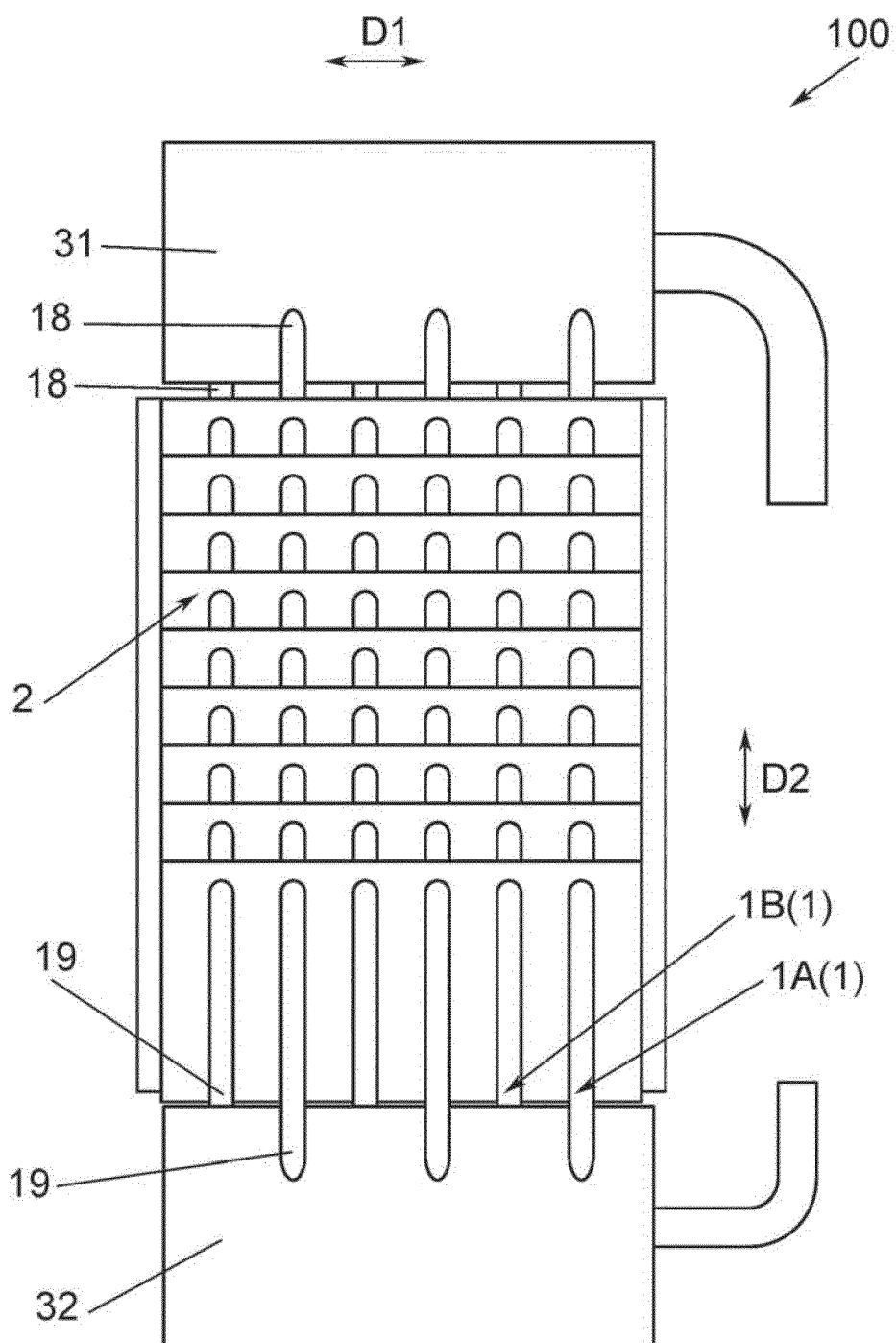


Fig. 2

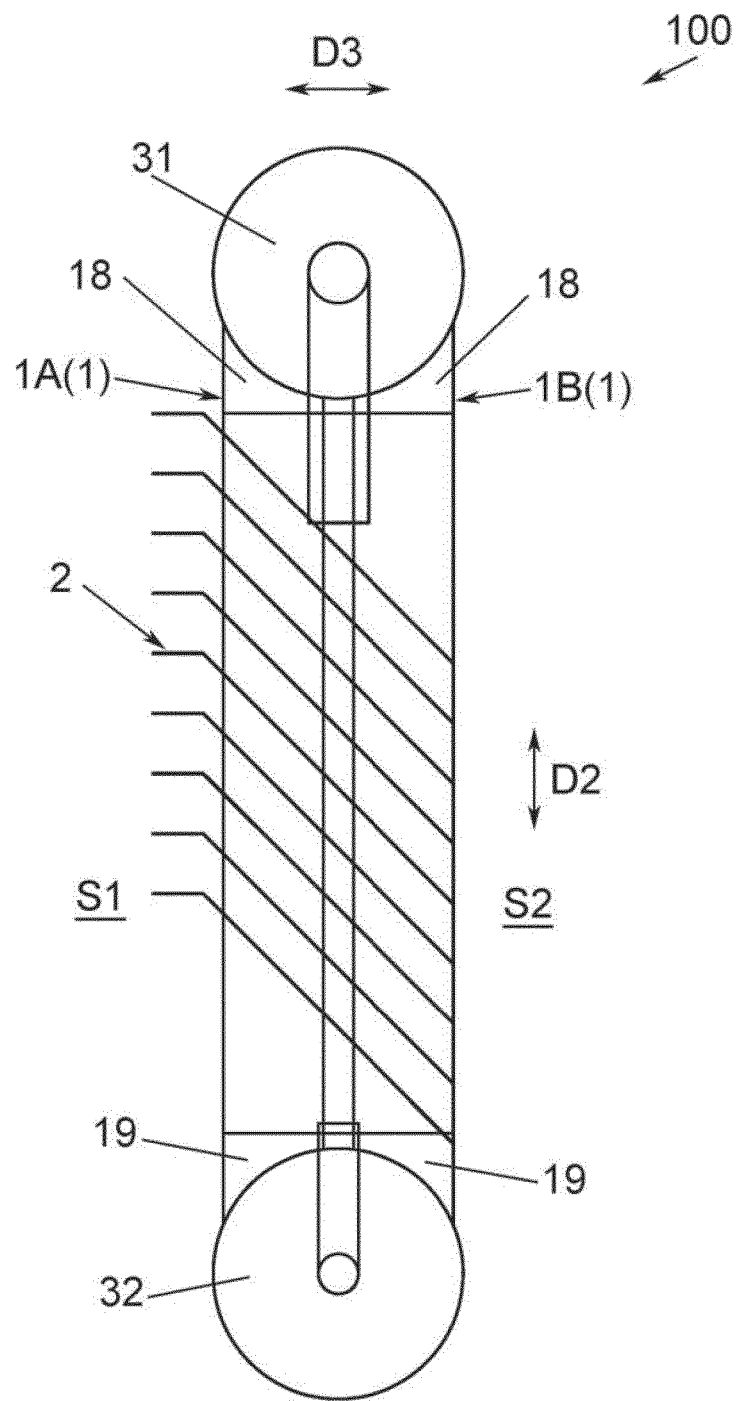


Fig. 3

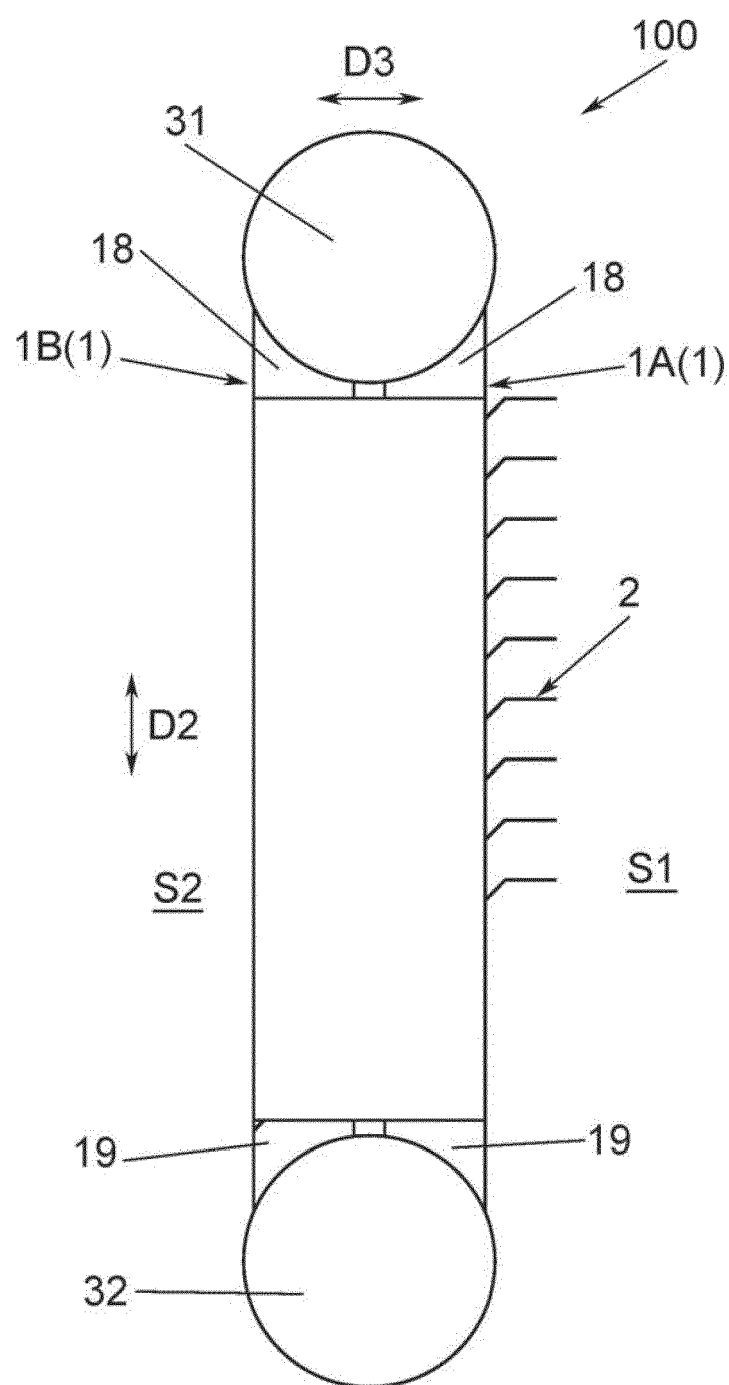


Fig. 4

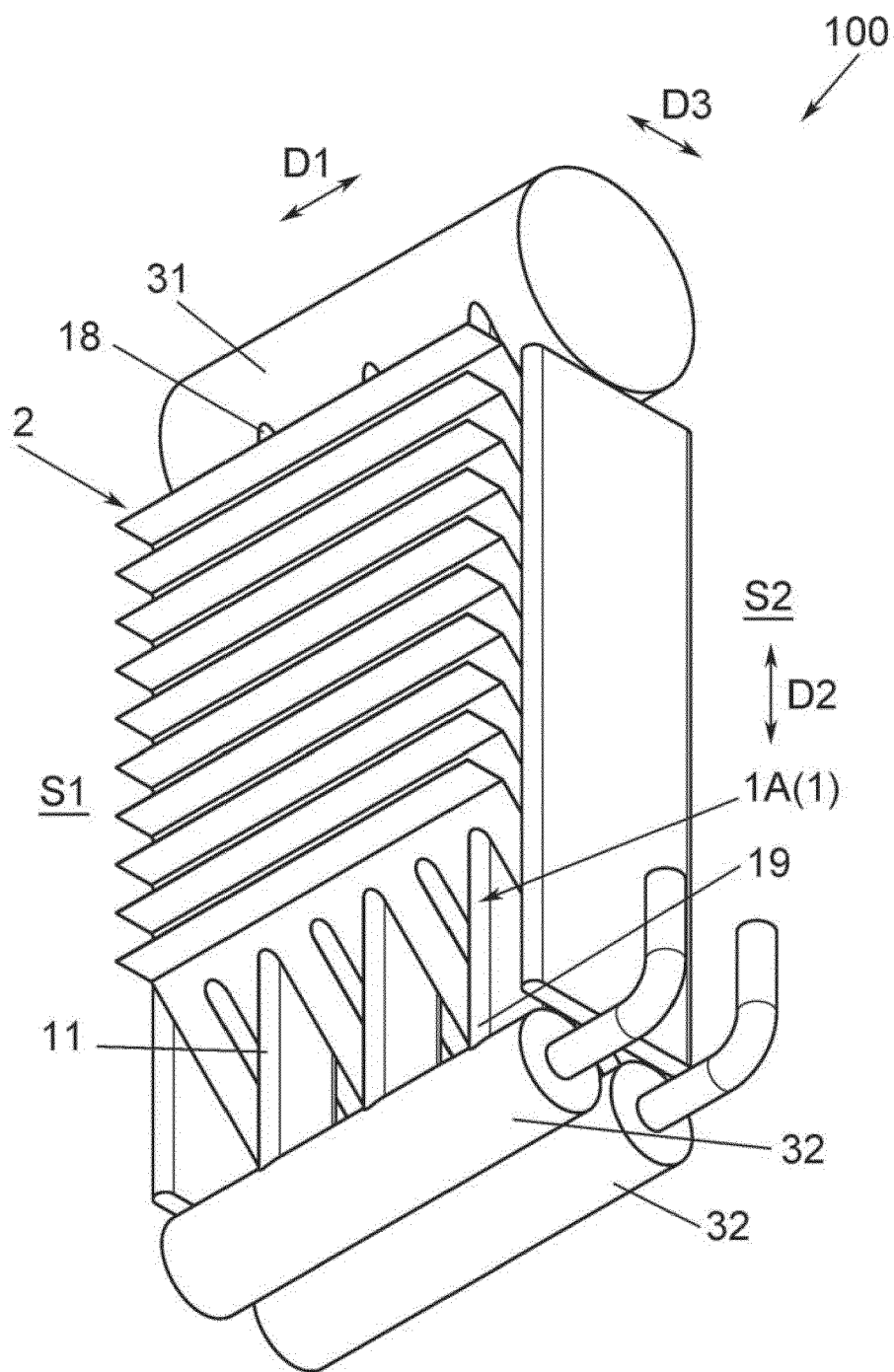


Fig. 5

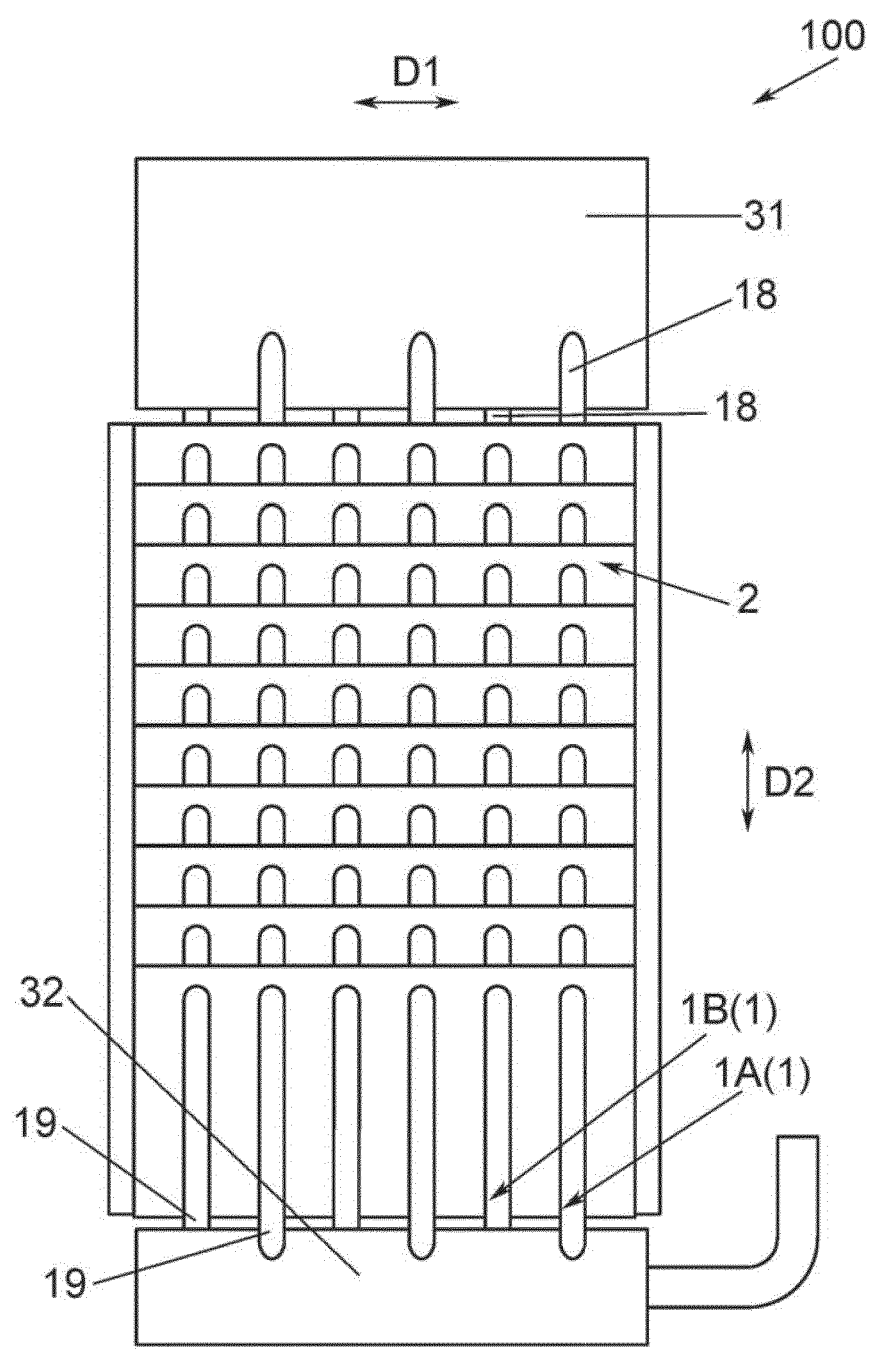


Fig. 6

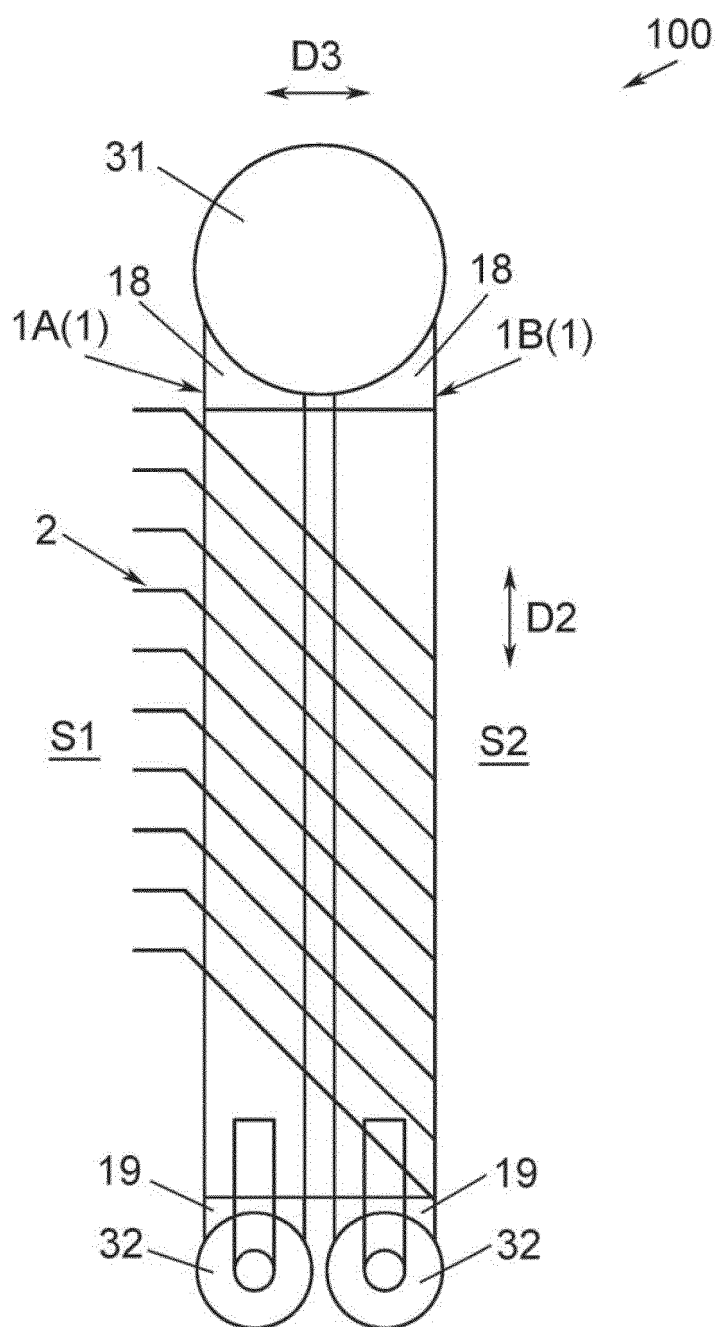


Fig. 7

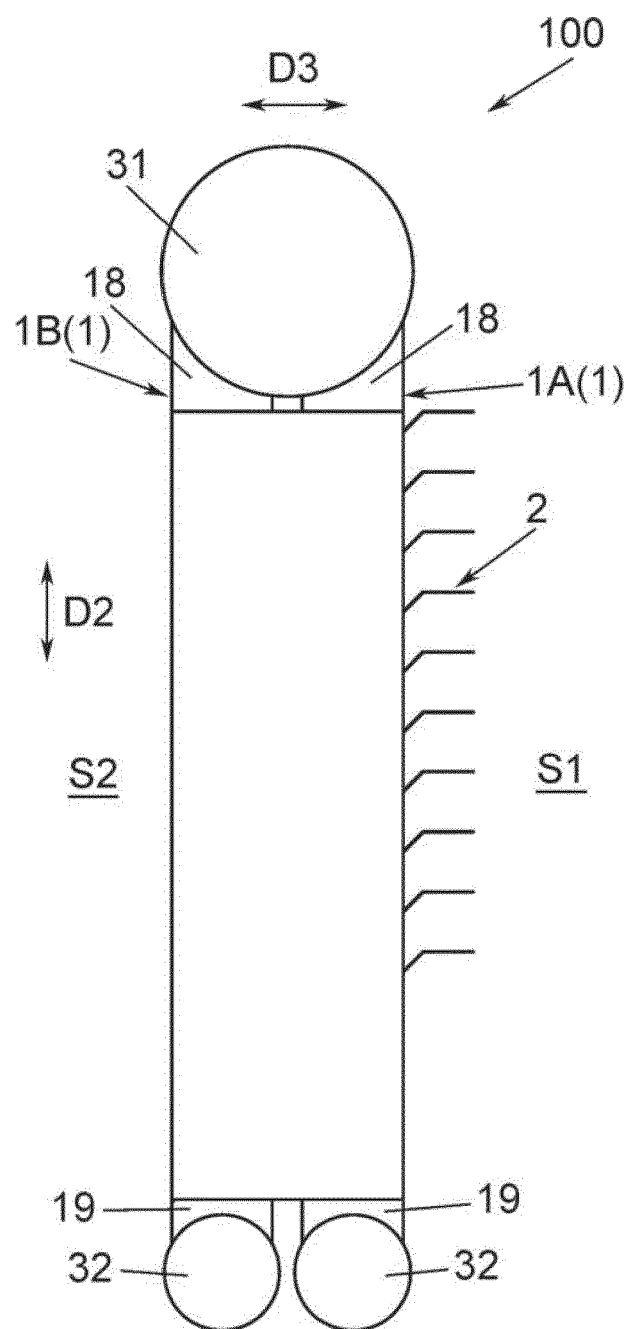


Fig. 8

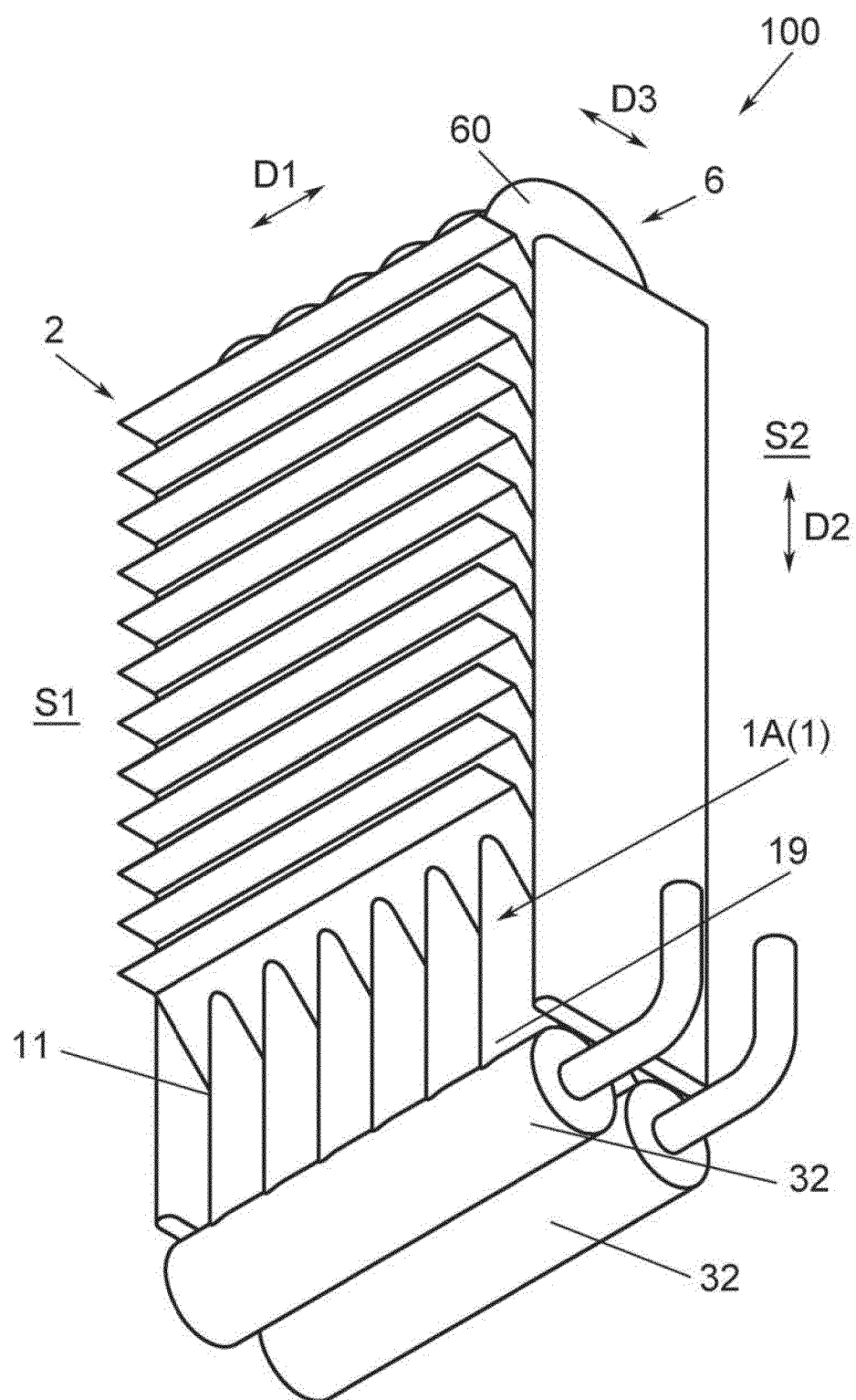


Fig. 9

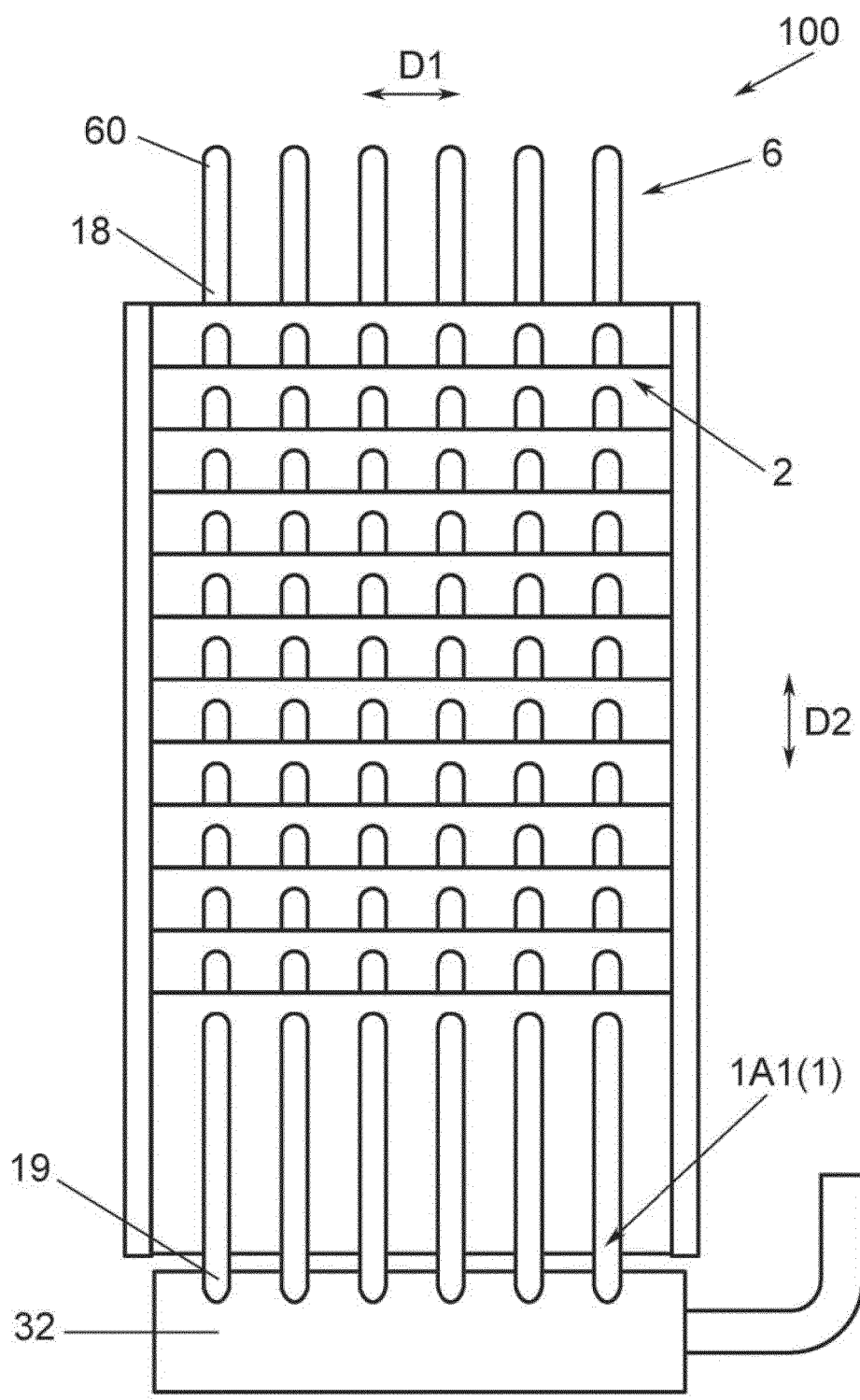


Fig. 10

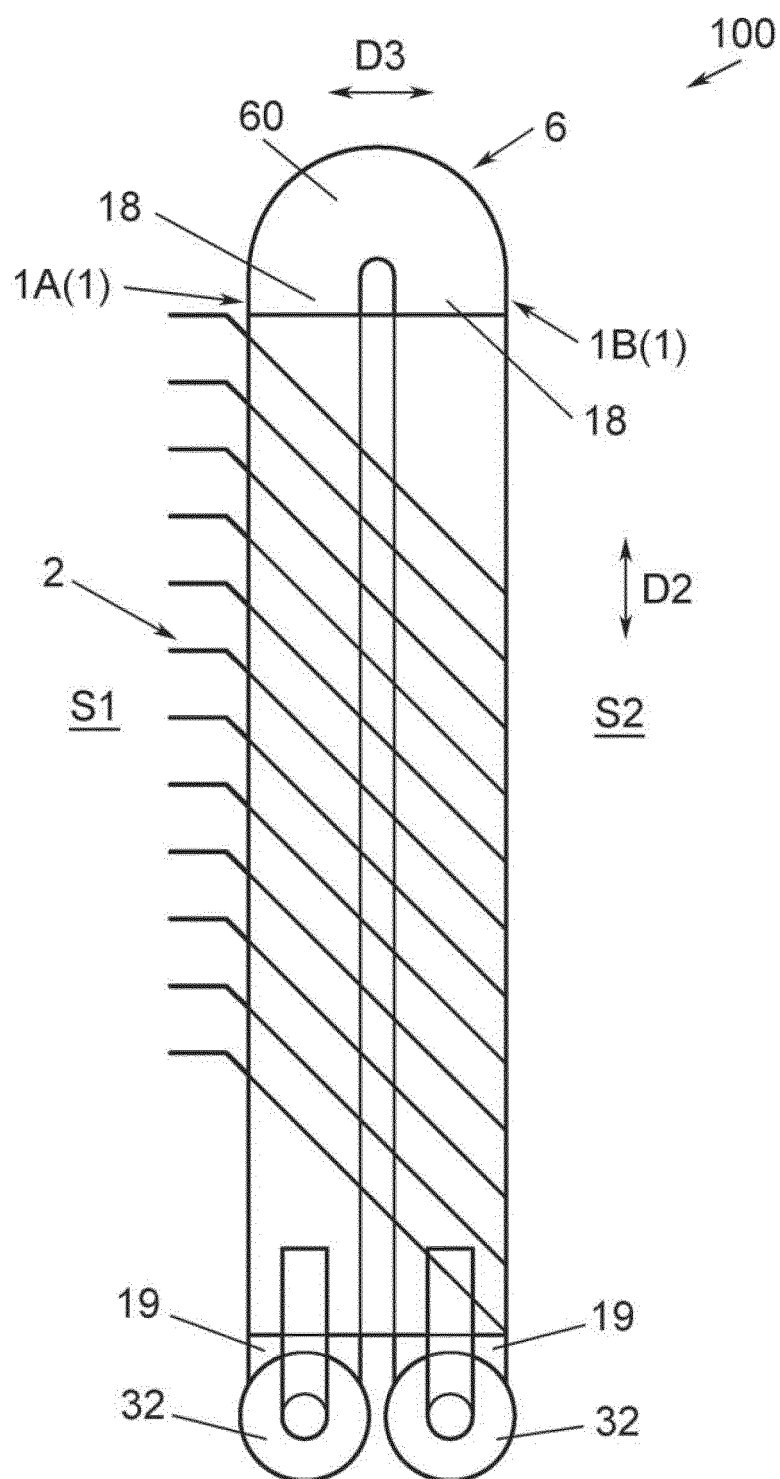


Fig. 11

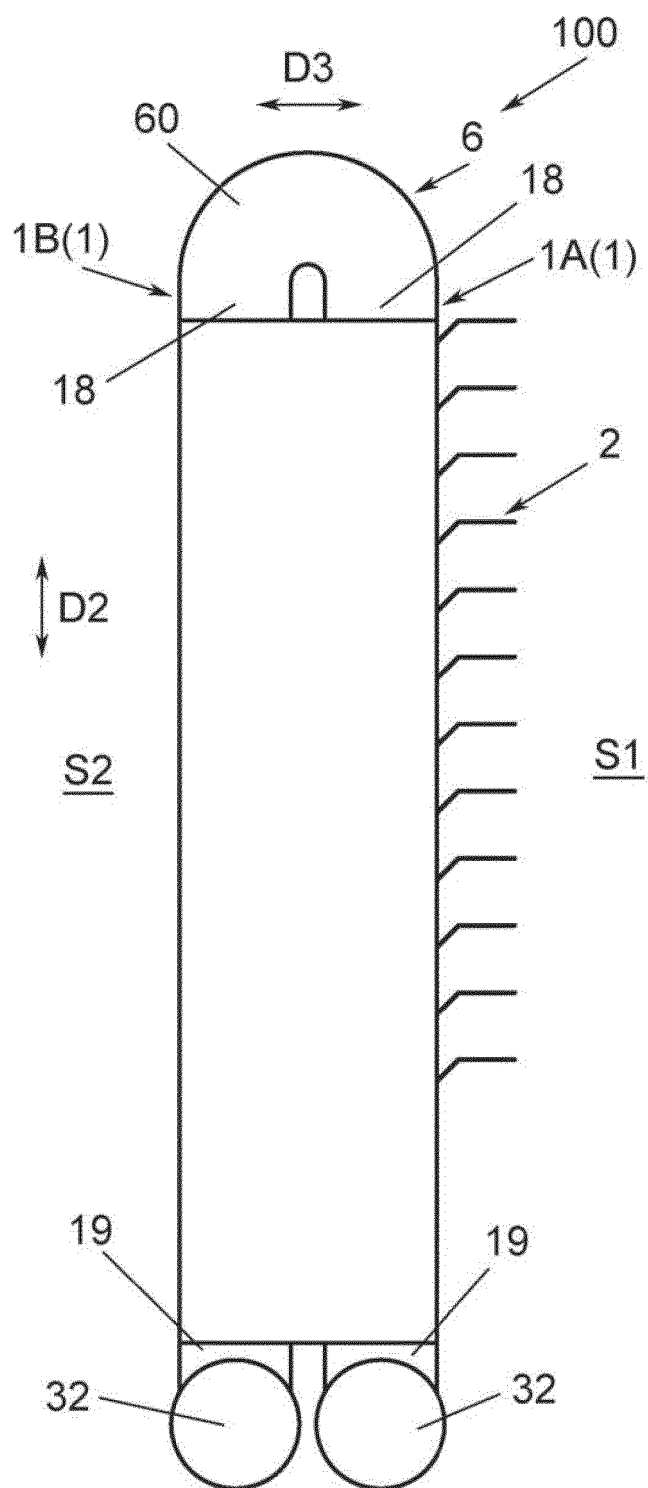


Fig. 12

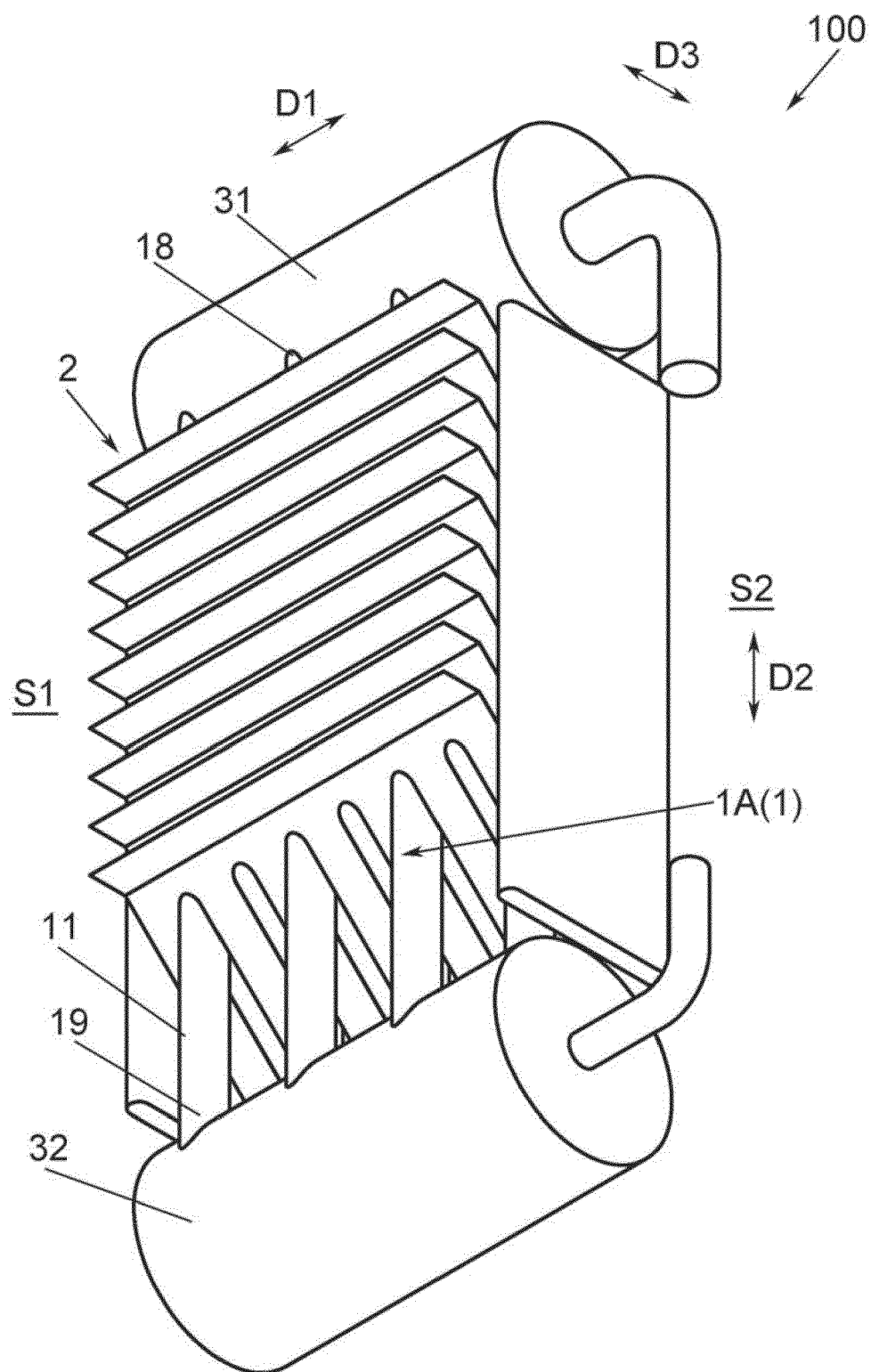


Fig. 13

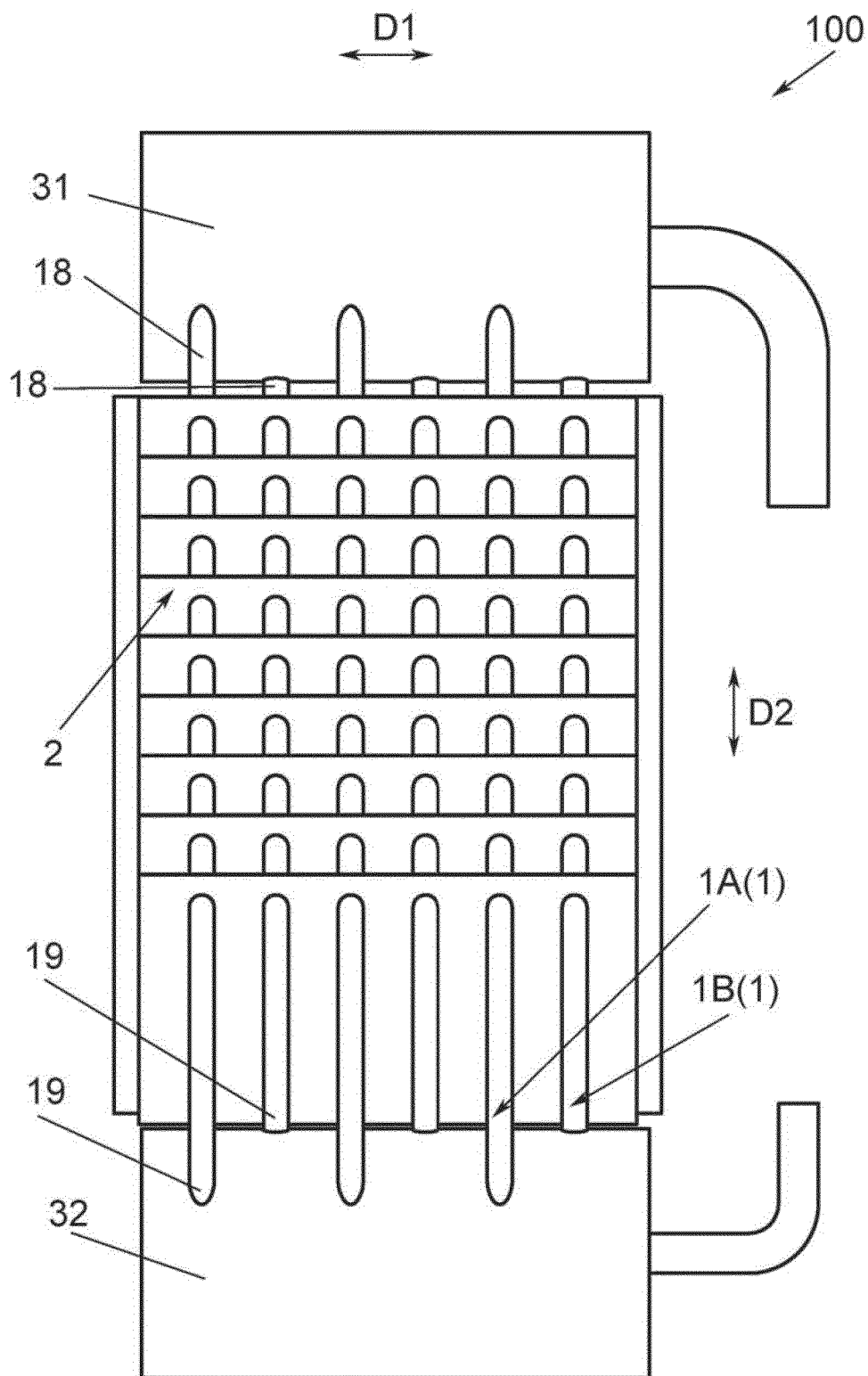


Fig. 14

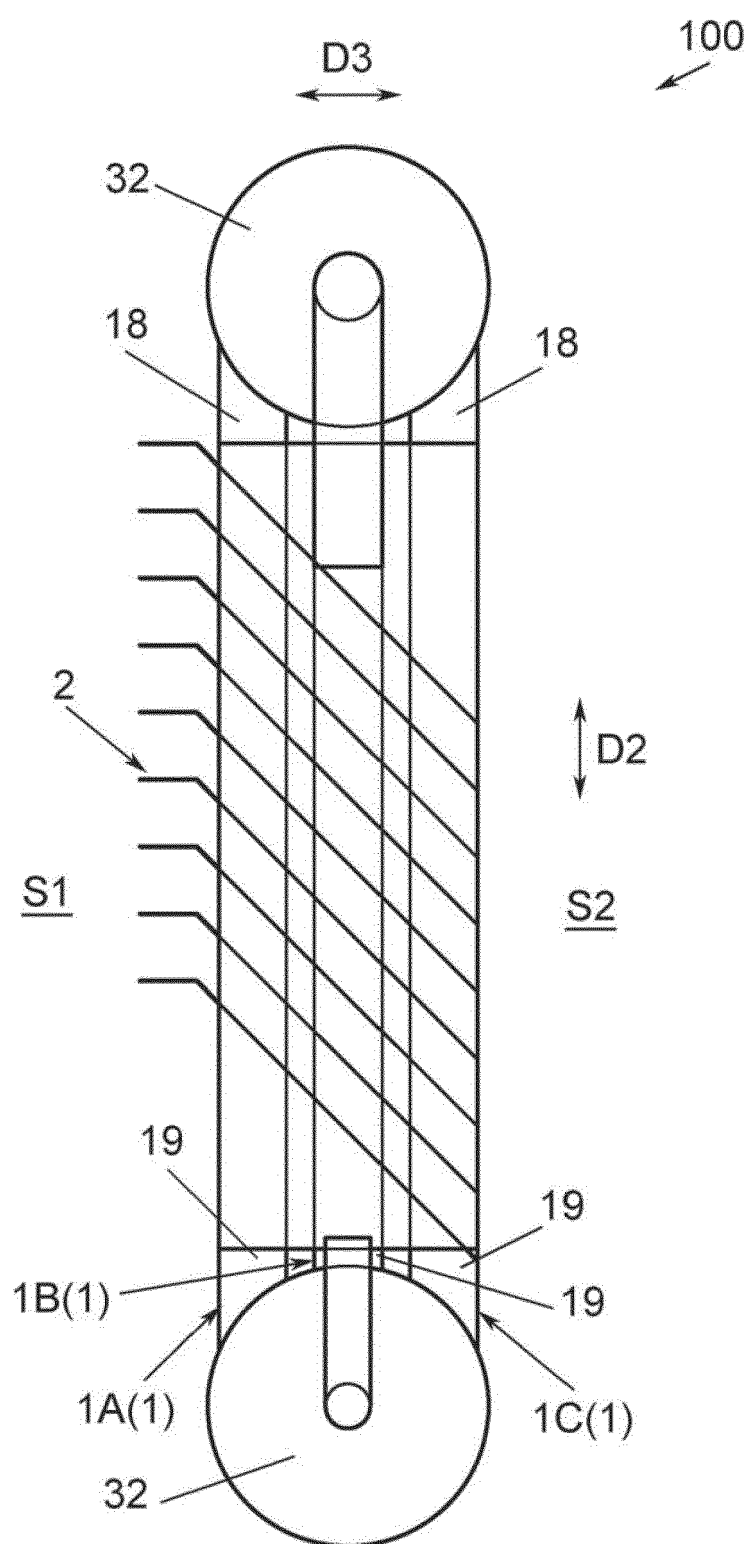


Fig. 15

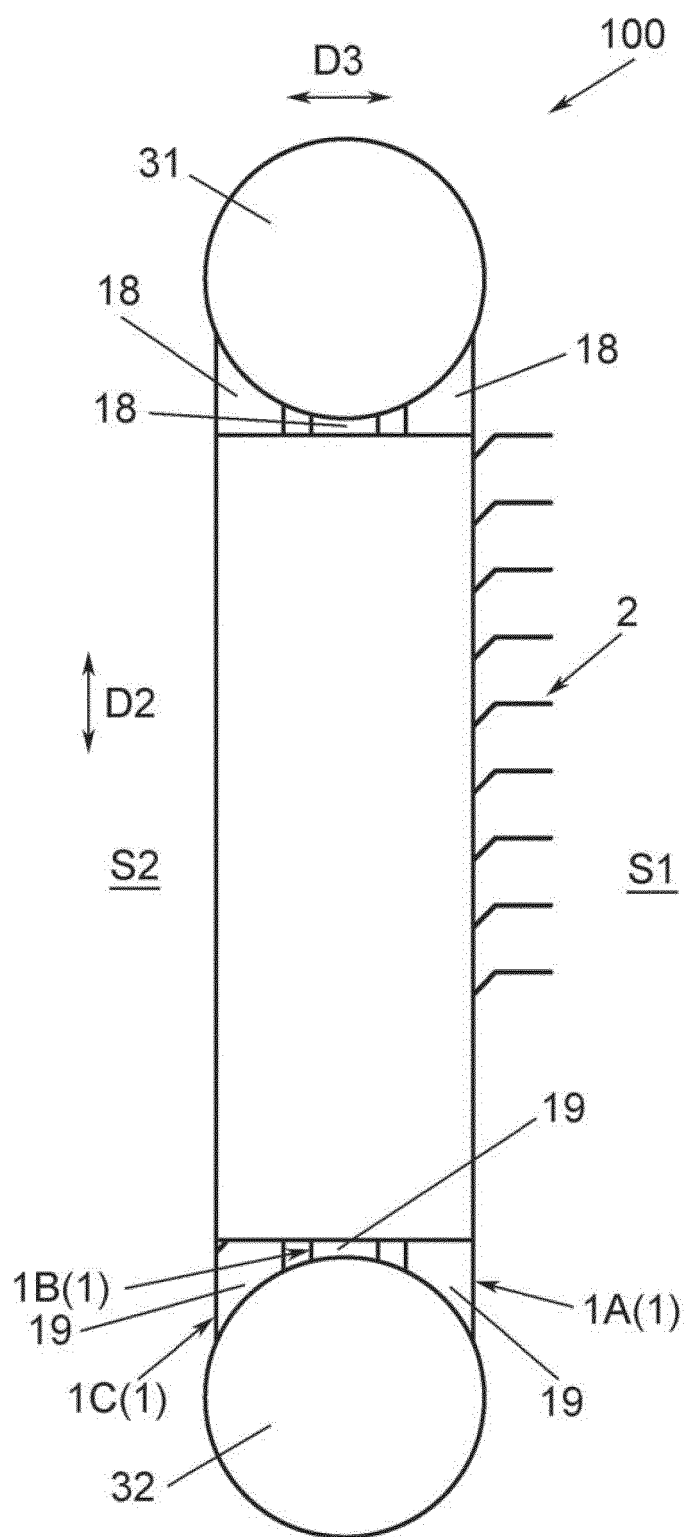


Fig. 16

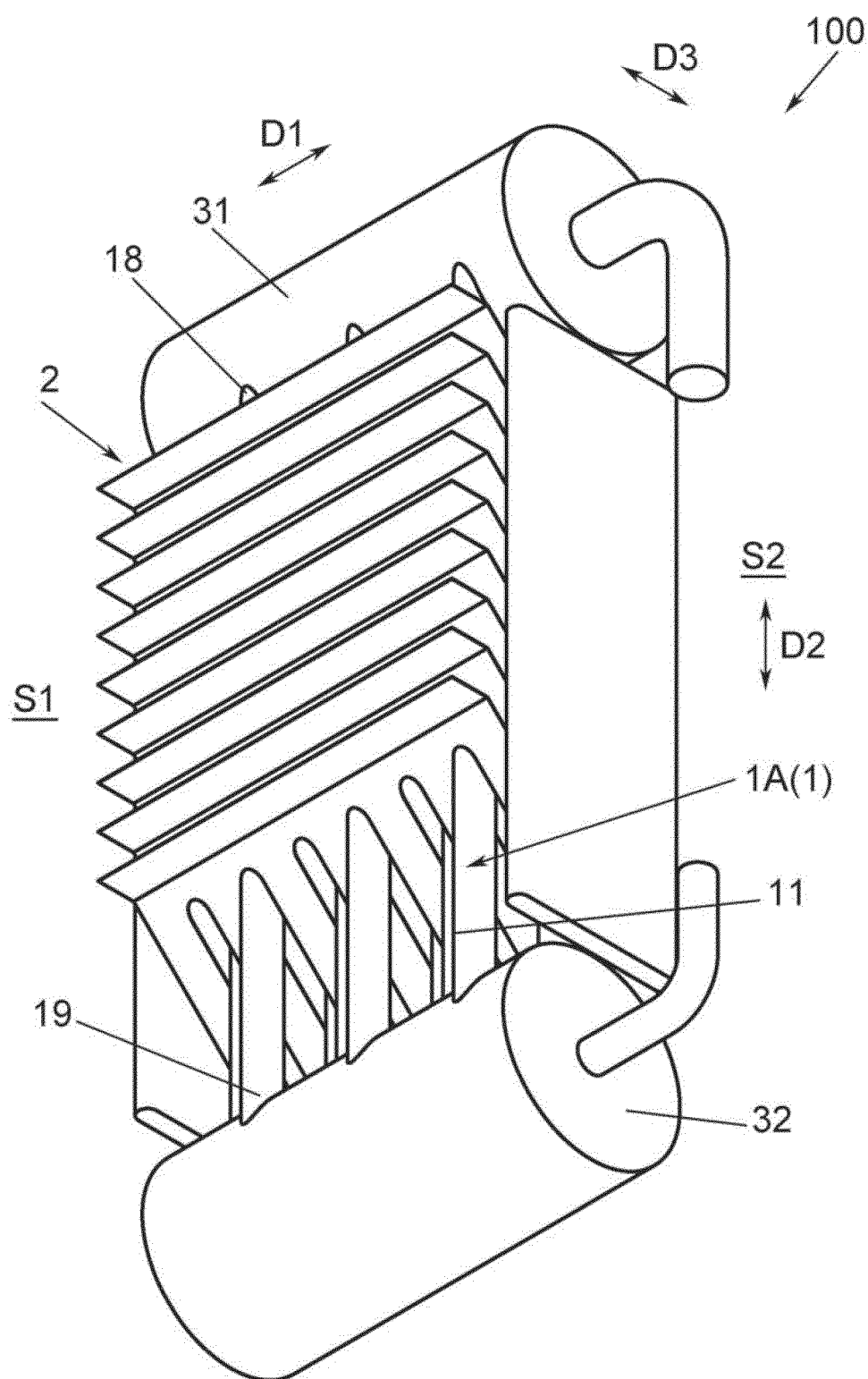


Fig. 17

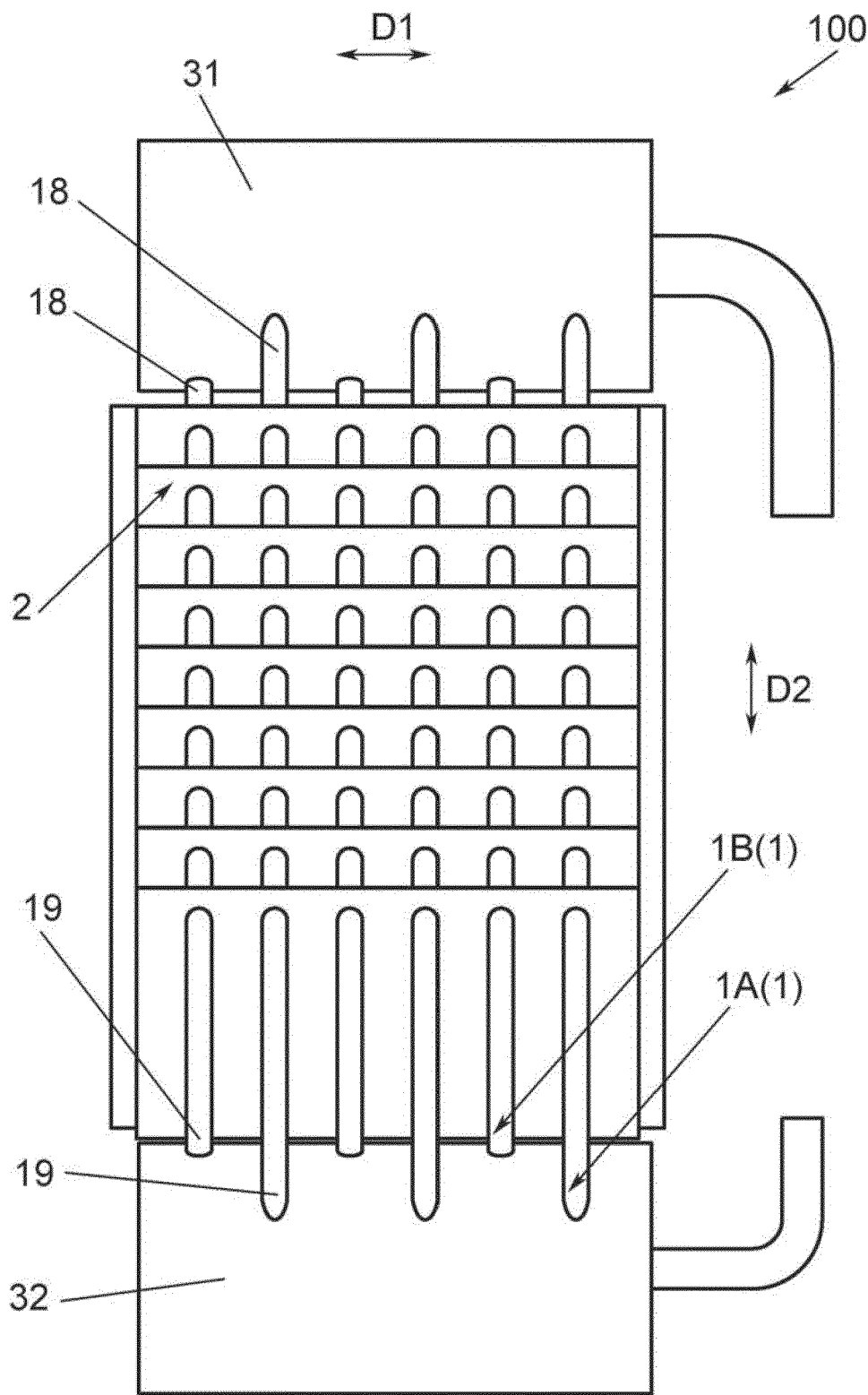


Fig. 18

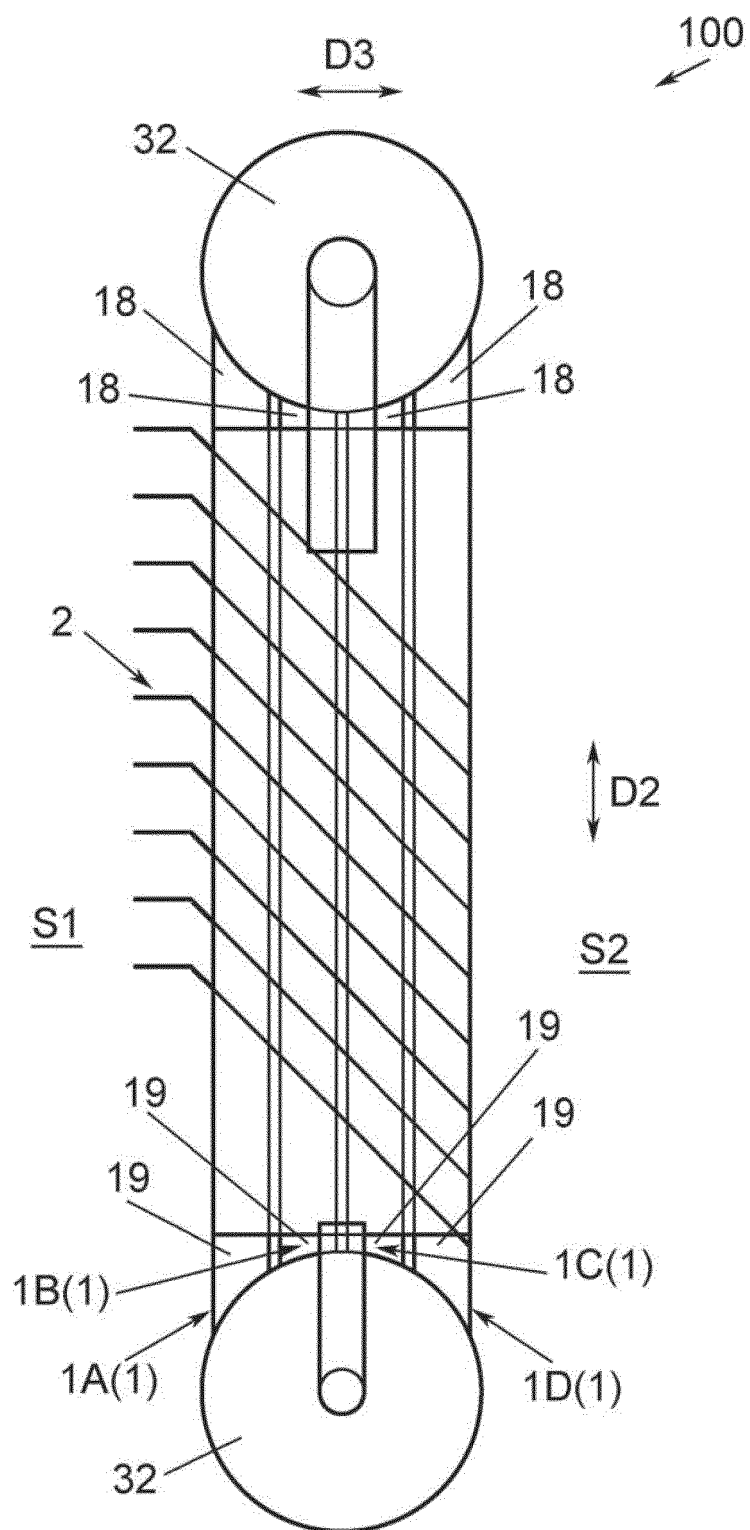


Fig. 19

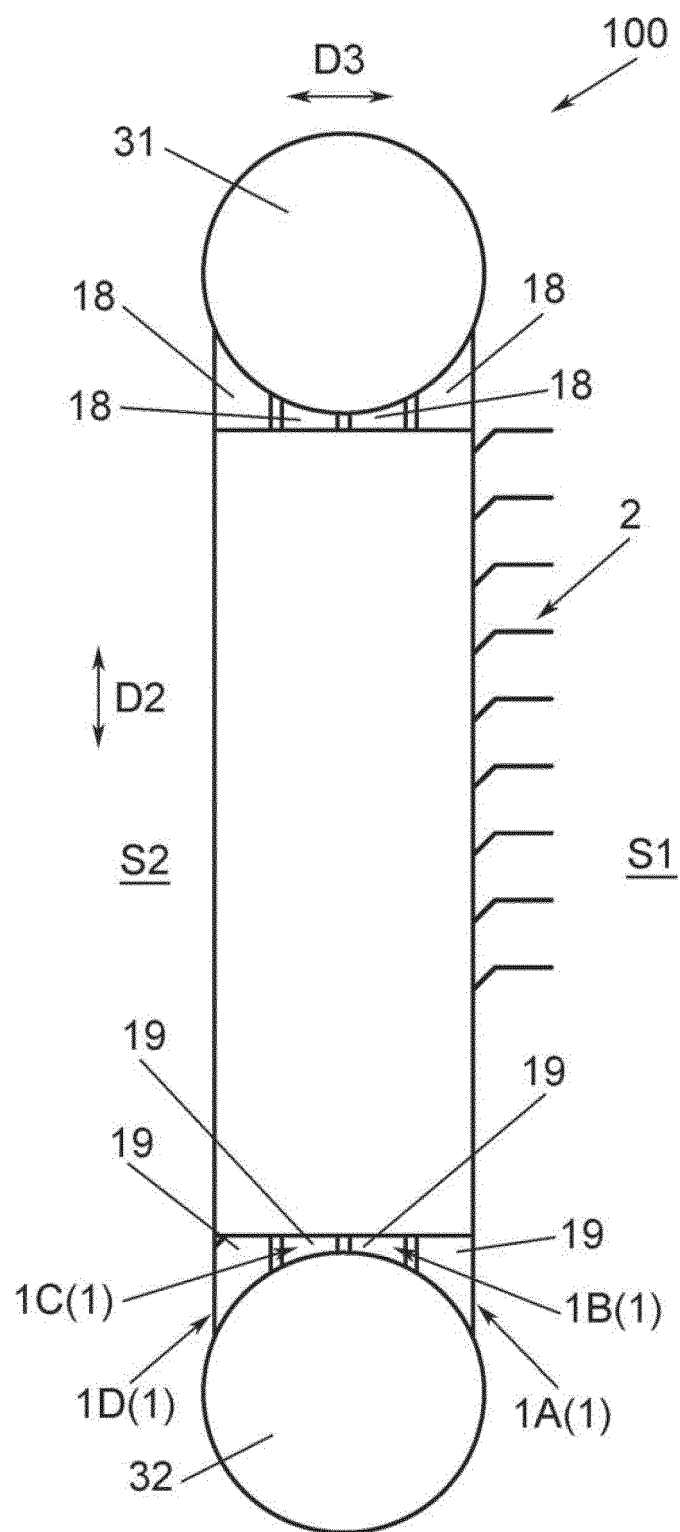


Fig. 20

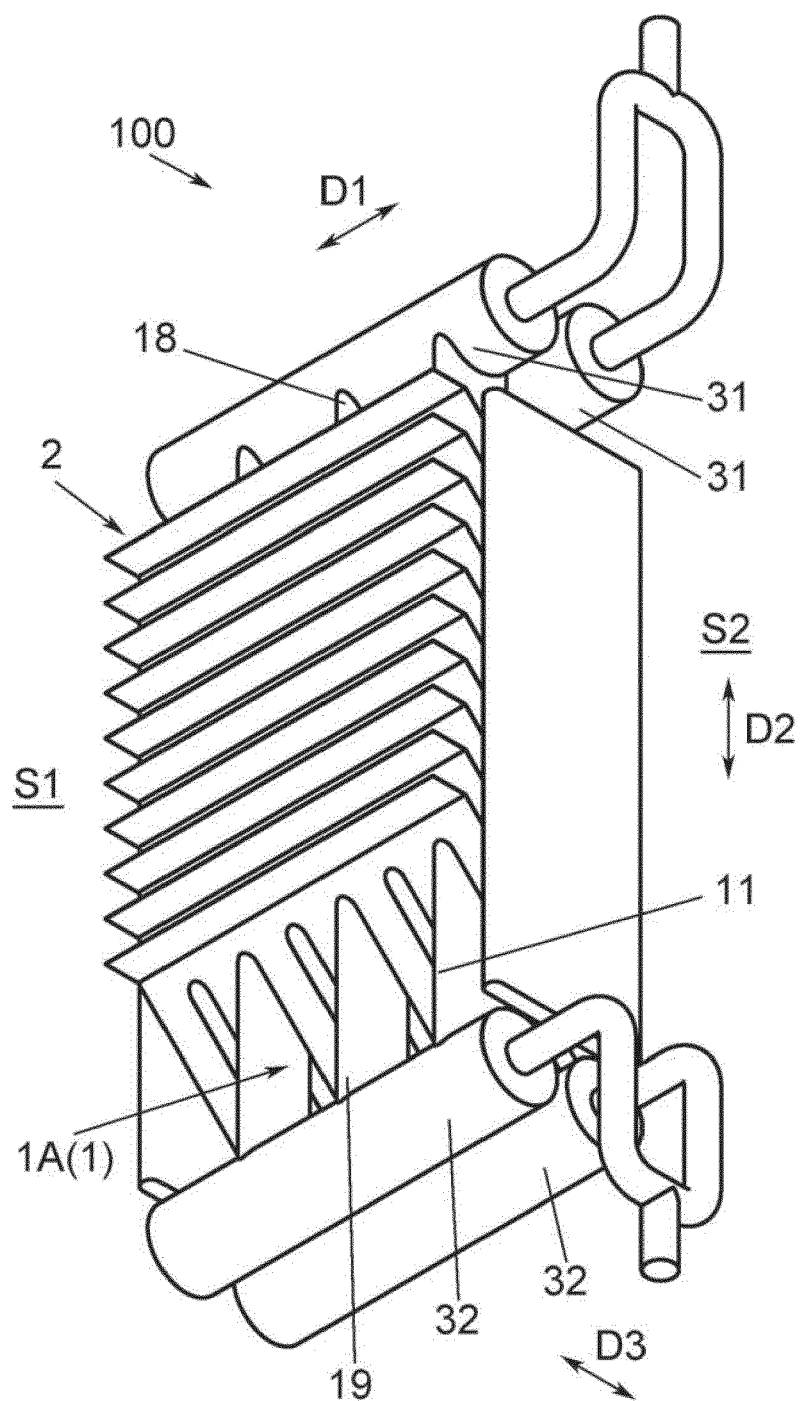


Fig. 21

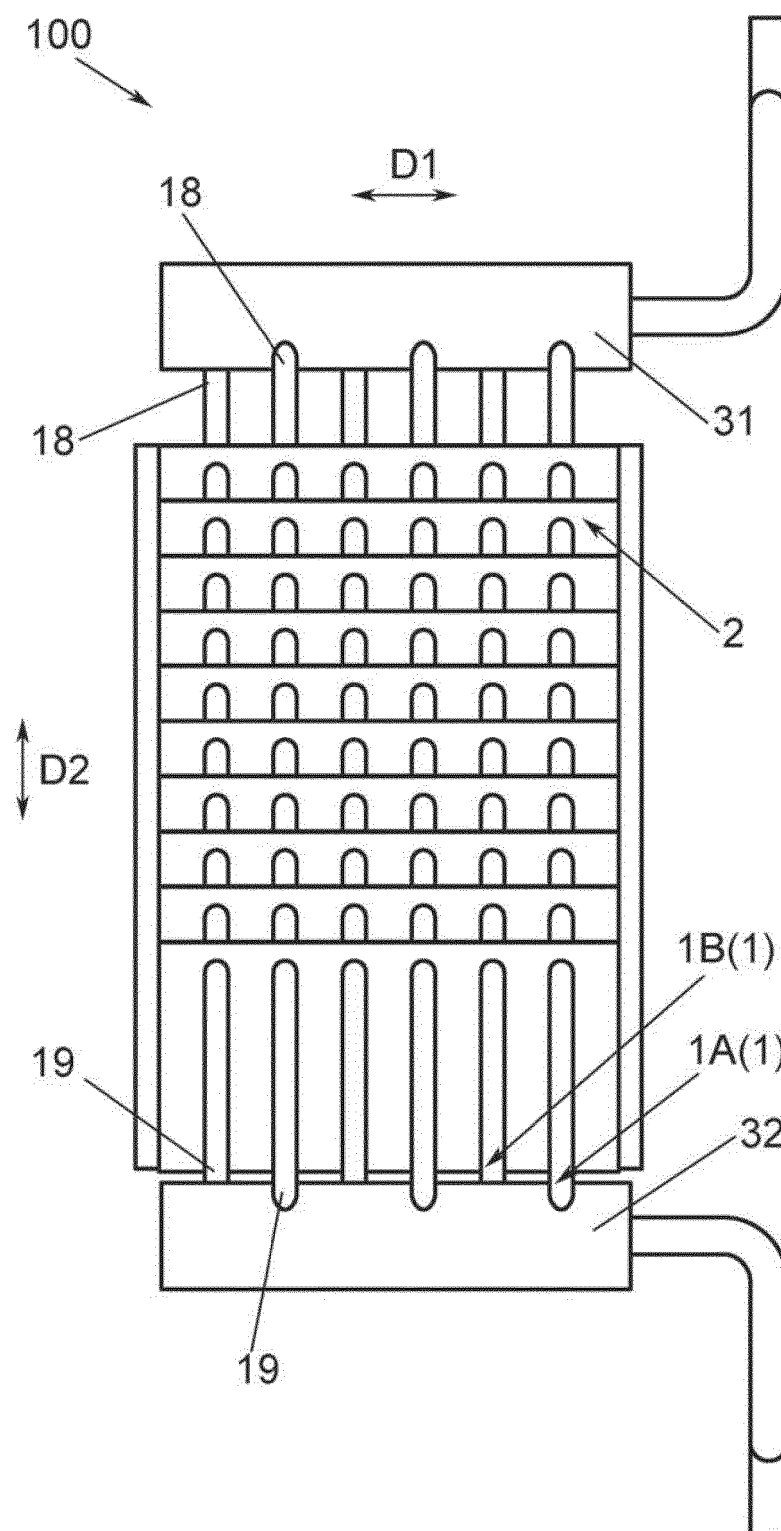


Fig. 22

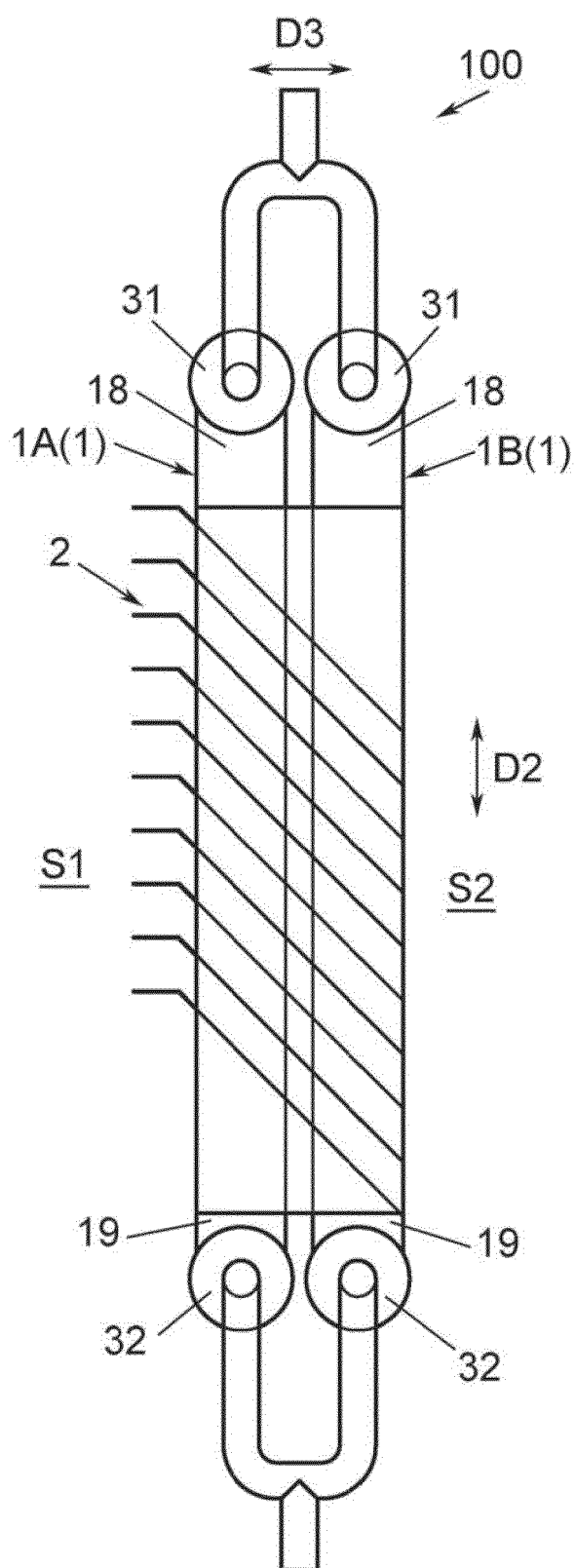


Fig. 23

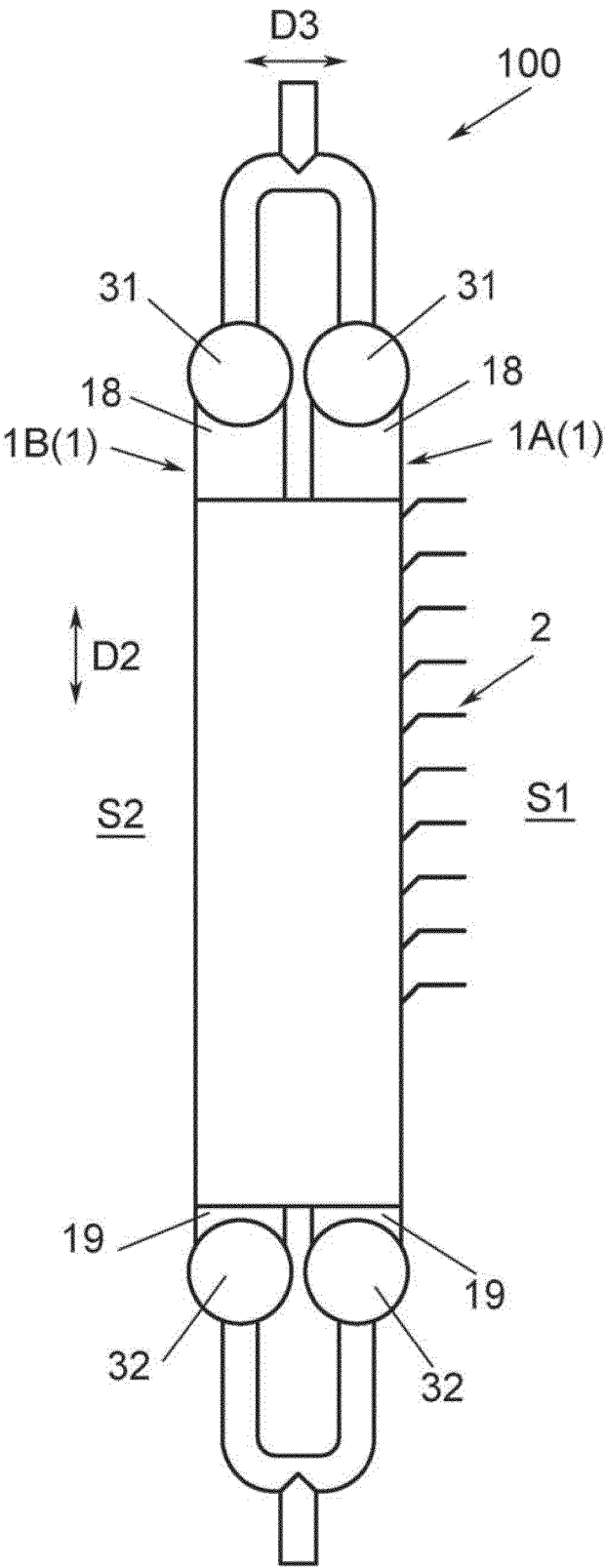


Fig. 24

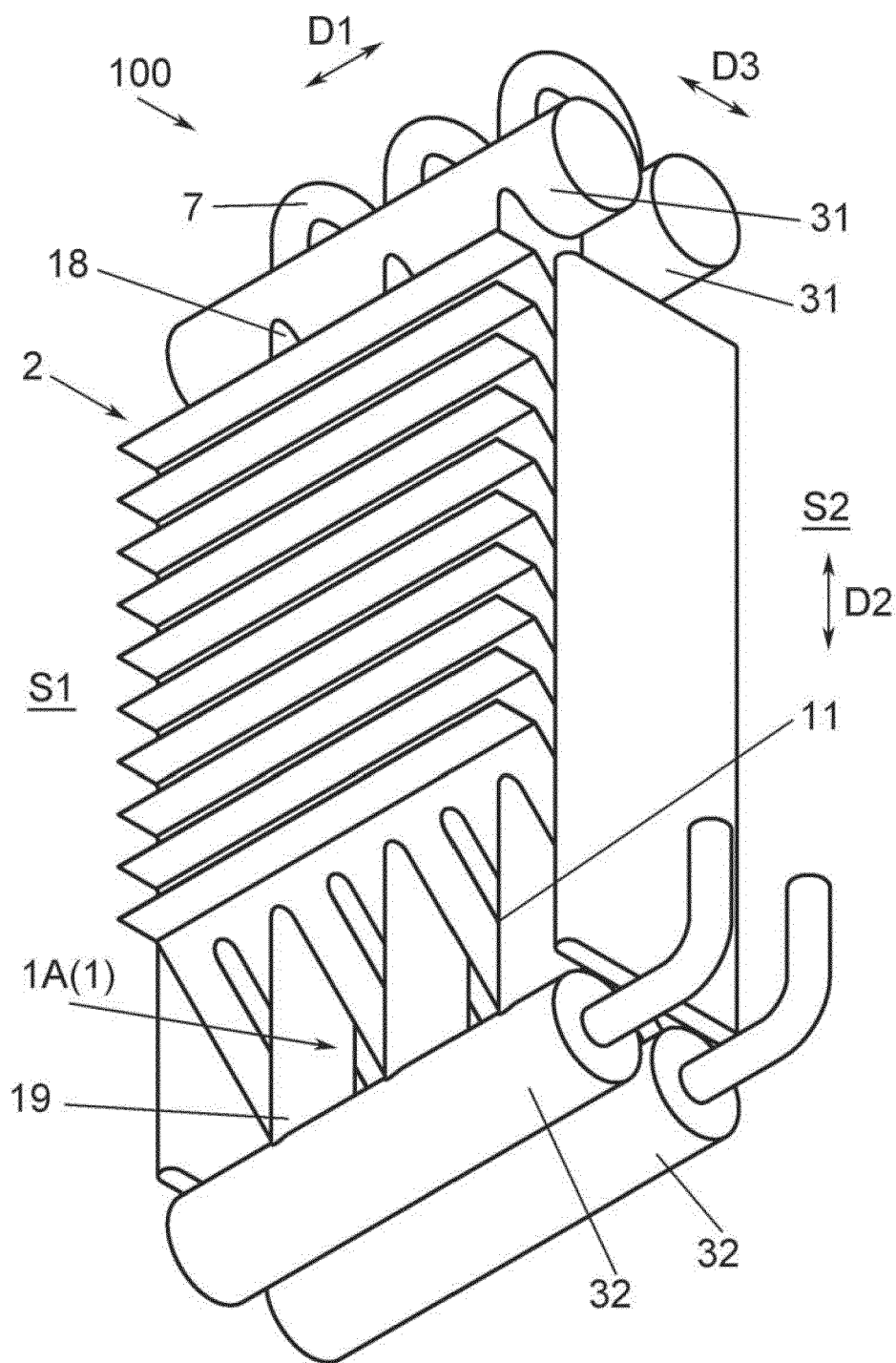


Fig. 25

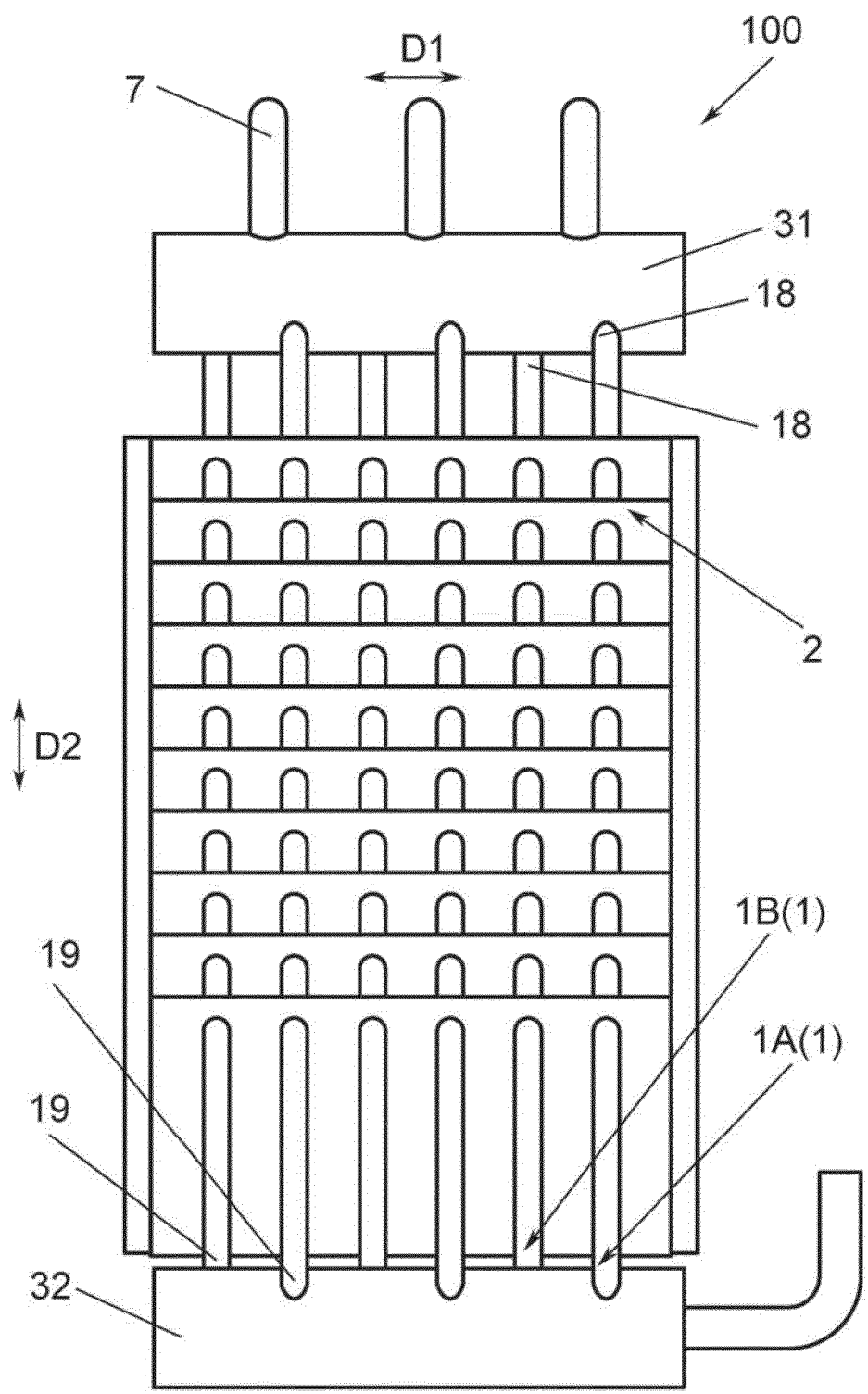


Fig. 26

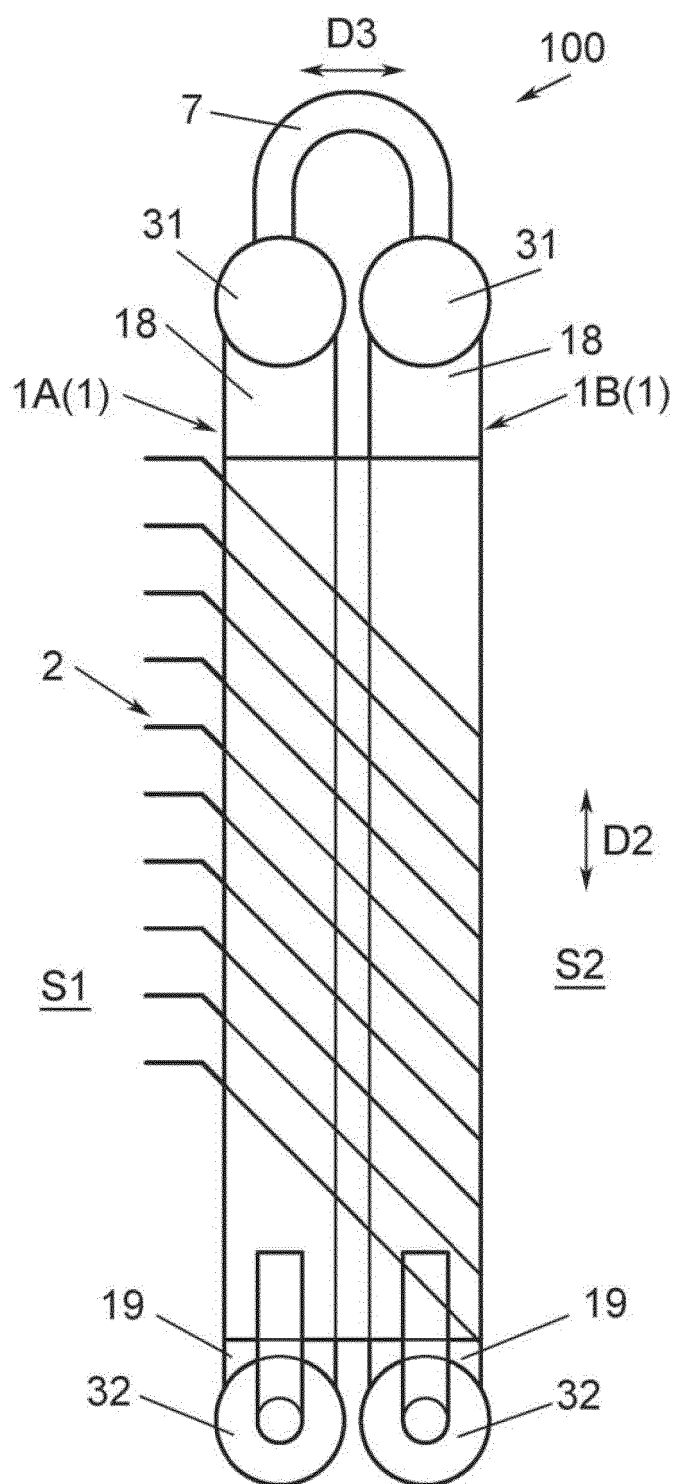


Fig. 27

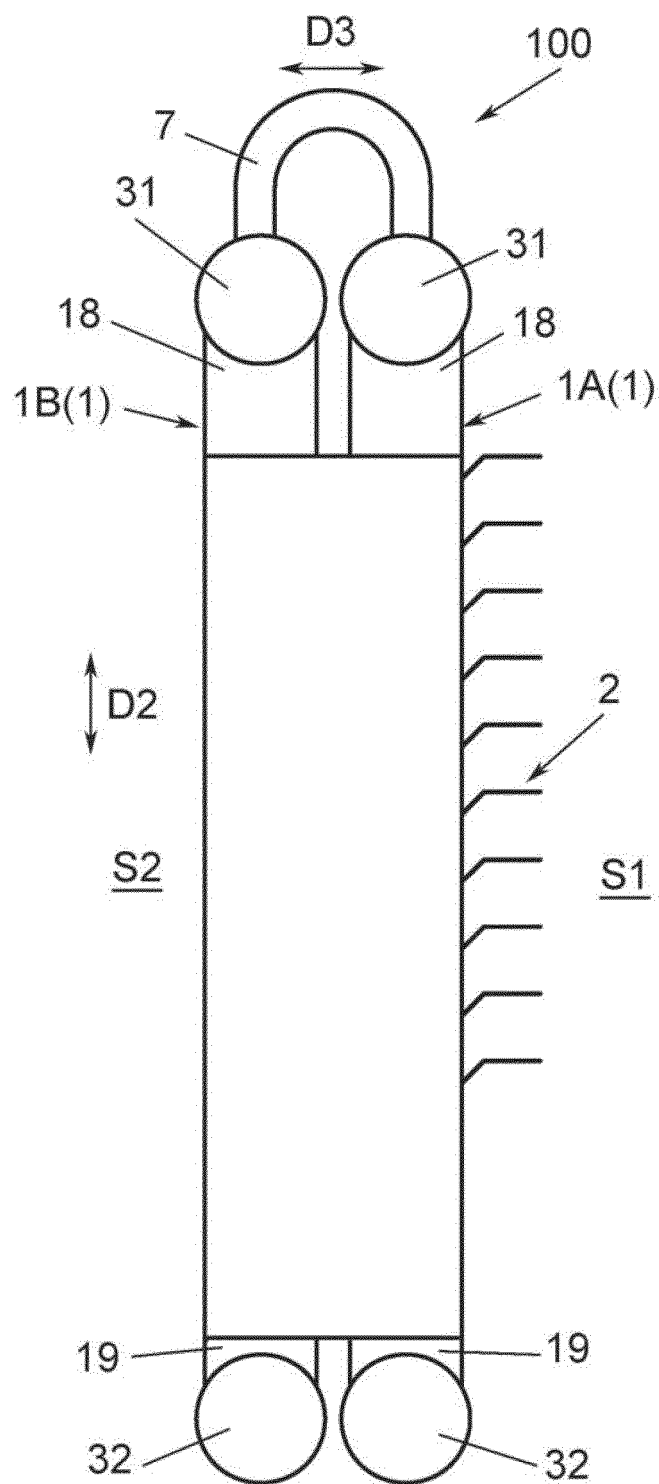


Fig. 28

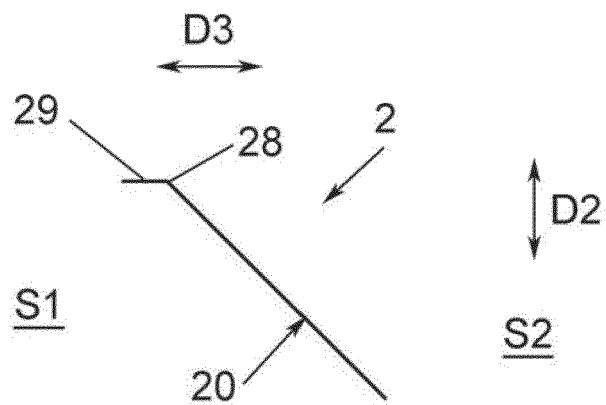


Fig. 29

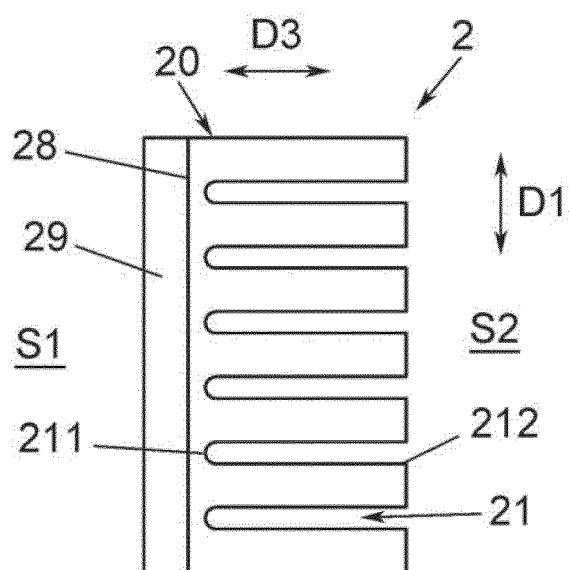


Fig. 30

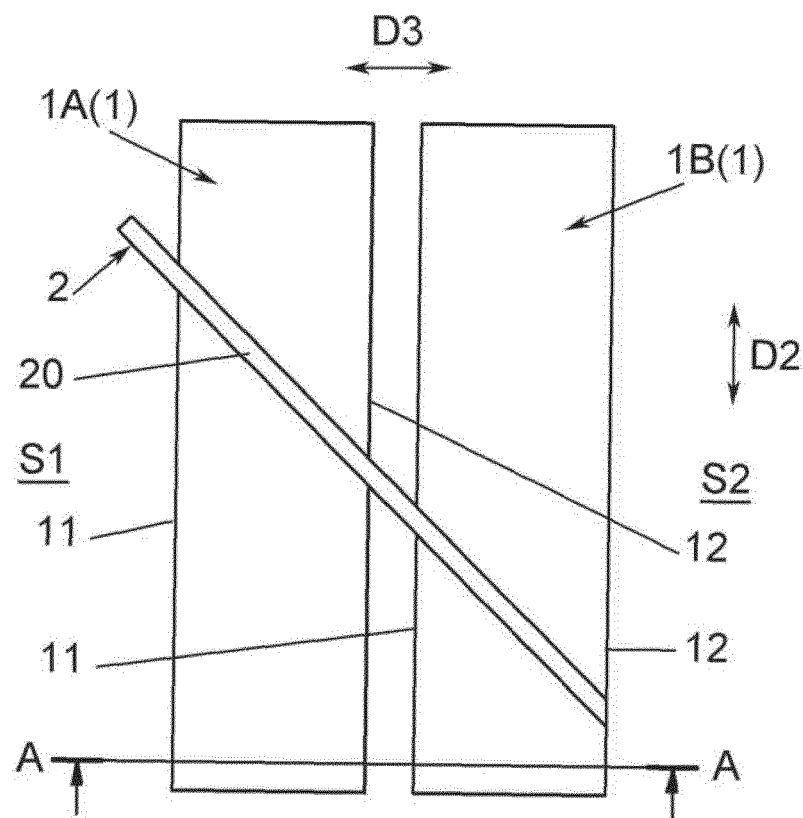


Fig. 31

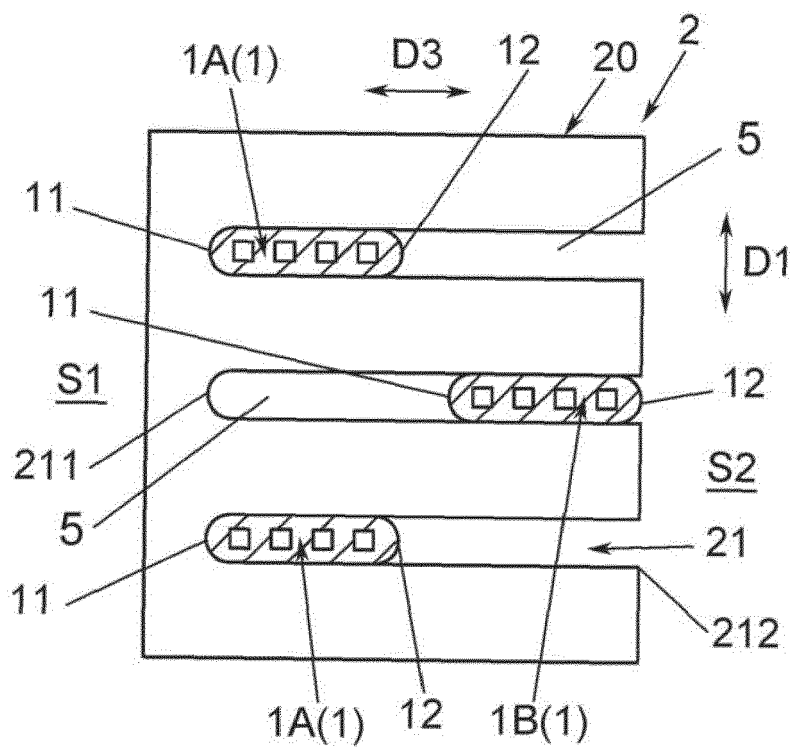


Fig. 32

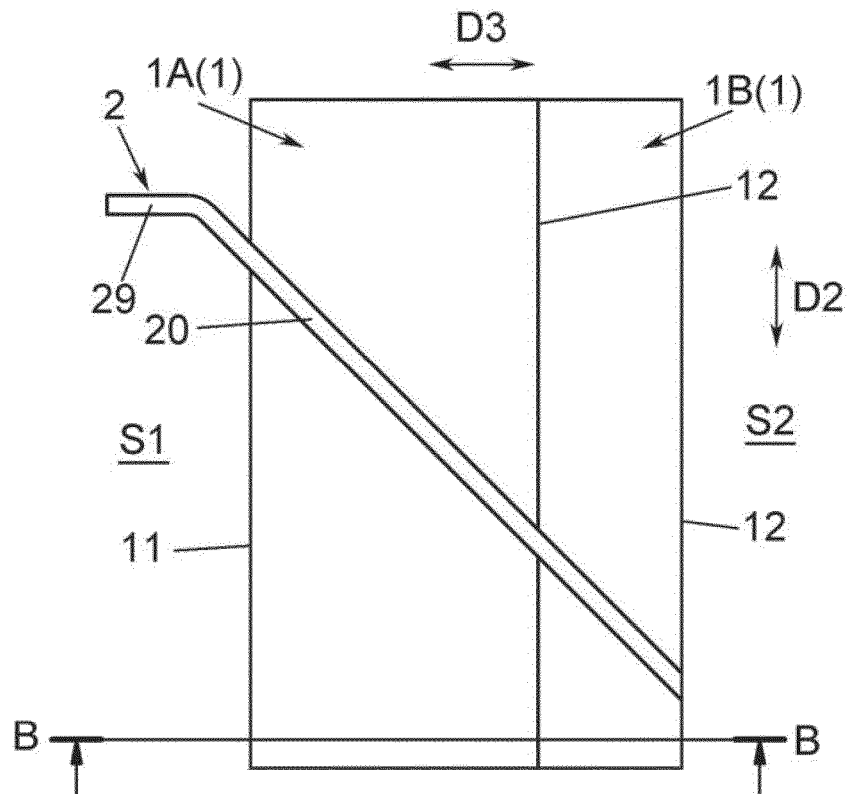


Fig. 33

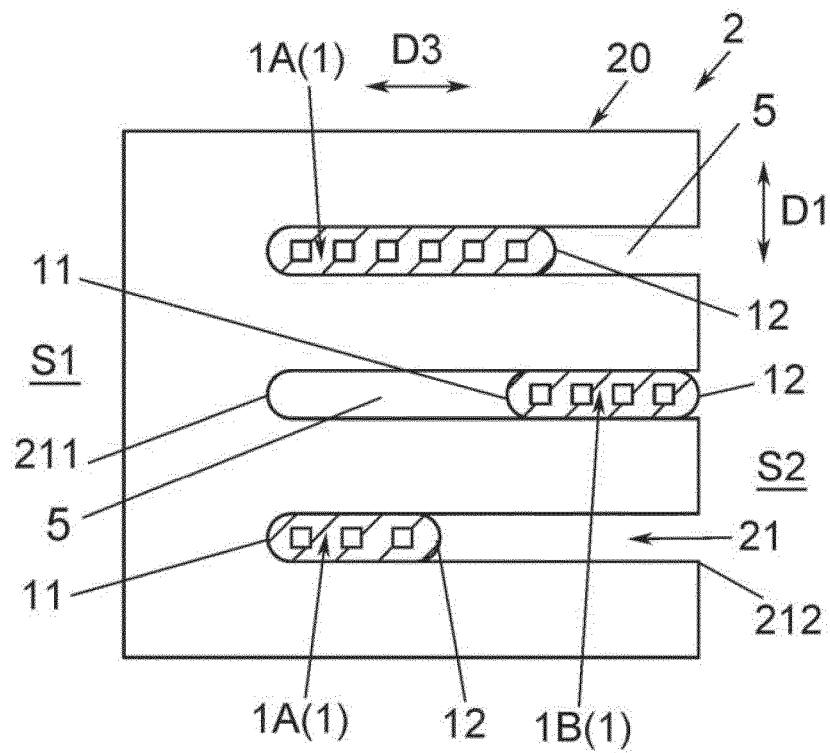


Fig. 34

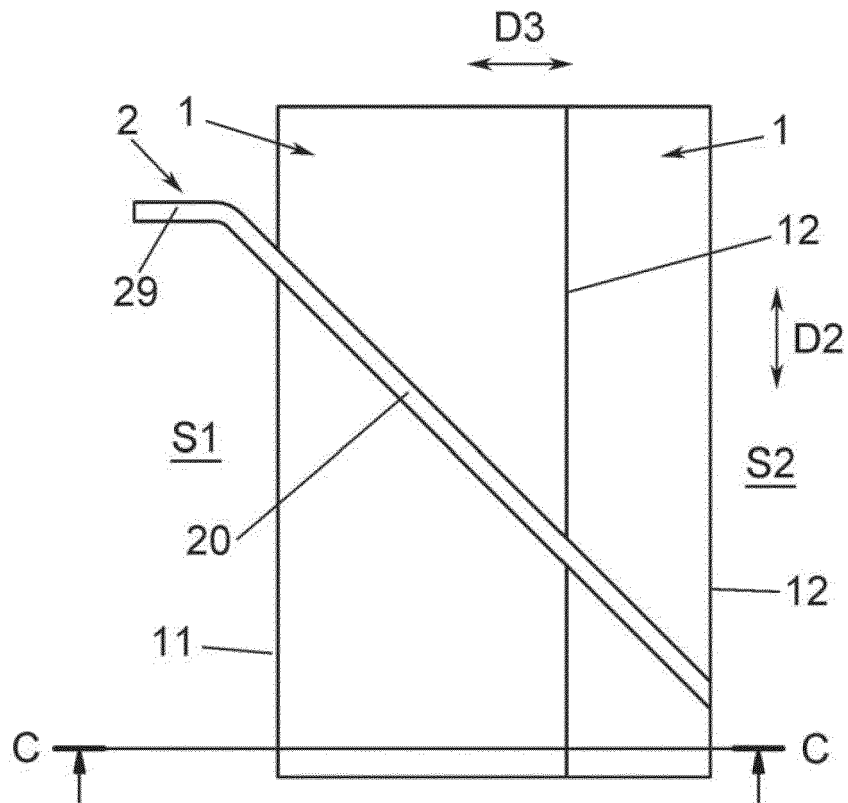


Fig. 35

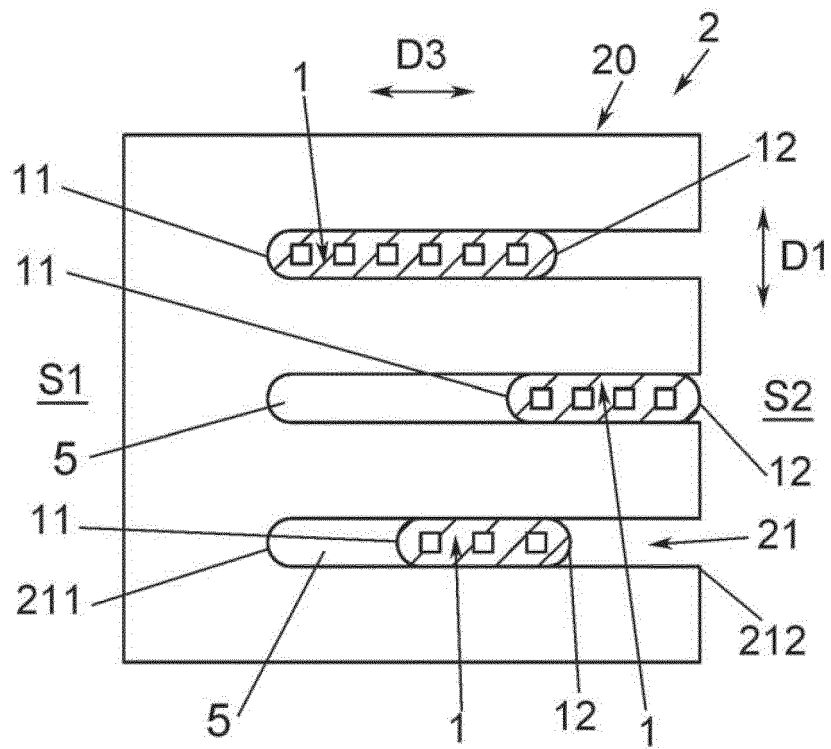


Fig. 36

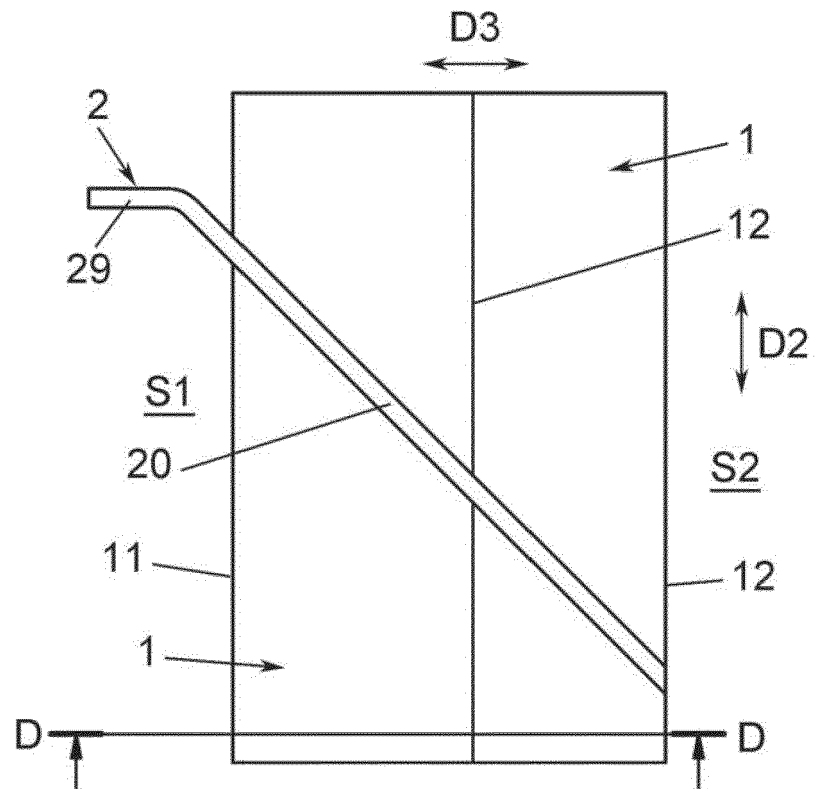


Fig. 37

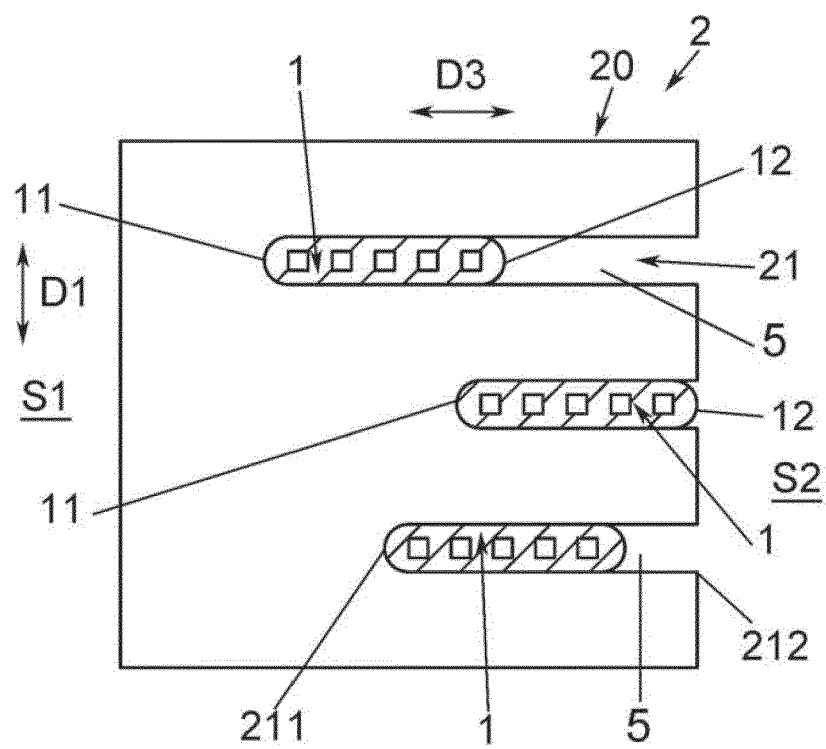


Fig. 38

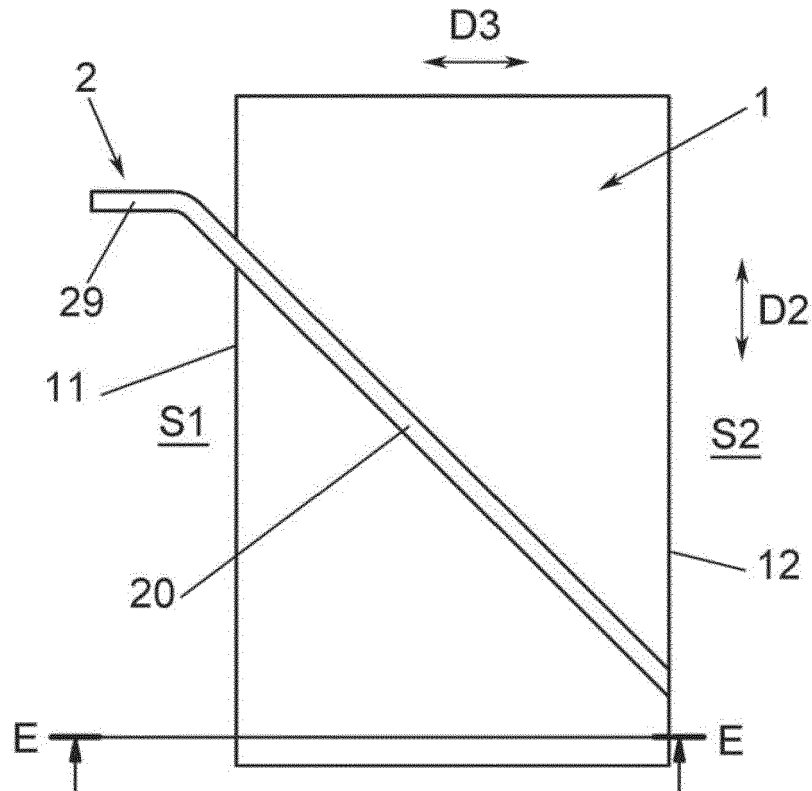


Fig. 39

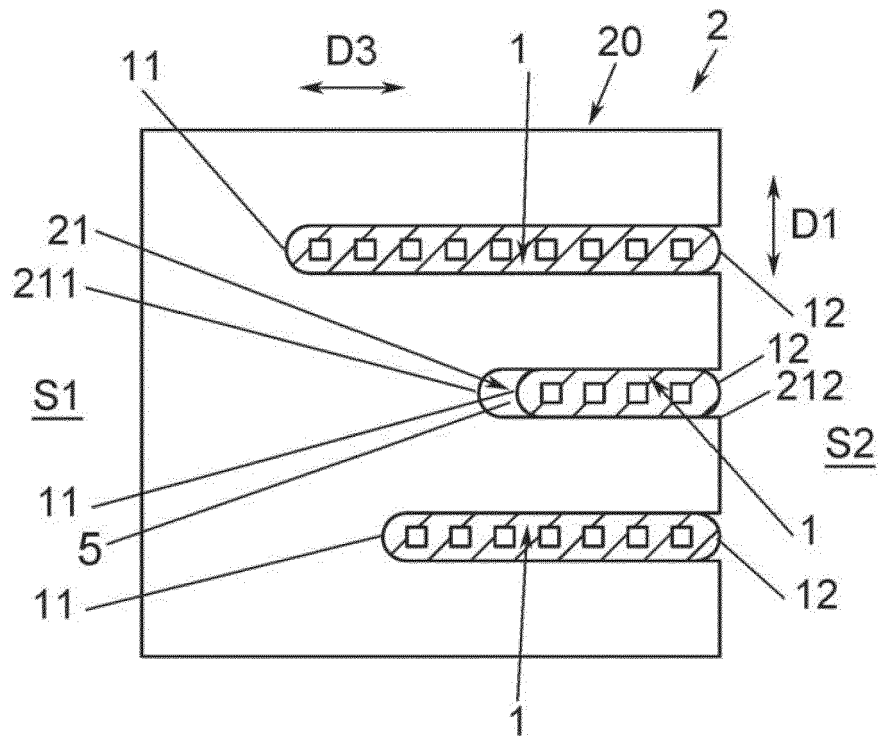


Fig. 40

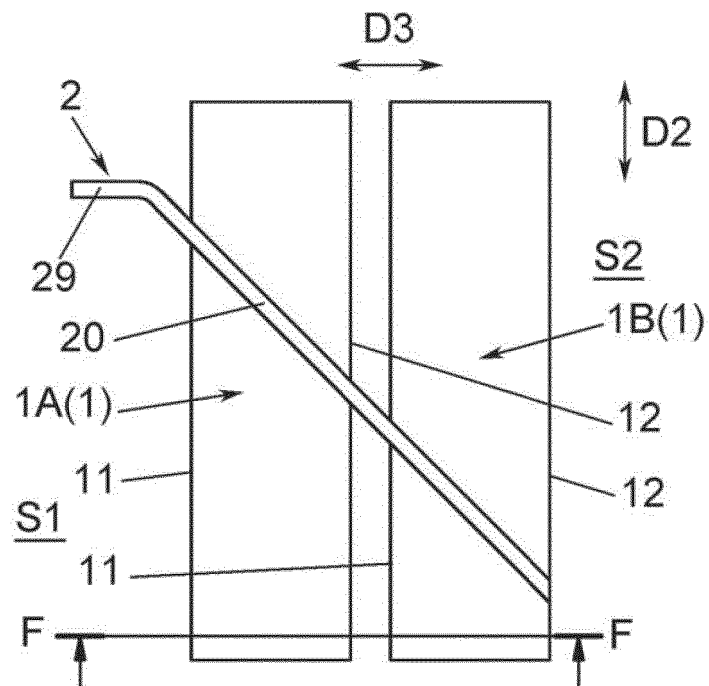


Fig. 41

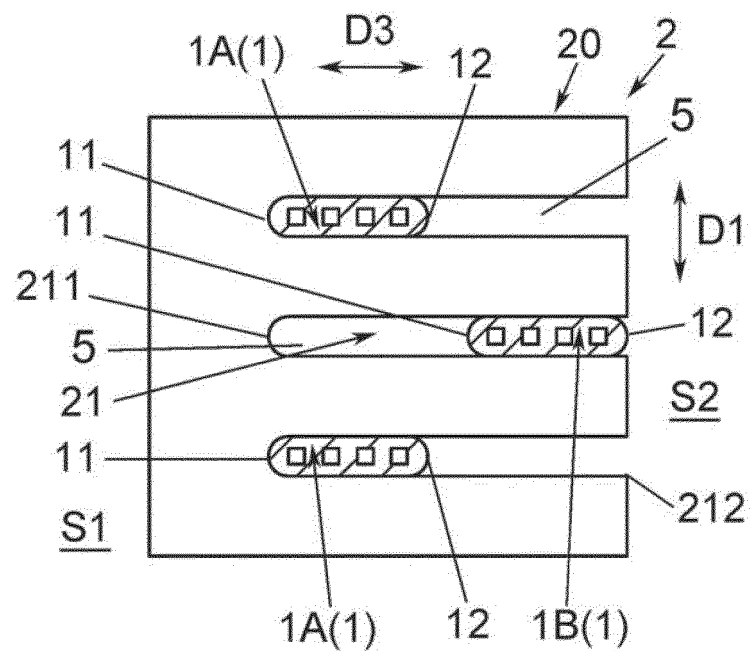


Fig. 42

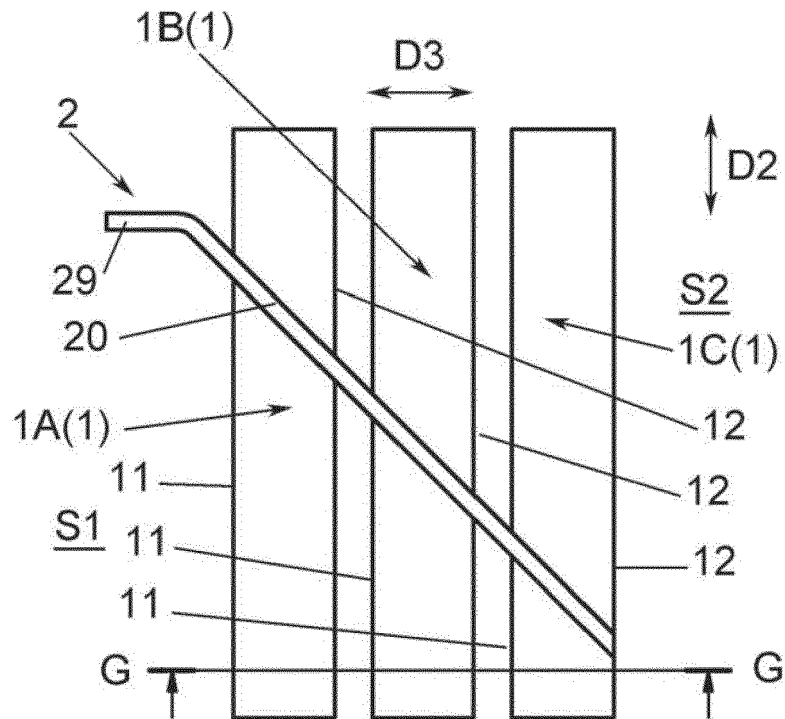


Fig. 43

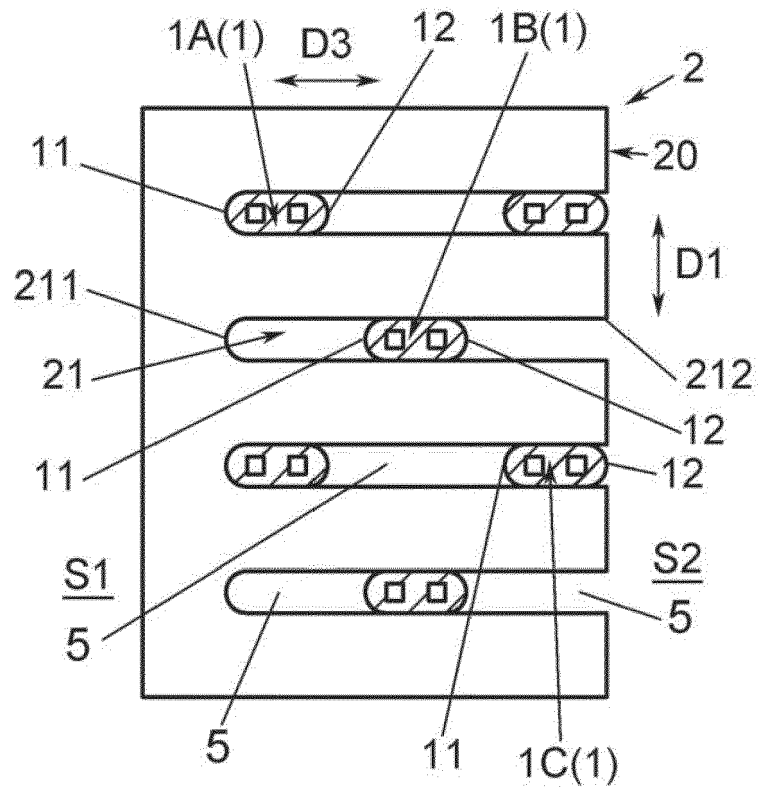


Fig. 44

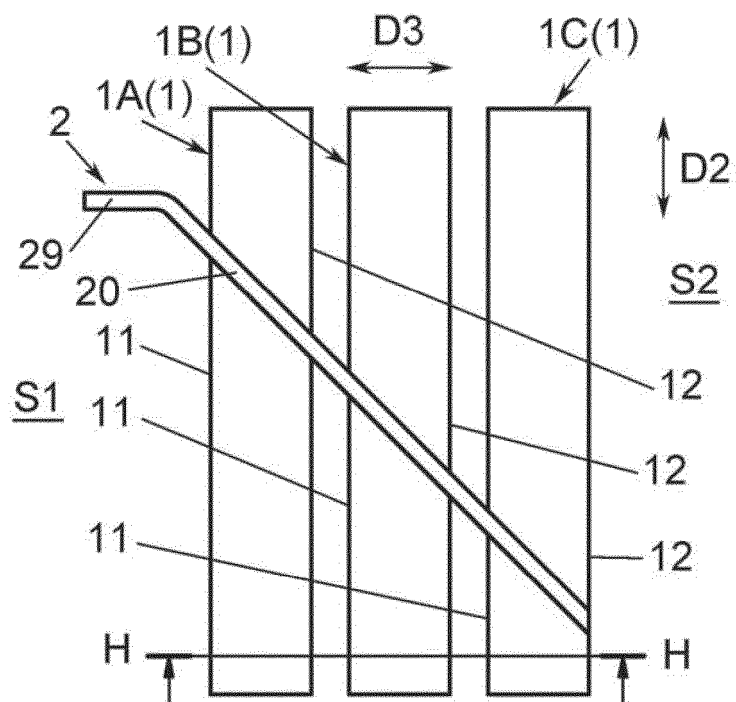


Fig. 45

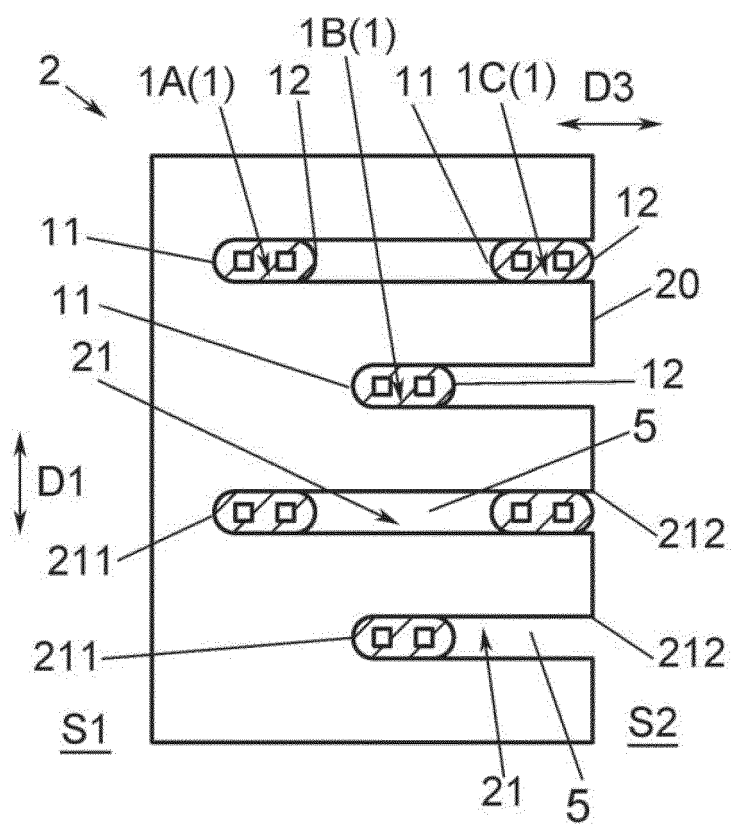


Fig. 46

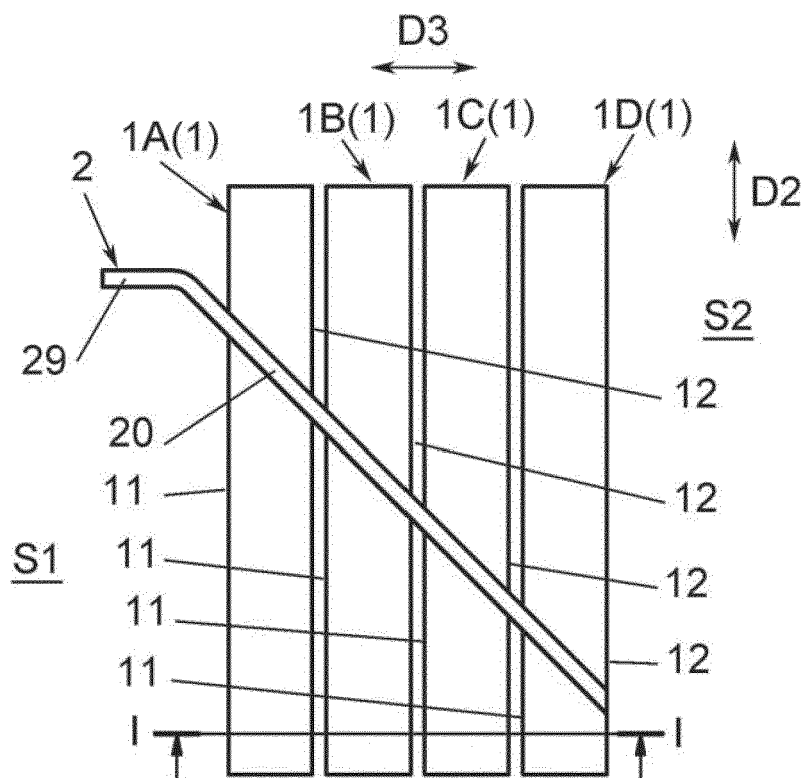


Fig. 47

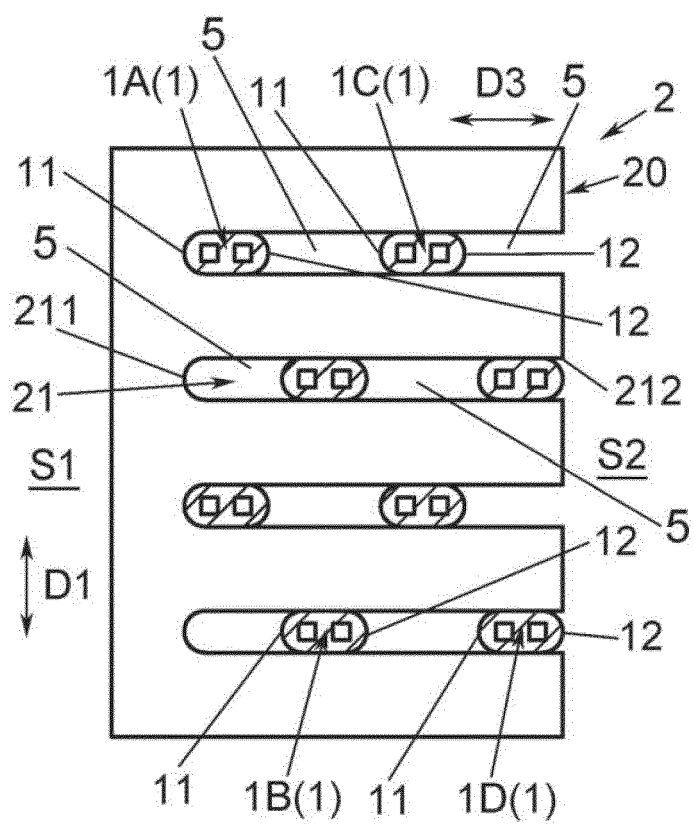
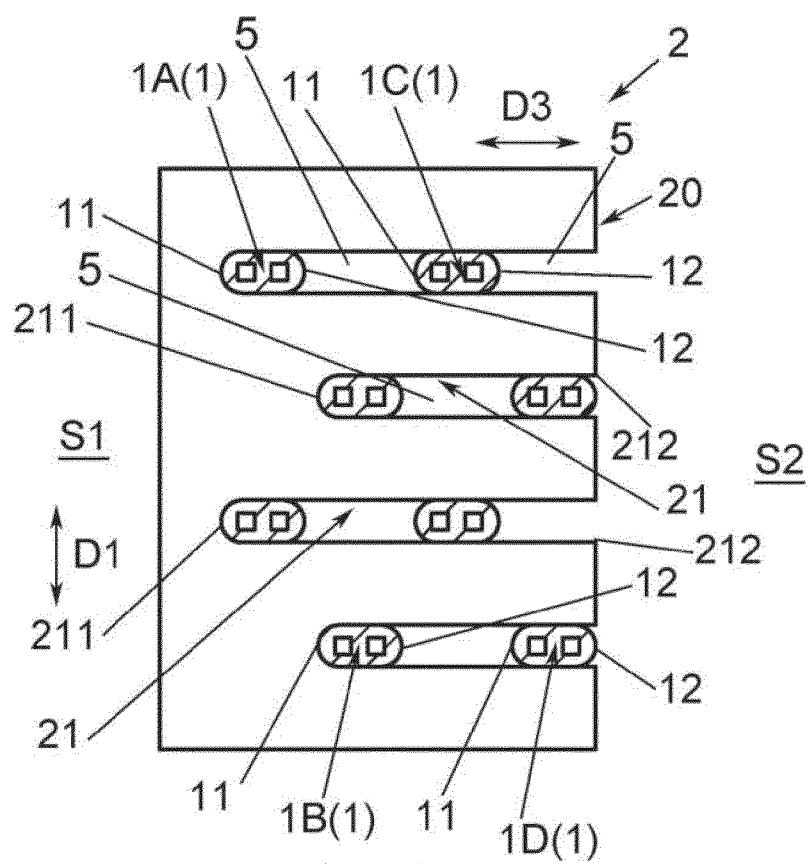
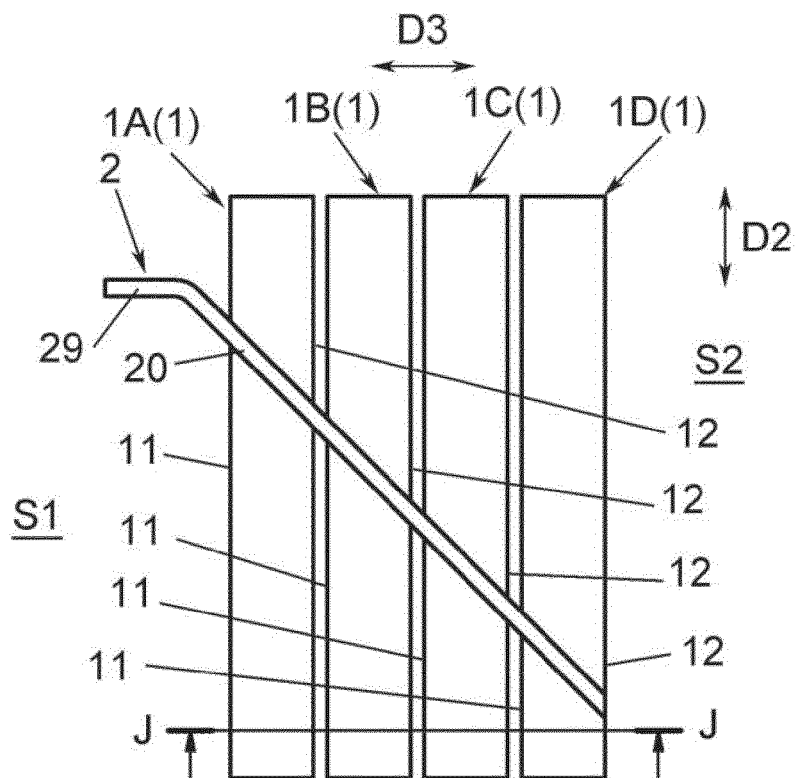


Fig. 48



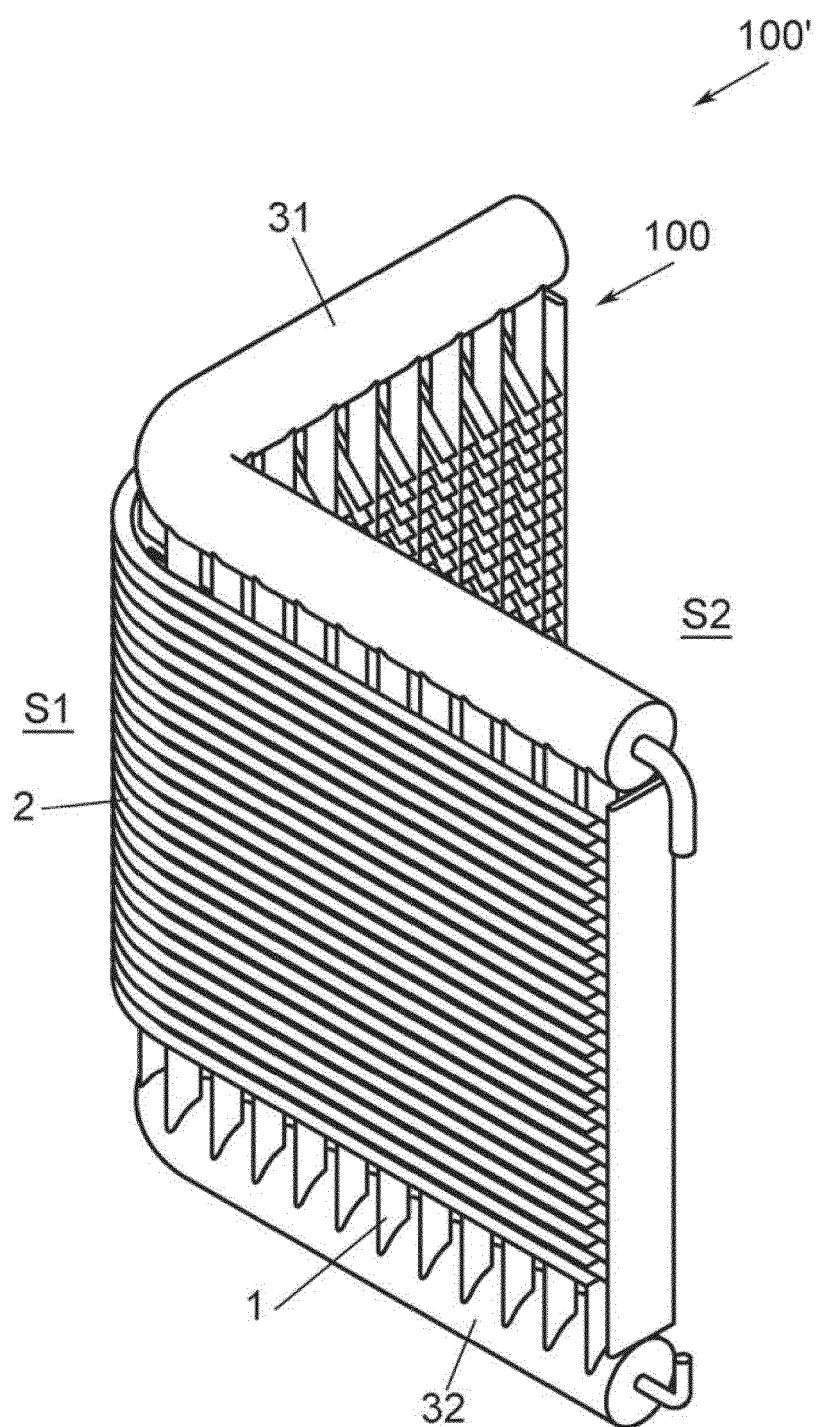


Fig. 51

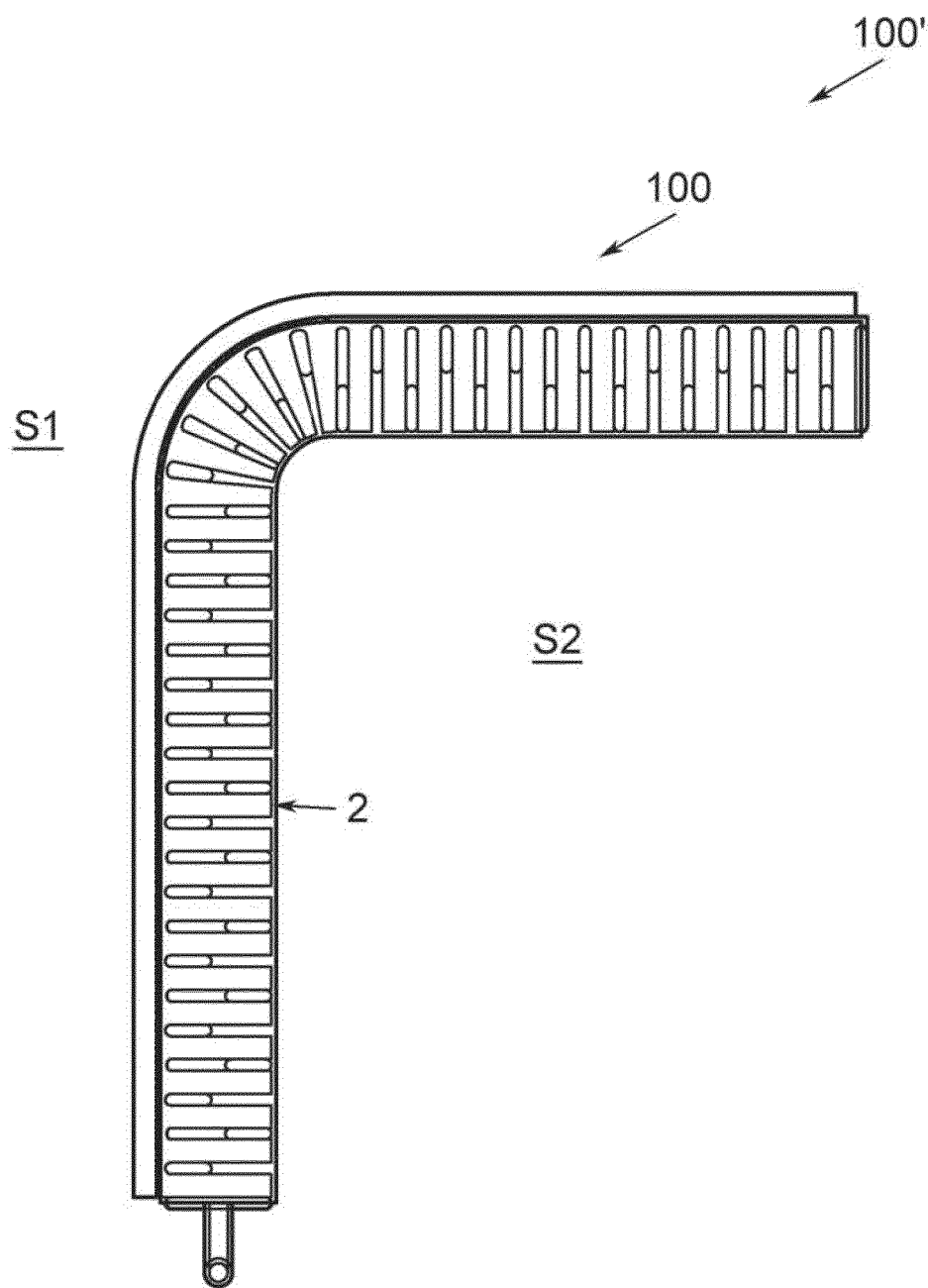


Fig. 52



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