

(19)



(11)

EP 4 560 238 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
28.05.2025 Bulletin 2025/22

(51) International Patent Classification (IPC):
F28D 1/047 ^(2006.01) **F28F 1/02** ^(2006.01)
F28F 1/12 ^(2006.01) **F28F 1/32** ^(2006.01)
F28F 17/00 ^(2006.01)

(21) Application number: **24214568.8**

(22) Date of filing: **21.11.2024**

(52) Cooperative Patent Classification (CPC):
F28D 1/0476; F28F 1/128; F28F 17/005;
F28F 1/025; F28F 1/325; F28F 2210/08;
F28F 2215/04

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR
 Designated Extension States:
BA
 Designated Validation States:
GE KH MA MD TN

(30) Priority: **23.11.2023 CN 202311585174**
23.11.2023 CN 202323168898 U

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(54) HEAT EXCHANGER, AIR CONDITIONING SYSTEM AND HEAT EXCHANGE SYSTEM

(57) The present invention relates to a heat exchanger (100) that includes a first heat exchanger core (1) and a second heat exchanger core (2) arranged side by side. The first heat exchanger core (1) includes a first main segment (10, 10A, 10B), a first connection segment (19, 19A, 19B) connected with the first main segment (10, 10A, 10B), and a first header (13). The first main segment (10, 10A, 10B) includes a plurality of first heat exchange tubes (11, 11A, 11B) arranged in a second direction (2) perpendicular to a first direction (D1). The second heat exchanger core (2) includes a second main segment (20), a second connection segment (29) connected with the second main segment (20), and a second header (23). The second main segment (20) includes a plurality of second heat exchange tubes (21) arranged in the second direction (D2). The first main segment (10, 10A, 10B) includes a first wind resistance region (17, 17A, 17B) and a second wind resistance region (18, 18A, 18B) arranged in a third direction (D3) perpendicular to the first direction (D1) and the second direction (D2), the second wind resistance region (18, 18A, 18B) being adjacent to the first header (13), and a wind resistance of the second wind resistance region (18, 18A, 18B) is smaller than that of the first wind resistance region (17, 17A, 17B), thereby improving the performance of the heat exchanger (100).

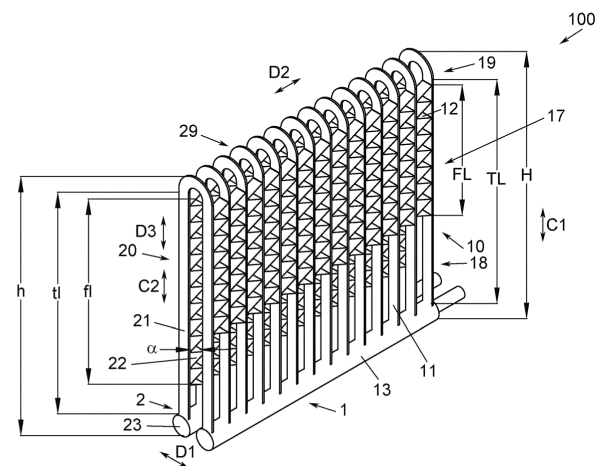


Fig. 1

Description

TECHNICAL FIELD

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

BACKGROUND

[0002] A heat exchanger including two rows of heat exchanger cores may be formed by bending a flat heat exchanger. The flat heat exchanger includes header(s), heat exchange tube(s), and fin(s), both ends of the heat exchange tube are connected to the headers.

SUMMARY

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

[0004] Embodiments of the present invention provide a heat exchanger including: a first heat exchanger core and a second heat exchanger core arranged side by side in a first direction. The first heat exchanger core includes: a first main segment, the first main segment of the first heat exchanger core including a plurality of first heat exchange tubes arranged in a second direction perpendicular to the first direction; a first connection segment connected with the first main segment; and a first header connected and fluidly communicated with the plurality of first heat exchange tubes on a side of the first main segment of the first heat exchanger core opposite to the first connection segment. The second heat exchanger core includes: a second main segment, the second main segment of the second heat exchanger core including a plurality of second heat exchange tubes arranged in the second direction; a second connection segment connected with the second main segment; and a second header connected and fluidly communicated with the plurality of second heat exchange tubes on a side of the second main segment of the second heat exchanger core opposite to the second connection segment. The plurality of first heat exchange tubes of the first main segment of the first heat exchanger core and the plurality of second heat exchange tubes of the second main segment of the second heat exchanger core are interconnected and in fluid communication by the first connection segment of the first heat exchanger core and the second connection segment of the second heat exchanger core, and the first main segment of the first heat exchanger core includes a first wind resistance region and a second wind resistance region arranged in a third direction perpendicular to the first direction and the sec-

ond direction, or in a first heat exchanger core extension direction perpendicular to the second direction and parallel to a first plane in which the first main segment of the first heat exchanger core is located, the second wind resistance region being adjacent to the first header, and a wind resistance of the second wind resistance region being smaller than that of the first wind resistance region.

[0005] According to embodiments of the present invention, the first wind resistance region has a size in the first heat exchanger core extension direction, the first main segment of the first heat exchanger core has a size in the first heat exchanger core extension direction, and a ratio of the size of the first wind resistance region to the size of the first main segment is greater than or equal to 20% and less than or equal to 90%; or a ratio of a size of the first wind resistance region in the third direction to a size of the first main segment of the first heat exchanger core in the third direction is greater than or equal to 20% and less than or equal to 90%; or a ratio of a length of a portion of the first heat exchange tube occupied by the first wind resistance region to a length of the first heat exchange tube is greater than or equal to 20% and less than or equal to 90%.

[0006] According to embodiments of the present invention, the first heat exchanger core has a first orthographic projection on a second plane in which the second main segment of the second heat exchanger core is located, the second heat exchanger core has a second orthographic projection on the second plane in which the second main segment of the second heat exchanger core is located, and a ratio of an overlapping area between the first orthographic projection of the first heat exchanger core and the second orthographic projection of the second heat exchanger core to an area of the second orthographic projection of the second heat exchanger core is greater than or equal to 50% and less than or equal to 100%.

[0007] According to embodiments of the present invention, an angle between the first main segment of the first heat exchanger core and the second main segment of the second heat exchanger core is greater than or equal to 0 degree and less than or equal to 45 degrees.

[0008] According to embodiments of the present invention, the first heat exchanger core has a size in the first heat exchanger core extension direction, the second heat exchanger core has a size in a second heat exchanger core extension direction perpendicular to the second direction and parallel to a second plane in which the second main segment of the second heat exchanger core is located, and a ratio of the size of the first heat exchanger core and the size of the second heat exchanger core is greater than or equal to 30% and less than or equal to 100%; or a ratio of a size of the first heat exchanger core in the third direction to a size of the second heat exchanger core in the third direction is greater than or equal to 30% and less than or equal to 100%.

[0009] According to embodiments of the present in-

vention, the first heat exchanger core has a size in the first heat exchanger core extension direction, the second heat exchanger core has a size in a second heat exchanger core extension direction perpendicular to the second direction and parallel to a second plane in which the second main segment of the second heat exchanger core is located, and a ratio of the size of the first heat exchanger core to the size of the second heat exchanger core is greater than or equal to 60% and less than or equal to 100%; or a ratio of a size of the first heat exchanger core in the third direction to a size of the second heat exchanger core in the third direction is greater than or equal to 60% and less than or equal to 100%.

[0010] According to embodiments of the present invention, the first main segment of the first heat exchanger core further includes: a first fin connected with the first heat exchange tubes and provided in the first wind resistance region, there is no fin in the second wind resistance region of the first main segment of the first heat exchanger core, the second main segment of the second heat exchanger core further includes: a second fin connected with the second heat exchange tubes, the second wind resistance region of the first main segment of the first heat exchanger core has a size in the first heat exchanger core extension direction, the second main segment of the second heat exchanger core has a size in a second heat exchanger core extension direction perpendicular to the second direction and parallel to a second plane in which the second main segment of the second heat exchanger core is located, and a ratio of the size of the second wind resistance region to the size of the second main segment of the second heat exchanger core is greater than or equal to 10% and less than or equal to 70%; or the first main segment of the first heat exchanger core further includes: a first fin connected with the first heat exchange tubes and provided in the first wind resistance region, there is no fin in the second wind resistance region of the first main segment of the first heat exchanger core, the second main segment of the second heat exchanger core further includes: a second fin connected with the second heat exchange tubes, the second wind resistance region of the first main segment of the first heat exchanger core has a size in the third direction, the second main segment of the second heat exchanger core has a size in the third direction, and a ratio of the size of the second wind resistance region to the size of the second main segment of the second heat exchanger core is greater than or equal to 10% and less than or equal to 70%.

[0011] According to embodiments of the present invention, the first main segment of the first heat exchanger core further includes: a first fin connected with the first heat exchange tubes and provided in the first wind resistance region, there is no fin in the second wind resistance region of the first main segment of the first heat exchanger core, the second main segment of the second heat exchanger core further includes: a wavy second fin connected with the second heat exchange tubes and

alternately arranged with the second heat exchange tubes, the second wind resistance region of the first main segment of the first heat exchanger core has a size in the first heat exchanger core extension direction, the second fin has a size in a second heat exchanger core extension direction perpendicular to the second direction and parallel to a second plane in which the second main segment of the second heat exchanger core is located, and a ratio of the size of the second wind resistance region to the size of the second fin is greater than or equal to 10% and less than or equal to 70%; or the first main segment of the first heat exchanger core further includes: a first fin connected with the first heat exchange tubes and provided in the first wind resistance region, there is no fin in the second wind resistance region of the first main segment of the first heat exchanger core, the second main segment of the second heat exchanger core further includes: a wavy second fin connected with the second heat exchange tubes and alternately arranged with the second heat exchange tubes, the second wind resistance region of the first main segment of the first heat exchanger core has a size in the third direction, the second fin has a size in the third direction, and a ratio of the size of the second wind resistance region to the size of the second fin is greater than or equal to 10% and less than or equal to 70%.

[0012] According to embodiments of the present invention, a spacing between the ends, connected with the first header, of at least some of the first heat exchange tubes is smaller than that of the first heat exchange tubes in the first wind resistance region.

[0013] According to embodiments of the present invention, the first heat exchange tube is a flat tube, and a spacing between the ends, connected with the first header, of at least some of the first heat exchange tubes is greater than or equal to a thickness of the first heat exchange tube.

[0014] According to embodiments of the present invention, the first heat exchange tube includes an end connected with the first header, the ends of the first heat exchange tubes include a plurality of sets of ends, and a spacing between the ends of each set of ends is smaller than a spacing between the first heat exchange tubes in the first wind resistance region.

[0015] According to embodiments of the present invention, a spacing between adjacent sets of ends is greater than the spacing between the ends in each set of ends.

[0016] According to embodiments of the present invention, the first heat exchange tube is a flat tube, and the spacing between the ends of each set of ends is greater than or equal to a thickness of the first heat exchange tube.

[0017] According to embodiments of the present invention, the first header includes a plurality of sub-headers, each of which is connected and fluidly communicated with the ends of one of the plurality of sets of ends of the first heat exchange tube.

[0018] According to embodiments of the present in-

vention, the first main segment of the first heat exchanger core further includes: a first fin connected with the first heat exchange tubes, the first fin including a first sub-fin located in the first wind resistance region, and a second sub-fin located in the second wind resistance region and being different from the first sub-fin.

[0019] According to embodiments of the present invention, the first sub-fin and the second sub-fin of the first fin are wavy fins, and a peak-to-peak distance of the first sub-fin is greater than or equal to 50% of a peak-to-peak distance of the second sub-fin and less than or equal to 90% of the peak-to-peak distance of the second sub-fin.

[0020] According to embodiments of the present invention, the second sub-fin of the first fin includes a main body and a plurality of heat exchange tube slots formed in the main body of the second sub-fin, the plurality of first heat exchange tubes being inserted into the heat exchange tube slots of the second sub-fin, and the first sub-fin of the first fin is a wavy fin.

[0021] According to embodiments of the present invention, a peak-to-peak distance of the first sub-fin is greater than or equal to 50% of a spacing between the second sub-fins, and less than or equal to the spacing between the second sub-fins.

[0022] According to embodiments of the present invention, the first heat exchanger core includes a plurality of heat exchanger sub-cores arranged in the second direction, the first header includes a plurality of sub-headers, and each of the plurality of sub-headers is connected and fluidly communicated with the first heat exchanger tubes of one of the plurality of heat exchanger sub-cores.

[0023] According to embodiments of the present invention, the first wind resistance region is adjacent to the second wind resistance region.

[0024] According to embodiments of the present invention, the first main segment of the first heat exchanger core further includes: a first fin connected with the first heat exchange tubes, the first fin including a first sub-fin extending in the first wind resistance region and extending to a boundary between the first wind resistance region and the second wind resistance region or near the boundary, and a second sub-fin extending in the first wind resistance region and the second wind resistance region.

[0025] According to embodiments of the present invention, the first sub-fin and the second sub-fin of the first fin are wavy fins and have sizes in the first heat exchanger core extension direction, and the size of the first sub-fin of the first fin is greater than or equal to 50% of the size of the second sub-fin of the first fin and less than the size of the second sub-fin of the first fin; or the first sub-fin and the second sub-fin of the first fin are wavy fins and have sizes in the third direction, and the size of the first sub-fin of the first fin is greater than or equal to 50% of the size of the second sub-fin of the first fin and less than the size of the second sub-fin of the first fin.

[0026] According to embodiments of the present invention, a number of the first sub-fins of the first fin is

greater than or equal to 10% of a number of the second sub-fins of the first fin and less than or equal to 80% of the number of second sub-fins of the first fin.

[0027] According to embodiments of the present invention, the first sub-fin and the second sub-fin of the first fin are wavy fins, the second sub-fin of the first fin includes a first sub-fin segment located in the first wind resistance region and a second sub-fin segment located in the second wind resistance region, the first sub-fin segment has the same size as the first sub-fin of the first fin in the first heat exchanger core extension direction or in the third direction, and a peak-to-peak distance of the first sub-fin segment of the second sub-fin of the first fin is greater than or equal to 50% of a peak-to-peak distance of the second sub-fin segment and less than or equal to 90% of the peak-to-peak distance of the second sub-fin segment.

[0028] According to embodiments of the present invention, a peak-to-peak distance of the first sub-fin segment of the second sub-fin of the first fin is equal to a peak-to-peak distance of the first sub-fin of the first fin.

[0029] According to embodiments of the present invention, the first sub-fin and the second sub-fin of the first fin have different types of fin structures.

[0030] According to embodiments of the present invention, the first fin and the second fin have the same shape.

[0031] According to embodiments of the present invention, the first main segment of the first heat exchanger core further includes a drainage insertion sheet provided between the first fin and the first header.

[0032] According to embodiments of the present invention, the first main segment of the first heat exchanger core further includes a drainage insertion sheet provided between the first sub-fin and the second sub-fin of the first fin.

[0033] According to embodiments of the present invention, the drainage insertion sheet includes a main body and a plurality of heat exchange tube slots formed in the main body of the drainage insertion sheet, the plurality of first heat exchange tubes being inserted into the heat exchange tube slots of the drainage insertion sheet.

[0034] According to embodiments of the present invention, the drainage insertion sheet is perpendicular to an axis of the first heat exchange tube or inclined relative to the axis of the first heat exchange tube; or the drainage insertion sheet is perpendicular to the third direction or inclined relative to the third direction; or the drainage insertion sheet is inclined relative to an axis of the first header, or includes a plurality of drainage insertion sheet segments inclined relative to the axis of the first header and connected with each other; or the drainage insertion sheet is inclined relative to the second direction, or includes a plurality of drainage insertion sheet segments inclined relative to the second direction and connected with each other.

[0035] According to embodiments of the present in-

vention, the second heat exchanger core further includes an outlet header connected and fluidly communicated with the second header, the first heat exchanger core further includes a refrigerant distribution device provided in the first header, and/or the second heat exchanger core further includes a refrigerant collection device provided in the second header.

[0036] According to embodiments of the present invention, the first heat exchanger core and the second heat exchanger core are formed by bending a flat heat exchanger, and the first connection segment and the second connection segment are bent segments.

[0037] According to embodiments of the present invention, a wind resistance of the second wind resistance region of the first main segment of the first heat exchanger core is smaller than that of the second main segment of the second heat exchanger core.

[0038] According to embodiments of the present invention, the second wind resistance region has a size in the first heat exchanger core extension direction, the first main segment of the first heat exchanger core has a size in the first heat exchanger core extension direction, and a ratio of the size of the second wind resistance region to the size of the first main segment is greater than or equal to 20% and less than or equal to 50%; or a ratio of a size of the second wind resistance region in the third direction to a size of the first main segment of the first heat exchanger core in the third direction is greater than or equal to 20% and less than or equal to 50%.

[0039] Embodiments of the present invention further provide an air conditioning system including the above-mentioned heater exchanger.

[0040] According to embodiments of the present invention, the first header and the second header are arranged horizontally in use.

[0041] According to embodiments of the present invention, in use, the second heat exchanger core is located upstream of the first heat exchanger core in a direction of air flow through the heat exchanger.

[0042] Embodiments of the present invention further provide a heat exchange system including: an exothermic heat exchanger; and an endothermic heat exchanger, wherein at least one of the exothermic heat exchanger and the endothermic heat exchanger is the above-mentioned heat exchanger.

[0043] With the heat exchanger, the air conditioning system having the heat exchanger and the heat exchange system having the heat exchanger according to the embodiments of the present invention, the performances of the heat exchanger, the air conditioning system and the heat exchange system may be improved by the provision of the wind resistance region with a low wind resistance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044]

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

Fig. 2 is a schematic perspective view of a heat exchanger according to a modification of the first embodiment of the present invention;

Fig. 3 is a schematic perspective view of a fin of the heat exchanger according to the first embodiment of the present invention;

Fig. 4 is a schematic perspective view of a heat exchanger according to a second embodiment of the present invention;

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

Fig. 6 is a schematic right side view of a portion of the first heat exchanger core of the heat exchanger shown in Fig. 5;

Fig. 7 is a schematic perspective view of a drainage insertion sheet of the first heat exchanger core of the heat exchanger shown in Fig. 5;

Fig. 8 is a schematic bottom view of the drainage insertion sheet of the first heat exchanger core of the heat exchanger shown in Fig. 7;

Fig. 9 is a schematic perspective view of the drainage insertion sheet of the first heat exchanger core of the heat exchanger shown in Fig. 7;

Fig. 10 is a schematic front view of the first heat exchanger core of the heat exchanger according to the second embodiment of the present invention;

Fig. 11 is a schematic right side view of a portion of the first heat exchanger core of the heat exchanger shown in Fig. 10;

Fig. 12 is a schematic front view of the first heat exchanger core of the heat exchanger according to the second embodiment of the present invention;

Fig. 13 is a schematic front view of the first heat exchanger core of the heat exchanger according to the second embodiment of the present invention;

Fig. 14 is a schematic perspective view of a heat exchanger according to a third embodiment of the present invention;

Fig. 15 is a schematic perspective view of a heat exchanger according to a fourth embodiment of the present invention;

Fig. 16 is a schematic front view of a first heat exchanger core of the heat exchanger shown in Fig. 15;

Fig. 17 is a schematic perspective view of a heat exchanger according to a fifth embodiment of the present invention;

Fig. 18 is a schematic perspective view of a heat exchanger according to a sixth embodiment of the present invention;

Fig. 19 is a schematic front view of a first heat exchanger core of the heat exchanger shown in Fig. 18;

Fig. 20 is a schematic perspective view of a heat

exchanger according to a seventh embodiment of the present invention;

Fig. 21 is a schematic front view of a first heat exchanger core of the heat exchanger shown in Fig. 20;

Fig. 22 is a schematic perspective view of a heat exchanger according to an eighth embodiment of the present invention;

Fig. 23 is a schematic enlarged perspective view of a second sub-fin of a first heat exchanger core of the heat exchanger shown in Fig. 22;

Fig. 24 is a schematic enlarged top view of the second sub-fin of the first heat exchanger core of the heat exchanger shown in Fig. 22;

Fig. 25 is a schematic perspective view of a heat exchanger according to a ninth embodiment of the present invention;

Fig. 26 is a schematic perspective view of a heat exchanger according to a tenth embodiment of the present invention;

Fig. 27 is a schematic front view of a first heat exchanger core of the heat exchanger shown in Fig. 26;

Fig. 28 is a schematic front view of the first heat exchanger core of the heat exchanger according to the tenth embodiment of the present invention;

Fig. 29 is a schematic front view of the first heat exchanger core of the heat exchanger according to the tenth embodiment of the present invention;

Fig. 30 is a schematic front view of the first heat exchanger core of the heat exchanger according to the tenth embodiment of the present invention;

Fig. 31 is a schematic front view of the first heat exchanger core of the heat exchanger according to the tenth embodiment of the present invention;

Fig. 32 is a schematic front view of the first heat exchanger core of the heat exchanger according to the tenth embodiment of the present invention;

Fig. 33 is a schematic perspective view of a heat exchanger according to an eleventh embodiment of the present invention;

Fig. 34 is a schematic front view of a portion of a first heat exchanger core of the heat exchanger according to the eleventh embodiment of the present invention;

Fig. 35 is a schematic front view of a portion of the first heat exchanger core of the heat exchanger according to the eleventh embodiment of the present invention;

Fig. 36 is a schematic front view of a portion of the first heat exchanger core of the heat exchanger according to the eleventh embodiment of the present invention; and

Fig. 37 is a schematic front view of a portion of the first heat exchanger core of the heat exchanger according to the eleventh embodiment of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

[0045] The present invention is further explained below by means of specific embodiments in conjunction with the drawings.

[0046] Specific embodiments according to the present invention are described below.

First embodiment

[0047] Fig. 1 is a schematic perspective view of a heat exchanger 100 according to a first embodiment of the present invention; Fig. 2 is a schematic perspective view of a heat exchanger 100 according to a modification of the first embodiment of the present invention; and Fig. 3 is a schematic perspective view of a fin 12, 22 of the heat exchanger 100 according to the first embodiment of the present invention.

[0048] Referring to Fig. 1, the heat exchanger 100 according to the embodiment of the present invention includes: a first heat exchanger core 1 and a second heat exchanger core 2 arranged side by side in a first direction D1. The first heat exchanger core 1 includes: a first main segment 10 including a plurality of first heat exchange tubes 11 arranged in a second direction D2 perpendicular to the first direction D1; a first connection segment 19 connected with the first main segment 10; and a first header 13 connected and fluidly communicated with the plurality of first heat exchange tubes 11 on a side of the first main segment 10 of the first heat exchanger core 1 opposite to the first connection segment 19. The second heat exchanger core 2 includes: a second main segment 20 including a plurality of second heat exchange tubes 21 arranged in the second direction D2; a second connection segment 29 connected with the second main segment 20; and a second header 23 connected and fluidly communicated with the plurality of second heat exchange tubes 21 on a side of the second main segment 20 of the second heat exchanger core 2 opposite to the second connection segment 29. The plurality of first heat exchange tubes 11 of the first main segment 10 of the first heat exchanger core 1 and the plurality of second heat exchange tubes 21 of the second main segment 20 of the second heat exchanger core 2 are connected and fluidly communicated with each other by the first connection segment 19 of the first heat exchanger core 1 and the second connection segment 29 of the second heat exchanger core 2. The first main segment 10 of the first heat exchanger core 1 includes a first wind resistance region 17 and a second wind resistance region 18 arranged in a third direction D3 perpendicular to the first direction D1 and the second direction D2, or in a first heat exchanger core extension direction C1 perpendicular to the second direction D2 and parallel to a first plane in which the first main segment 10 of the first heat exchanger core 1 is located, the second wind resistance region 18 being adjacent to the first header 13, and a wind resistance of the second wind resistance region 18 being smaller

than that of the first wind resistance region 17. In addition, the wind resistance of the second wind resistance region 18 of the first main segment 10 of the first heat exchanger core 1 may be smaller than that of the second main segment 20 of the second heat exchanger core 2. It should be noted that the "wind resistance" is a wind resistance at a constant wind speed. The wind resistance of the first wind resistance region 17 of the first main segment 10 of the first heat exchanger core 1 may be equal to that of the second main segment 20 of the second heat exchanger core 2. An angle α , between the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2 may be greater than or equal to 0 degree and less than or equal to 45 degrees. Of course, the angle α , between the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2 may also be greater than 45 degrees. In the embodiment shown in the figures, only the case that the angle is equal to 0 degree is illustrated.

[0049] In the embodiment of the present invention, the first heat exchanger core 1 and the second heat exchanger core 2 may be formed by bending a flat heat exchanger, and the first connection segment 19 and the second connection segment 29 are bent segments. As an alternative, the plurality of first heat exchange tubes 11 of the first heat exchanger core 1 and the plurality of second heat exchange tubes 21 of the second heat exchanger core 2 may be connected with each other by a plurality of connection tubes, respectively, the connection tubes composing the first connection segment 19 and the second connection segment 29. In addition, the plurality of first heat exchange tubes 11 of the first heat exchanger core 1 and the plurality of second heat exchange tubes 21 of the second heat exchanger core 2 may also be connected with each other in other manners.

[0050] Referring to Fig. 1, in the embodiment of the present invention, for the first wind resistance region 17, the first wind resistance region 17 has a size in the first heat exchanger core extension direction C1, the first main segment 10 of the first heat exchanger core 1 has a size in the first heat exchanger core extension direction C1, and a ratio of the size of the first wind resistance region 17 to the size of the first main segment 10 is greater than or equal to 20% and less than or equal to 90%; or a ratio of a size of the first wind resistance region 17 in the third direction D3 to a size of the first main segment 10 of the first heat exchanger core 1 in the third direction D3 is greater than or equal to 20% and less than or equal to 90%; or a ratio of a length of a portion of the first heat exchange tube 11 occupied by the first wind resistance region 17 to a length of the first heat exchange tube 11 is greater than or equal to 20% and less than or equal to 90%. For the second wind resistance region 18, the second wind resistance region 18 has a size in the first heat exchanger core extension direction C1, the first main segment 10 of the first heat exchanger core 1

has a size in the first heat exchanger core extension direction C1, and a ratio of the size of the second wind resistance region 18 to the size of the first main segment 10 is greater than or equal to 20% and less than or equal to 50%; or a ratio of a size of the second wind resistance region 18 in the third direction D3 to a size of the first main segment 10 of the first heat exchanger core 1 in the third direction D3 is greater than or equal to 20% and less than or equal to 50%.

[0051] Referring to Fig. 1, in the embodiment of the present invention, the first heat exchanger core 1 has a first orthographic projection on a second plane in which the second main segment 20 of the second heat exchanger core 2 is located, the second heat exchanger core 2 has a second orthographic projection on the second plane in which the second main segment 20 of the second heat exchanger core 2 is located, and a ratio of an overlapping area between the first orthographic projection of the first heat exchanger core 1 and the second orthographic projection of the second heat exchanger core 2 to an area of the second orthographic projection of the second heat exchanger core 2 is greater than or equal to 50% and less than or equal to 100%.

[0052] Referring to Fig. 1, in the embodiment of the present invention, the first heat exchanger core 1 has a size in the first heat exchanger core extension direction C1, the second heat exchanger core 2 has a size in a second heat exchanger core extension direction C2 perpendicular to the second direction D2 and parallel to the second plane in which the second main segment 20 of the second heat exchanger core 2 is located, and a ratio of the size of the first heat exchanger core 1 to the size of the second heat exchanger core 2 is greater than or equal to 30% and less than or equal to 100%, for example, being greater than or equal to 60% and less than or equal to 100%. As an alternative, a ratio of a size of the first heat exchanger core 1 in the third direction D3 to a size of the second heat exchanger core 2 in the third direction D3 is greater than or equal to 30% and less than or equal to 100%, for example, being greater than or equal to 60% and less than or equal to 100%.

[0053] In the embodiment shown in the figures, the third direction D3 is parallel to the first heat exchanger core extension direction C1 and the second heat exchanger core extension direction C2. In the case that the angle α between the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2 is greater than 0 degree, for example, the third direction D3 may be parallel to the first plane in which the first main segment 10 of the first heat exchanger core 1 is located or to the second plane in which the second main segment 20 of the second heat exchanger core 2 is located, the first plane and the second plane is symmetrical with respect to a plane in which the third direction D3 is located, or the first plane and the second plane is inclined relative to the third direction D3, therefore, the third direction D3 is parallel to the first heat exchanger core extension direction C1 or

the second heat exchanger core extension direction C2, or the third direction D3 is inclined relative to the first heat exchanger core extension direction C1 and the second heat exchanger core extension direction C2.

[0054] Referring to Fig. 1, in the embodiment of the present invention, the first main segment 10 of the first heat exchanger core 1 further includes: a first fin 12 connected with the first heat exchange tubes 11 and provided in the first wind resistance region 17. There is no fin in the second wind resistance region 18 of the first main segment 10 of the first heat exchanger core 1. The second main segment 20 of the second heat exchanger core 2 further includes: a second fin 22 connected with the second heat exchange tubes 21. The second wind resistance region 18 of the first main segment 10 of the first heat exchanger core 1 has a size in the first heat exchanger core extension direction C1, the second main segment 20 of the second heat exchanger core 2 has a size in the second heat exchanger core extension direction C2, and a ratio of the size of the second wind resistance region 18 to the size of the second main segment 20 of the second heat exchanger core 2 is greater than or equal to 10% and less than or equal to 70%; or the second resistance region 18 of the first main segment 10 of the first heat exchanger core 1 has a size in the third direction D3, the second main segment 20 of the second heat exchanger core 2 has a size in the third direction D3, and a ratio of the size of the second resistance area 18 to the size of the second main segment 20 of the second heat exchanger core 2 is greater than or equal to 10% and less than or equal to 70%.

[0055] Referring to Fig. 1, in the embodiment of the present invention, the first main segment 10 of the first heat exchanger core 1 further includes: a first fin 12 connected with the first heat exchange tubes 11 and provided in the first wind resistance region 17. There is no fin in the second wind resistance region 18 of the first main segment 10 of the first heat exchanger core 1. The second main segment 20 of the second heat exchanger core 2 further includes: a wavy second fin 22 connected with the second heat exchange tubes 21 and alternately arranged with the second heat exchange tubes 21. The second wind resistance region 18 of the first main segment 10 of the first heat exchanger core 1 has a size in the first heat exchanger core extension direction C1, the second fin 22 has a size in the second heat exchanger core extension direction C2, and a ratio of the size of the second wind resistance region 18 to the size of the second fin 22 is greater than or equal to 10% and less than or equal to 70%; or the second wind resistance region 18 of the first main segment 10 of the first heat exchanger core 1 has a size in the third direction D3, the fin 22 has a size in the third direction D3, and a ratio of the size of the second wind resistance region 18 to the size of the second fin 22 is greater than or equal to 10% and less than or equal to 70%.

[0056] As shown in Fig. 1, in the embodiment of the present invention, the first fin 12 and the second fin 22

have the same shape.

[0057] The difference between the heat exchanger 100 of the modification shown in Fig. 2 and the heat exchanger 100 of the embodiment shown in Fig. 1 is that an outlet header is provided. Referring to Fig. 2, in the embodiment of the present invention, the second heat exchanger core 2 further includes an outlet header 24 connected and fluidly communicated with the second header 23. The outlet header 24 and the second header 23 may be substantially parallel.

[0058] The specific examples shown in Figs. 1 to 3 are described below.

[0059] The heat exchanger 100 includes: the first heat exchanger core 1 and the second heat exchanger core 2. The first heat exchanger core 1 includes: the first main segment 10 and the first header 13. The first main segment 10 includes the plurality of first heat exchange tubes 11 and the plurality of first fins 12. The first heat exchange tubes 11 are arranged at intervals in an axial direction of the first header 13, while the first fins 12 are arranged at intervals between the first heat exchange tubes 11 connected with the first header 13. The second heat exchanger core 2 includes: the second main segment 20 and the second header 23. The second main segment 20 includes: the plurality of second heat exchange tubes 21 and the plurality of second fins 22. The second heat exchange tubes 21 are arranged at intervals in an axial direction of the second header 23, while the second fins 22 are arranged at intervals between the second heat exchange tubes 21 connected with the second header 23. The heat exchange tube may be a flat tube.

[0060] The first heat exchanger core 1 and the second heat exchanger core 2 form a passage through which refrigerant flows. For example, the first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 are connected with each other to form flow passages, respectively. The first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 may also be connected with each other by adapters to form the flow passages, respectively, or the first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 may be connected with each other by an adapter, instead of being connected in one-to-one correspondence. The first heat exchanger core 1 and the second heat exchanger core 2 are arranged in a front-to-back arrangement in a thickness direction of the heat exchanger 100. The first heat exchanger core 1 may be on a leeward side, and a certain angle α , may also be formed between the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2.

[0061] A length of the first heat exchange tube 11 of the first heat exchanger core 1 is TL, a peak-to-peak distance of the first fin 12 is FP1, a width of the first fin 12 is FW, and a length of the first fin 12 is FL. A length of the second heat

exchange tube 21 of the second heat exchanger core 2 is tl , a peak-to-peak distance of the second fin 22 is fp , a width of the second fin 22 is fw , and a length of the second fin 22 is fl .

[0062] In the specific examples shown in Figs. 1 to 3, a heat exchange amount of the first heat exchanger core 1 on an air side is adjusted by reducing a heat exchange area of the first heat exchanger core 1, ultimately achieving a reduction in an amount of condensation water of the heat exchanger 100.

[0063] Characteristics of the heat exchanger 100 in the first embodiment are as follows:

a height H of the first heat exchanger core 1 = a height h of the second heat exchanger core 2;

$0^\circ < \alpha$, the angle α , between the first heat exchanger core 1 and the second heat exchanger core 2 $\leq 45^\circ$; when an outer diameter of the first header 13 is equal to an outer diameter of the second header 23, the length TL of the first heat exchange tube 11 is equal to the length tl of the second heat exchange tube 21; a structure of the first fin 12 is the same as a structure of the second fin 22;

$30\% \times \text{the length } fl \text{ of the second fin 22} < \text{the length } FL \text{ of the first fin 12} \leq 90\% \times \text{the length } fl \text{ of the second fin 22}$.

[0064] Referring to Fig. 2, the second heat exchanger core 2 further includes an outlet header 24 connected and fluidly communicated with the second header 23. The second header 23 and the outlet header 24 are connected and fluidly communicated with each other by a connection tube 3. The second heat exchanger core 2 may also include other headers provided between the second header 23 and the outlet header 24, and connected and fluidly communicated with the second header 23 and the outlet header 24.

Second embodiment

[0065] Fig. 4 is a schematic perspective view of a heat exchanger 100 according to a second embodiment of the present invention; Fig. 5 is a schematic front view of a first heat exchanger core 1 of the heat exchanger 100 according to the second embodiment of the present invention; Fig. 6 is a schematic right view of a portion of the first heat exchanger core 1 of the heat exchanger 100 shown in Fig. 5; Fig. 7 is a schematic perspective view of a drainage insertion sheet 16 of the first heat exchanger core 1 of the heat exchanger 100 shown in Fig. 5; Fig. 8 is a schematic bottom view of the drainage insertion sheet 16 of the first heat exchanger core 1 of the heat exchanger 100 shown in Fig. 7; Fig. 9 is a schematic perspective view of the drainage insertion sheet 16 of the first heat exchanger core 1 of the heat exchanger 100 shown in Fig. 7; Fig. 10 is a schematic front view of the first heat exchanger core 1 of the heat exchanger 100 according to the second embodiment of the present invention; Fig. 11

is a schematic right view of a portion of the first heat exchanger core 1 of the heat exchanger 100 shown in Fig. 10; Fig. 12 is a schematic front view of the first heat exchanger core 1 of the heat exchanger 100 according to the second embodiment of the present invention; and Fig. 13 is a schematic front view of the first heat exchanger core 1 of the heat exchanger 100 according to the second embodiment of the present invention.

[0066] The heat exchanger 100 of the second embodiment shown in Figs. 4 to 13 is obtained by adding a drainage structure (e.g. a drainage insertion sheet 16) based on the heat exchanger 100 of the first embodiment.

[0067] Referring to Figs. 4 to 13, in the embodiment of the present invention, the first main segment 10 of the first heat exchanger core 1 further includes the drainage insertion sheet 16 provided between the first fin 12 and the first header 13 or below the first fin 12.

[0068] Referring to Figs. 7 to 9, in the embodiment of the present invention, the drainage insertion sheet 16 may have a comb shape. The drainage insertion sheet 16 includes a main body 160 and a plurality of heat exchange tube slots 161 formed in the main body 160 of the drainage insertion sheet 16, the plurality of first heat exchange tubes 11 being inserted into the plurality of heat exchange tube slots 161 of the drainage insertion sheet 16. The drainage insertion sheet 16 may also include a water baffle 162.

[0069] Referring to Figs. 4 to 13, in the embodiment of the present invention, the drainage insertion sheet 16 (e.g., a length direction and/or a width direction of the drainage insertion sheet 16) is perpendicular to an axis of the first heat exchange tube 11 or inclined relative to the axis of the first heat exchange tube 11; or the drainage insertion sheet 16 (such as the length direction and/or the width direction of the drainage insertion sheet 16) may be perpendicular to the third direction $D3$ or inclined relative to the third direction $D3$. For example, the drainage insertion sheet 16 (such as the length direction of the drainage insertion sheet 16) is inclined relative to the axis of the first header 13, or the drainage insertion sheet 16 includes a plurality of drainage insertion sheet segments 16S that (such as the length direction) are inclined relative to the axis of the first header 13 and connected with each other; or the drainage insertion sheet 16 (such as the length direction of the drainage insertion sheet 16) is inclined relative to the second direction $D2$, or includes a plurality of drainage insertion sheet segments 16S that (such as the length direction) are inclined relative to the second direction $D2$ and connected with each other.

[0070] The specific example shown in Figs. 4 to 13 are described below.

[0071] Characteristics of the heat exchanger 100 shown in Figs. 4 to 13 are as follows:

the height H of the first heat exchanger core 1 = the height h of the second heat exchanger core 2; when the outer diameter of the first header 13 is equal to the outer diameter of the second header

23, the length TL of the first heat exchange tube 11 is equal to the length tl of the second heat exchange tube 21;

the structure of the first fin 12 is the same as the structure of the second fin 22; and

$30\% \times \text{the length fl of the second fin 22} < \text{the length FL of the first fin 12} \leq 90\% \times \text{the length fl of the second fin 22}$.

[0072] In the heat exchanger shown in the figures, the drainage insertion sheet 16 with water collection function and drainage function is added below the first fin 12.

[0073] The heat exchanger 100 may include a refrigerant distribution device. As shown in Figs. 7 to 9, the drainage insertion sheet 16 includes: the main body 160; the plurality of heat exchange tube slots 161 arranged in parallel and formed in the main body 160 of the drainage insertion sheet 16; and the water baffle 162 extending from an edge of the main body 160 in a width direction to one side (e.g., an upper side in use) of the main body 160 in a thickness direction. The water baffle 162 may be formed by bending, with a certain angle (e.g., an angle of 60 to 135 degrees, an angle of 90 to 120 degrees, etc.) being formed between the water baffle 162 and the main body 160, and the water baffle 162 and the main body 160 form a water collection space and a drainage path.

[0074] Certain angle may be formed between the drainage insertion sheet 16 and the first heat exchange tubes 11, facilitating the rapid flow of the condensation water to the water collection space, as shown in Figs. 10 and 11.

[0075] Certain angle may be formed between the drainage insertion sheet 16 and the first header 13, facilitating the rapid flow of the condensation water through the drainage path to one or two sides of the first heat exchanger core 1, as shown in Figs. 12 and 13.

[0076] For the heat exchanger 100 of the present embodiment, the first heat exchanger core 1 may further include the refrigerant distribution device provided in the first header 13. Therefore, the refrigerant may be reasonably and evenly distributed to the plurality of first heat exchange tubes 11, and the second heat exchanger core 2 may also include a refrigerant collection device provided in the second header 23. Therefore, pressure distribution of the refrigerant may be reasonably adjusted to achieve a more effective heat exchange effect. In addition, the second header 23 may include a plurality of sub-headers.

Third embodiment

[0077] Fig. 14 is a schematic perspective view of a heat exchanger according to a third embodiment of the present invention. The heat exchanger 100 shown in Fig. 14 is obtained by adjusting the height of the first heat exchanger core 1 based on the heat exchanger 100 of the first embodiment.

[0078] Characteristics of the heat exchanger 100 in the third embodiment are as follows:

$30\% \times \text{the height h of the second heat exchanger core 2} < \text{the height H of the first heat exchanger core 1} \leq 90\% \times \text{the height h of the second heat exchanger core 2}$;

when the outer diameter of the first header 13 is equal to the outer diameter of the second header 23, $30\% \times \text{the length tl of the second heat exchange tube 21} < \text{the length TL of the first heat exchange tube 11} \leq 90\% \times \text{the length tl of the second heat exchange tube 21}$;

the structure of the first fin 12 is the same as the structure of the second fin 22; and

$20\% \times \text{the length fl of the second fin 22} < \text{the length FL of the first fin 12} \leq 80\% \times \text{the length fl of the second fin 22}$.

[0079] Similarly, like the second embodiment, the heat exchanger 100 of the third embodiment may further include the drainage insertion sheet 16 with drainage function.

Fourth embodiment

[0080] Fig. 15 is a schematic perspective view of a heat exchanger 100 according to a fourth embodiment of the present invention; and Fig. 16 is a schematic front view of a first heat exchanger core 1 of the heat exchanger 100 shown in Fig. 15.

[0081] The difference between the heat exchanger 100 according to the fourth embodiment of the present invention and the heat exchanger 100 according to the first embodiment of the present invention is that the second wind resistance region 18 is provided with a fin, a sub-fin, a portion of the fin, or a portion of the sub-fin.

[0082] Referring to Figs. 15 to 16, in the embodiment of the present invention, the first main segment 10 of the first heat exchanger core 1 further includes a first fin 12 connected with the first heat exchange tubes 11. The first fin 12 includes a first sub-fin 121 located in the first wind resistance region 17, and a second sub-fin 122 located in the second wind resistance region 18 and being different from the first sub-fin 121. The first sub-fin 121 and the second sub-fin 122 of the first fin 12 may have the same type of fin structure or different types of fin structures. In the present embodiment, the first sub-fin 121 and the second sub-fin 122 of the first fin 12 have the same type of fin structure.

[0083] For example, referring to Figs. 15 to 16, the first sub-fin 121 and the second sub-fin 122 of the first fin 12 are wavy fins, and a peak-to-peak distance of the first sub-fin 121 is greater than or equal to 50% of a peak-to-peak distance of the second sub-fin 122, and less than or equal to 90% of the peak-to-peak distance of the second sub-fin 122. The first sub-fin 121 and the second sub-fin 122 of the first fin 12 may be an integrated fin or individual fins.

[0084] The specific example shown in Figs. 15 to 16 is described below.

[0085] The heat exchanger 100 shown in Figs. 15 to 16 includes: the first heat exchanger core 1 and the second heat exchanger core 2. The first heat exchanger core 1 includes: the first main segment 10 and the first header 13. The first main segment 10 includes the plurality of first heat exchange tubes 11 and the plurality of first fins 12. The first fin 12 includes the first sub-fin 121 and the second sub-fin 122, which may be individual fins or different portions of the same fin. The first fin 12 may be formed by joining the individual first sub-fin 121 and second sub-fin 122 together. The first heat exchange tubes 11 are arranged at intervals in the axial direction of the first header 13, while the first fins 12 are arranged at intervals between the first heat exchange tubes 11 connected with the first header 13. The second heat exchanger core 2 includes the second main segment 20 and the second header 23. The second main segment 20 includes the plurality of second heat exchange tubes 21 and the plurality of second fins 22. The second heat exchange tubes 21 are arranged at intervals in the axial direction of the second header 23, while the second fins 22 are arranged at intervals between the second heat exchange tubes 21 connected with the second header 23. The heat exchange tube may be a flat tube.

[0086] The first heat exchanger core 1 and the second heat exchanger core 2 form the passage through which the refrigerant flows. For example, the first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 are connected with each other to form flow passages, respectively. The first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 may also be connected with each other by adapters to form the flow passages, respectively, or the first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 may be connected with each other by an adapter, instead of being connected in one-to-one correspondence. The first heat exchanger core 1 and the second heat exchanger core 2 are arranged in a front-to-back arrangement in the thickness direction of the heat exchanger 100. The first heat exchanger core 1 may be on the leeward side, the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2 may be arranged in parallel, and a certain angle may also be formed between the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2.

[0087] A length of the first heat exchange tube 11 of the first heat exchanger core 1 is TL, a peak-to-peak distance of the first sub-fin 121 is FP1, a length of the first sub-fin 121 is FL1, a peak-to-peak distance of the second sub-fin 122 is FP2, a length of the second sub-fin 122 is FL2; a length of the second heat exchange tube 21 of the second heat exchanger core 2 is tl, a peak-to-peak distance of the second fin 22 is fp, and a length of the second fin 22 is fl.

[0088] In the fourth embodiment, the heat exchange amount of the first heat exchanger core 1 on the air side is adjusted by reducing a heat exchange intensity, i.e., a density of the fins, of the first heat exchanger core 1, ultimately achieving the reduction in the amount of condensation water of the heat exchanger 100.

[0089] Characteristics of the heat exchanger 100 in the fourth embodiment are as follows:

the height H of the first heat exchanger core 1 = the height h of the second heat exchanger core 2; when the outer diameter of the first header 13 is equal to the outer diameter of the second header 23, the length TL of the first heat exchange tube 11 = the length tl of the second heat exchange tube 21; the structure of the first fin 12 is the same as the structure of the second fin 22; $30\% * \text{the length fl of the second fin 22} < \text{the length FL1 of the first sub-fin 121} \leq 90\% * \text{the length fl of the second fin 22}$; $50\% * \text{the length fl of the second fin 22} < \text{the length FL1 of the first sub-fin 121} + \text{the length FL2 of the second sub-fin 122} < \text{the length fl of the second fin 22}$; and $50\% * \text{the peak-to-peak distance FP2 of the second sub-fin 122} \leq \text{the peak-to-peak distance FP1 of the first sub-fin 121} < 90\% * \text{the peak-to-peak distance FP2 of the second sub-fin 122}$.

Fifth embodiment

[0090] Fig. 17 is a schematic perspective view of a heat exchanger according to a fifth embodiment of the present invention.

[0091] The heat exchanger 100 shown in Fig. 17 is obtained by adjusting the height of the first heat exchanger core 1 based on the heat exchanger 100 of the fourth embodiment.

[0092] Characteristics of the heat exchanger 100 in the fifth embodiment are as follows:

$30\% * \text{the height h of the second heat exchanger core 2} < \text{the height H of the first heat exchanger core 1} \leq 90\% * \text{the height h of the second heat exchanger core 2}$; when the outer diameter of the first header 13 is equal to the outer diameter of the second header 23, $30\% * \text{the length tl of the second heat exchange tube 21} < \text{the length TL of the first heat exchange tube 11} \leq 90\% * \text{the length tl of the second heat exchange tube 21}$; the structure of the first fin 12 is the same as the structure of the second fin 22; $20\% * \text{the length fl of the second fin 22} < \text{the length FL1 of the first sub-fin 121} \leq 80\% * \text{the length fl of the second fin 22}$; $40\% * \text{the length fl of the second fin 22} < \text{the length FL1 of the first sub-fin 121} + \text{the length FL2 of the second sub-fin 122} < \text{the length fl of the second fin 22}$.

second sub-fin 122 $\leq 90\%$ * the length fl of the second fin 22; and
 50% * the peak-to-peak distance FP2 of the second sub-fin 122 $<$, the peak-to-peak distance FP1 of the first sub-fin 121 $\leq 90\%$ * the peak-to-peak distance FP2 of the second sub-fin 122.

[0093] Similarly, like the second embodiment, the heat exchanger 100 of the fifth embodiment may also include the drainage insertion sheet 16 with drainage function.

Sixth embodiment

[0094] Fig. 18 is a schematic perspective view of a heat exchanger 100 according to a sixth embodiment of the present invention; and Fig. 19 is a schematic front view of a first heat exchanger core 1 of the heat exchanger 100 shown in Fig. 18.

[0095] The difference between the heat exchanger 100 according to the sixth embodiment of the present invention and the heat exchanger 100 according to the first embodiment of the present invention is that a portion of the second wind resistance region 18 is provided with a fin, a sub-fin, a portion of the fin, or a portion of the sub-fin.

[0096] Referring to Figs. 18 to 19, in the embodiment of the present invention, the first wind resistance region 17 is adjacent to the second wind resistance region 18. The first main segment 10 of the first heat exchanger core 1 further includes: the first fin 12 connected with the first heat exchange tubes 11. The first fin 12 includes the first sub-fin 121 extending in the first wind resistance region 17 and extending to a boundary between the first wind resistance region 17 and the second wind resistance region 18 or near the boundary, and the second sub-fin 122 extending in the first wind resistance region 17 and the second wind resistance region 18. The first sub-fin 121 only extends in the first wind resistance region 17. The second sub-fin 122 extends in the first wind resistance region 17 and extends in the second wind resistance region 18. According to the embodiment of the present invention, a number of the first sub-fins 121 of the first fin 12 may be greater than or equal to 10% of a number of the second sub-fins 122 of the first fin 12 and less than or equal to 80% of the number of the second sub-fins 122 of the first fin 12.

[0097] Referring to Figs. 18 to 19, in the embodiment of the present invention, the first sub-fin 121 and the second sub-fin 122 of the first fin 12 are wavy fins. The first sub-fin 121 of the first fin 12 has a size in the first heat exchanger core extension direction C1, the second sub-fin 122 of the first fin 12 has a size in the first heat exchanger core extension direction C1, and the size of the first sub-fin 121 of the first fin 12 is greater than or equal to 50% of the size of the second sub-fin 122 of the first fin 12 and less than the size of the second sub-fin 122 of the first fin 12. As an alternative, the first sub-fin 121 of the first fin 12 has a size in the third direction D3, the second sub-fin 122 of the first fin 12 has a size in the third direction D3, and the size of

the first sub-fin 121 of the first fin 12 is greater than or equal to 50% of the size of the second sub-fin 122 of the first fin 12 and less than the size of the second sub-fin 122 of the first fin 12. Referring to Figs. 18 to 19, in the embodiment of the present invention, the first sub-fin 121 and the second sub-fin 122 of the first fin 12 are wavy fins, the first sub-fin 121 and the second sub-fin 122 of the first fin 12 may have the same peak-to-peak distance, and the second sub-fin 122 of the first fin 12 includes: a first sub-fin segment 1221 located in the first wind resistance region 17 and a second sub-fin segment 1222 located in the second wind resistance region 18.

[0098] The specific example shown in Figs. 18 to 19 is described below.

[0099] The heat exchanger 100 shown in Figs. 18 to 19 includes: the first heat exchanger core 1 and the second heat exchanger core 2. The first heat exchanger core 1 includes: the first main segment 10 and the first header 13. The first main segment 10 includes the plurality of first heat exchange tubes 11 and the plurality of first fins 12. The first fin 12 includes the first sub-fin 121 and the second sub-fin 122, the second sub-fin 122 including the first sub-fin segment 1221 and the second sub-fin segment 1222. The first sub-fin segment 1221 and the second sub-fin segment 1222 may be individual fins or different portions of the same fin. For example, the second sub-fin 122 is formed by joining the first sub-fin segment 1221 and the second sub-fin segment 1222 as individual fins together. The first heat exchange tubes 11 are arranged at intervals in the axial direction of the first header 13, while the first fins 12 are arranged at intervals between the first heat exchange tubes 11 connected with the first header 13. The second heat exchanger core 2 includes: the second main segment 20 and the second header 23. The second main segment 20 includes: the plurality of second heat exchange tubes 21 and the plurality of second fins 22. The second heat exchange tubes 21 are arranged at intervals in the axial direction of the second header 23, while the second fins 22 are arranged at intervals between the second heat exchange tubes 21 connected with the second header 23.

[0100] The first heat exchanger core 1 and the second heat exchanger core 2 form the passage through which the refrigerant flows. For example, the first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 are connected with each other to form flow passages, respectively. The first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 may also be connected with each other by adapters to form the flow passages, respectively, or the first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 may be connected with each other by an adapter, instead of being connected in one-to-one correspondence. The first heat exchanger core 1 and the

second heat exchanger core 2 are arranged in a front-to-back arrangement in the thickness direction of the heat exchanger 100. The first heat exchanger core 1 may be on the leeward side, the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2 may be arranged in parallel, and a certain angle may also be formed between the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2.

[0101] A length of the first heat exchange tube 11 of the first heat exchanger core 1 is TL, a peak-to-peak distance of the first sub-fin 121 is FP1, a length of the first sub-fin 121 is FL1, a number of the first sub-fins 121 is N1, a peak-to-peak distance of the first sub-fin segment 1221 is FP2A, a length of the first sub-fin segment 1221 is FL2A, a number of the first sub-fin segment 1221 is N2A, a peak-to-peak distance of the second sub-fin segment 1222 is FP2B, a length of the second sub-fin segment 1222 is FL2B, a number of the second sub-fin segment 1222 is N2B, and a length of the second sub-fin 1222 is FL2 (FL2=FL2A+FL2B), a number of the second sub-fins 122 is N2; and a length of the second heat exchange tube 21 of the second heat exchanger core 2 is tl, a peak-to-peak distance of the second fin 22 is fp, and a length of the second fin 22 is fl.

[0102] In the sixth embodiment, the heat exchange amount of the first heat exchanger core 1 on the air side is adjusted by reducing a heat exchange intensity, i.e. a density and a number of the fins, of the first heat exchanger core 1, ultimately achieving the reduction in the amount of the condensation water of the heat exchanger 100.

[0103] Characteristics of the heat exchanger 100 in the six embodiment are as follows:

the height H of the first heat exchanger core 1 = the height h of the second heat exchanger core 2;
when the outer diameter of the first header 13 is equal to the outer diameter of the second header 23, the length TL of the first heat exchange tube 11 = the length tl of the second heat exchange tube 21;
the structure of the first fin 12 is the same as the structure of the second fin 22;
30% * the length fl of the second fin 22 <, the length FL1 of the first sub-fin 121 ≤ 90% * the length fl of the second fin 22;
50% * the length fl of the second fin 22 <, the length FL2A of the first sub-fin segment 1221 + the length FL2B of the second sub-fin segment 1222 ≤ the length fl of the second fin 22;
50% * the length FL1 of the first sub-fin 121 ≤ the length FL2A of the first sub-fin segment 1221 ≤ the length FL1 of the first sub-fin 121;
the peak-to-peak distance FP2A of the first sub-fin segment 1221 = the peak-to-peak distance FP1 of the first sub-fin 121;
50% * the peak-to-peak distance FP2B of the second

sub-fin segment 1222 ≤ the peak-to-peak distance FP2A of first sub-fin segment 1221 ≤ 90% * the peak-to-peak distance FP2B of the second sub-fin segment 1222;

the number N1 of the first sub-fins 121 + the number N2 of the second sub-fins 122 = the number n of the second fins 22; and

10% * the number n of the second fins 22 ≤ the number N2 of the second sub-fins 122 ≤ 80% * the number n of the second fins 22.

Seventh embodiment

[0104] Fig. 20 is a schematic perspective view of a heat exchanger according to a seventh embodiment of the present invention; and Fig. 21 is a schematic front view of a first heat exchanger core of the heat exchanger shown in Fig. 20.

[0105] The difference between the heat exchanger 100 according to the seventh embodiment of the present invention and the heat exchanger 100 according to the first embodiment of the present invention is that a portion of the second wind resistance region 18 is provided with a fin, a sub-fin, a portion of the fin or a portion of the sub-fin, and the heat exchanger 100 according to the seventh embodiment of the present invention is obtained by adjusting the height of the first heat exchanger core 1 and the peak-to-peak distance of the second sub-fin 122 based on the heat exchanger 100 of the sixth embodiment.

[0106] Referring to Figs. 20 to 21, in the embodiment of the present invention, the first sub-fin 121 and the second sub-fin 122 of the first fin 12 are wavy fins, the second sub-fin 122 of the first fin 12 includes: the first sub-fin segment 1221 located in the first wind resistance region 17 and the second sub-fin segment 1222 located in the second wind resistance region 18, and the first sub-fin segment 1221 and the second sub-fin segment 1222 may be individual fins and connected with each other. The first sub-fin segment 1221 has the same size as the first sub-fin 121 of the first fin 12 in the first heat exchanger core extension direction C1 or in the third direction D3, and the peak-to-peak distance of the first sub-fin segment 1221 of the second sub-fin 122 of the first fin 12 is greater than or equal to 50% of the peak-to-peak distance of the second sub-fin segment 1222 and less than or equal to 90% of the peak-to-peak distance of the second sub-fin segment 1222. The peak-to-peak distance of the first sub-fin segment 1221 of the second sub-fin 122 of the first fin 12 may be equal to the peak-to-peak distance of the first sub-fin 121 of the first fin 12.

[0107] For the first sub-fin segment 1221 and the second sub-fin segment 1222 of the second sub-fin 122 of the first fin 12 in Figs. 20 to 21, the first sub-fin segment 1221 may be used as the first sub-fin 121 of the first fin 12 in Figs. 15 to 17, and the second sub-fin segment 1222 may be used as the second sub-fin 122 of the first fin 12 in Figs. 15 to 17.

[0108] The specific example shown in Figs. 20 to 21 is described below.

[0109] The heat exchanger 100 shown in Figs. 20 to 21 includes: the first heat exchanger core 1 and the second heat exchanger core 2. The first heat exchanger core 1 includes: the first main segment 10 and the first header 13. The first main segment 10 includes the plurality of first heat exchange tubes 11 and the plurality of first fins 12. The first fin 12 includes the first sub-fin 121 and the second sub-fin 122, the second sub-fin 122 including the first sub-fin segment 1221 and the second sub-fin segment 1222. The first sub-fin segment 1221 and the second sub-fin segment 1222 may be individual fins or different portions of the same fin. For example, the second sub-fin 122 is formed by joining the first sub-fin segment 1221 and the second sub-fin segment 1222 as individual fins together. The first heat exchange tube 11 is arranged at intervals in an axial direction of the first header 13, while the first fins 12 are arranged at intervals between the first heat exchange tubes 11 connected with the first header 13. The second heat exchanger core 2 includes: the second main segment 20 and the second header 23. The second main segment 20 includes the plurality of second heat exchange tubes 21 and the plurality of second fins 22. The second heat exchange tubes 21 are arranged at intervals in an axial direction of the second header 23, while the second fins 22 are arranged at intervals between the second heat exchange tubes 21 connected with the second header 23.

[0110] The first heat exchanger core 1 and the second heat exchanger core 2 form the passage through which the refrigerant flows. For example, the first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 are connected with each other to form the flow passages, respectively. The first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 may also be connected with each other by adapters to form the flow passages, respectively, or the first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 may be connected with each other by an adapter, instead of being connected in one-to-one correspondence. The first heat exchanger core 1 and the second heat exchanger core 2 are arranged in a front-to-back arrangement in the thickness direction of the heat exchanger 100. The first heat exchanger core 1 may be on the leeward side, the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2 may be arranged in parallel, and a certain angle may also be formed between the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2.

[0111] A length of the first heat exchange tube 11 of the first heat exchanger core 1 is TL, a peak-to-peak distance of the first sub-fin 121 is FP1, a length of the first sub-fin

121 is FL1, a number of the first sub-fins 121 is N1, a peak-to-peak distance of the first sub-fin segment 1221 is FP2A, a length of the first sub-fin segment 1221 is FL2A, a number of the first sub-fin segments 1221 is N2A, a peak-to-peak distance of the second sub-fin segment 1222 is FP2B, a length of the second sub-fin segment 1222 is FL2B, a number of second sub-fin segments 1222 is N2B, a length of the second sub-fin 122 is FL2 (FL2=FL2A+FL2B), and a number of the second sub-fins 122 is N2; and a length of the second heat exchange tube 21 of the second heat exchanger core 2 is tl, a peak-to-peak distance of the second fin 22 is fp, and a length of the second fin 22 is fl.

[0112] In the seventh embodiment, a heat exchange amount of the first heat exchanger core 1 on the air side is adjusted by reducing a heat exchange intensity, i.e. a density, a number and a length of the fins, of the first heat exchanger core 1, ultimately achieving the reduction in the amount of condensation water of the heat exchanger 100.

[0113] Characteristics of the heat exchanger 100 in the seventh embodiment are as follows:

30% * the height h of the second heat exchanger core 2 <, the height H of the first heat exchanger core 1 ≤ 90% * the height h of the second heat exchanger core 2;

when the outer diameter of the first header 13 is equal to the outer diameter of the second header 23, 30% * the length tl of the second heat exchange tube 21 <, the length TL of the first heat exchange tube 11 ≤ 90% * the length tl of the second heat exchange tube 21;

the structure of the first fin 12 is the same as the structure of the second fin 22;

20% * the length fl of the second fin 22 <, the length FL1 of the first sub-fin 121 ≤ 80% * the length fl of the second fin 22;

40% * the length fl of the second fin 22 <, the length FL2A of the first sub-fin segment 1221 + the length FL2B of the second sub-fin segment 1222 ≤ 90% * the length fl of the second fin 22;

50% * the length FL1 of the first sub-fin 121 <, the length FL2A of the first sub-fin segment 1221 ≤ the length FL1 of the first sub-fin 121;

the peak-to-peak distance FP2A of the first sub-fin segment 1221 = the peak-to-peak distance FP1 of the first sub-fin 121;

50% * the peak-to-peak distance FP2B of the second sub-fin segment 1222 ≤ the peak-to-peak distance FP2A of the first sub-fin segment 1221 ≤ 90% * the peak-to-peak distance FP2B of the second sub-fin segment 1222;

the number N1 of the first sub-fins 121 + the number N2 of the second sub-fins 122 = the number n of the second fins 22; and

10% * the number n of the second fins 22 ≤ the number N2 of the second sub-fins 122 ≤ 80% * the

number n of the second fins 22.

Eighth embodiment

[0114] Fig. 22 is a schematic perspective view of a heat exchanger 100 according to an eighth embodiment of the present invention; Fig. 23 is an enlarged perspective view of a second sub-fin 121 of a first heat exchanger core 1 of the heat exchanger 100 shown in Fig. 22; and Fig. 24 is a schematic enlarged top view of the second sub-fin 121 of the first heat exchanger core 1 of the heat exchanger 100 shown in Fig. 22.

[0115] The main difference between the heat exchanger 100 according to the eighth embodiment of the present invention and the heat exchanger 100 according to the first embodiment of the present invention is that the second wind resistance region 18 is provided with a fin or a sub-fin.

[0116] Referring to Fig. 22, in the embodiment of the present invention, the first main segment 10 of the first heat exchanger core 1 further includes: the first fin 12 connected with the first heat exchange tubes 11. The first fin 12 includes the first sub-fin 121 located in the first wind resistance region 17 and the second sub-fin 122 located in the second wind resistance region 18 and being different from the first sub-fin 121.

[0117] Referring to Fig. 22, in the embodiment of the present invention, the first main segment 10 of the first heat exchanger core 1 further includes the drainage insertion sheet 16 provided between the first sub-fin 121 and the second sub-fin 122 of the first fin 12.

[0118] For example, referring to Figs. 23 to 24, the second sub-fin 122 of the first fin 12 includes a main body 1220 and a plurality of heat exchange tube slots 1223 formed in the main body 1220 of the second sub-fin 122, the plurality of first heat exchange tubes 11 being inserted into the heat exchange tube slots 1223 of the second sub-fin 122, and the first sub-fin 121 of the first fin 12 being a wavy fin. The peak-to-peak distance of the first sub-fin 121 is greater than or equal to 50% of the peak-to-peak distance of the second sub-fin 122, and less than or equal to the peak-to-peak distance of the second sub-fin 122. In addition, the second sub-fin 122 of the first fin 12 may also be any existing suitable comb fin.

[0119] The specific example shown in Figs. 22 to 24 is described below.

[0120] The heat exchanger 100 shown in Fig. 22 includes: the first heat exchanger core 1 and the second heat exchanger core 2. The first heat exchanger core 1 includes: the first main segment 10 and the first header 13. The first main segment 10 includes the plurality of first heat exchange tubes 11, the plurality of first fins 12, and the drainage insertion sheet 16. The first fin 12 includes the first sub-fin 121 located in the first wind resistance region 17 and the second sub-fin 122 located in the second wind resistance region 18. The first heat exchange tubes 11 are arranged at intervals in the axial direction of the first header 13, and the first sub-fins 121

are arranged at intervals between the first heat exchange tubes 11 connected with the first header 13. The second heat exchanger core 2 includes: the second main segment 20 and the second header 23. The second main segment 20 includes the plurality of second heat exchange tubes 21 and the plurality of second fins 22. The second heat exchange tubes 21 are arranged at intervals in the axial direction of the second header 23, while the second fins 22 are arranged at intervals between the second heat exchange tubes 21 connected with the second header 23.

[0121] The first heat exchanger core 1 and the second heat exchanger core 2 form the passage through which the refrigerant flows. For example, the first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 are connected with each other to form the flow passages. The first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 may also be connected with each other by adapters to form the flow passages, respectively, or the first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 may be connected with each other by an adapter, instead of being connected in one-to-one correspondence. The first heat exchanger core 1 and the second heat exchanger core 2 are arranged in a front-to-back arrangement in the thickness direction of heat exchanger 100. The first heat exchanger core 1 may be on the leeward side, the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2 may be arranged in parallel, and a certain angle may also be formed between the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2.

[0122] A length of the first heat exchange tube 11 of the first heat exchanger core 1 is TL, a peak-to-peak distance of the first sub-fin 121 is FP1, a length of the first sub-fin 121 is FL1, a size of all the second sub-fins 122 as a whole in the first heat exchanger core extension direction C1 is FL2, and a spacing between the second sub-fins 122 is FP2; and a length of the second heat exchange tube 21 of the second heat exchanger core 2 is tl, a peak-to-peak distance of the second fin 22 is fp, and a length of the second fin 22 is fl.

[0123] In the eighth embodiment, the heat exchange amount of the first heat exchanger core 1 on the air side is adjusted by reducing a heat exchange intensity, i.e. a density of the fins, of the first heat exchanger core 1, ultimately achieving the reduction in the amount of condensation water of the heat exchanger 100.

[0124] Characteristics of the heat exchanger 100 in the eighth embodiment are as follows:

the height H of the first heat exchanger core 1 = the height h of the second heat exchanger core 2;

when the outer diameter of the first header 13 is equal to the outer diameter of the second header 23, the length TL of the first heat exchange tube 11 = the length tl of the second heat exchange tube 21; the structure of the first sub-fin 121 is the same as the structure of the second fin 22;

the first sub-fin 121 and the second fin 22 adopt wavy fins, and the second sub-fin 122 adopts a comb fin, the second sub-fin 122 includes a main body 1210 and a plurality of heat exchange tube slots 1211 formed in the main body 1210 of the second sub-fin 122, the plurality of first heat exchange tubes 11 being inserted into the heat exchange tube slots 1211 of the second sub-fin 122, the second sub-fin 122 may have a plurality of turbulent structures that enhance heat exchange and heat transfer, the drainage insertion sheet 16 is located between the first sub-fin 121 and the second sub-fin 122 to discharge the condensation water generated by the first sub-fin 121;

$30\% * \text{the length fl of the second fin 22} \leq \text{the length FL1 of the first sub-fin 121} \leq 90\% * \text{the length fl of the second fin 22}$;

at the same wind speed, the wind resistance of the first sub-fin 121 is greater than that of the second sub-fin 122, for example, $50\% * \text{the spacing FP2 of the second sub-fin 122} \leq \text{the peak-to-peak distance FP1 of the first sub-fin 121} < \text{the spacing FP2 of the second sub-fin 122}$; and

a certain angle may be formed between the second sub-fin 122 and the first heat exchange tube 11 (such as a flat tube).

Ninth embodiment

[0125] Fig. 25 is a schematic perspective view of a heat exchanger according to a ninth embodiment of the present invention. The heat exchanger 100 shown in Fig. 25 is obtained by adjusting the height of the first heat exchanger core 1 based on the heat exchanger 100 of the eighth embodiment.

[0126] Characteristics of the heat exchanger 100 in the ninth embodiment are as follows:

$30\% * \text{the height h of the second heat exchanger core 2} < \text{the height H of the first heat exchanger core 1} \leq 90\% * \text{the height h of the second heat exchanger core 2}$;

when the outer diameter of the first header 13 is equal to the outer diameter of the second header 23, $30\% * \text{the length tl of the second heat exchange tube 21} < \text{the length TL of the first heat exchange tube 11} \leq 90\% * \text{the length tl of the second heat exchange tube 21}$;

the structure of the first sub-fin 121 is the same as the structure of the second fin 22;

$20\% * \text{the length fl of the second fin 22} < \text{the length FL1 of the first sub-fin 121} \leq 80\% * \text{the length fl of the}$

second fin 22;

$40\% * \text{the length fl of the second fin 22} < \text{the length FL1 of the first sub-fin 121} + \text{the size FL2 of the second sub-fin 122} \leq 90\% * \text{the length fl of the second fin 22}$;

the first sub-fin 121 and the second fin 22 adopt wavy fins, as shown in Figs. 23 to 24, and the second sub-fin 122 adopts a comb fin, the second sub-fin 122 includes the main body 1220 and the plurality of heat exchange tube slots 1223 formed in the main body 1220 of the second sub-fin 122, the plurality of first heat exchange tubes 11 being inserted into the heat exchange tube slots 1223 of the second sub-fin 122, the second sub-fin 122 may have a plurality of turbulent structures that enhance heat exchange and heat transfer, for example, a plurality of openings 1225 formed in the main body 1220 of the second sub-fin 122, and the drainage insertion sheet 16 is located between the first sub-fin 121 and the second sub-fin 122 to discharge the condensation water generated by the first sub-fin 121; and

at the same wind speed, the wind resistance of the first sub-fin 121 is greater than that of the second sub-fin 122, for example, $50\% * \text{the spacing FP2 of the second sub-fin 122} \leq \text{the peak-to-peak distance FP1 of the first sub-fin 121} < \text{the spacing FP2 of the second sub-fin 122}$.

Tenth embodiment

[0127] Fig. 26 is a schematic perspective view of a heat exchanger 100 according to a tenth embodiment of the present invention; Fig. 27 is a schematic front view of a first heat exchanger core 1 of the heat exchanger 100 shown in Fig. 26; and Figs. 28 to 32 are schematic front views of the first heat exchanger core 1 of the heat exchanger 100 according to the tenth embodiment of the present invention.

[0128] The main difference between the heat exchanger 100 according to the tenth embodiment of the present invention and the heat exchanger 100 according to the first embodiment of the present invention is that at least some of the first heat exchange tubes 11 have bent portions in the second wind resistance regions 18.

[0129] Referring to Figs. 26 to 32, in the embodiment of the present invention, a spacing TS2 between the ends 14 of at least some of the first heat exchange tubes 11 connected with the first header 13 is smaller than a spacing TS1 between the first heat exchange tubes 11 in the first wind resistance region 17. For example, the spacing TS2 between the ends 14 of the first heat exchange tubes 11 connected with the first header 13 is smaller than the spacing TS1 between the first heat exchange tubes 11 in the first wind resistance region 17. For example, the first heat exchange tube 11 may be a flat tube, and the spacing TS2 between the ends 14 of at least some of the first heat exchange tubes 11 connected with the first header 13 is greater or equal

to a thickness TD of the first heat exchange tube 11. Referring to Figs. 30 to 32, the ends 14 of the first heat exchange tubes 11 includes a plurality of sets of ends 15, and the spacing TS2 between the ends 14 of each set of ends 15 is smaller than the spacing TS1 of the first heat exchange tubes 11 in the first wind resistance region 17. A spacing between adjacent sets of ends 15 is greater than the spacing TS2 between the ends 14 of each set of ends 15. For example, the first heat exchange tube 11 is a flat tube, and the spacing TS2 between the ends 14 of each set of ends 15 is greater than or equal to the thickness TD of the first heat exchange tube 11. The first header 13 may include a plurality of sub-headers 13A, 13B, each of which is connected and fluidly communicated with the ends 14 of one of the plurality of sets of ends 15 of the first heat exchange tube 11.

[0130] The specific example shown in Figs. 26 to 32 is described below.

[0131] The heat exchanger 100 shown in Figs. 26 to 32 includes: the first heat exchanger core 1 and the second heat exchanger core 2. The first heat exchanger core 1 includes the first main segment 10 and the first header 13. The first main segment 10 includes the plurality of first heat exchange tubes 11 and the plurality of first fins 12. The first heat exchange tube 11 includes the first heat exchange tube segment 111 located in the first wind resistance region 17, and the second heat exchange tube segment 112 and a third heat exchange tube segment 113 located in the second wind resistance region 18, wherein the third heat exchange tube segment 113 may be used as the end 14 of the first heat exchange tube 11 or may include the end 14 of the first heat exchange tube 11. Certain angles are formed between the second heat exchange tube segment 112 and the first heat exchange tube segment 111 and between the second heat exchange tube segment 112 and the third heat exchange tube segment 113 by bending, respectively, and the first heat exchange tube segment 111 and the third heat exchange tube segment 113 may be parallel to the first heat exchanger core extension direction C1, while the second heat exchange tube segment 112 is inclined relative to the first heat exchanger core extension direction C1. The first heat exchange tube segment 111, the second heat exchange tube segment 112, and the third heat exchange tube segment 113 may be located in the first plane in which the first main segment of the first heat exchanger core is located. The first heat exchange tubes 11 are arranged at intervals in the axial direction of the first header 13, while the first fins 12 are arranged at intervals between the first heat exchange tubes 11 connected with the first header 13. The second heat exchanger core 2 includes the second main segment 20 and the second header 23. The second main segment 20 includes the plurality of second heat exchange tubes 21 and the plurality of second fins 22. The second heat exchange tubes 21 are arranged at intervals in the axial direction of the second header 23, while the second fins 22 are arranged at intervals between the second heat

exchange tubes 21 connected with the second header 23. The heat exchange tube may be a flat tube.

[0132] The first heat exchanger core 1 and the second heat exchanger core 2 form the passage through which the refrigerant flows. For example, the first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 are connected with each other to form the flow passages. The first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 may also be connected with each other by adapters to form the flow passages, respectively, or the first heat exchange tubes 11 of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 may be connected with each other by an adapter, instead of being connected in one-to-one correspondence. The first heat exchanger core 1 and the second heat exchanger core 2 are arranged in a front-to-back arrangement in the thickness direction of heat exchanger 100. The first heat exchanger core 1 may be on the leeward side, the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2 may be arranged in parallel, and a certain angle may also be formed between the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2.

[0133] A size of the first heat exchange tube 11 of the first heat exchanger core 1 in the first heat exchanger core extension direction C1 or the third direction D3 is TL, a thickness of the first heat exchange tube 11 is TD, a peak-to-peak distance of the first fin 12 is FP, a length of the first fin 12 is FL, a length of the first heat exchange tube segment 111 is TL1, a spacing between the first heat exchange tube segments 111 is TS1, a size of the second heat exchange tube segment 112 in the first heat exchanger core extension direction C1 or the third direction D3 is TL2, a length of the third heat exchange tube segment 113 is TL3, a spacing between the third heat exchange tube segments 113 is TS2, a length of the second heat exchange tube 21 of the second heat exchanger core 2 is tl, a peak-to-peak distance of the second fin 22 is fp, and a length of the second fin 22 is fl.

[0134] In the tenth embodiment, the heat exchange amount of the first heat exchanger core 1 on the air side is adjusted by reducing a heat exchange area of the first heat exchanger core 1, ultimately achieving the reduction in the amount of the condensation water of the heat exchanger 100.

[0135] Characteristics of the heat exchanger 100 in the tenth embodiment are as follows:

the height H of the first heat exchanger core 1 = the height h of the second heat exchanger core 2;
when the outer diameter of the first header 13 is equal to the outer diameter of the second header 23, the size TL of the first heat exchange tube 11 = the

length tl of the second heat exchange tube 21;
 the size TL of the first heat exchange tube 11 = the
 length $TL1$ of the first heat exchange tube segment
 111 + the size $TL2$ of the second heat exchange tube
 segment 112 + the length $TL3$ of the third heat
 exchange tube segment 113;
 the structure of the first fin 12 is the same as the
 structure of the second fin 22;
 $50 \times$ the length $TL1$ of the first heat exchange tube
 segment 111 $<$, the length FL of the first fin 12 $<$, the
 length $TL1$ of the first heat exchange tube segment
 111;
 $30\% \times$ the size TL of the first heat exchange tube 11 $<$,
 the length $TL1$ of the first heat exchange tube seg-
 ment 111 $\leq 90\% \times$ the size TL of the first heat ex-
 change tube 11;
 the thickness TD of the first heat exchange tube 11 $<$,
 the spacing $TS2$ of the third heat exchange tube
 segment 113 $<$ the spacing $TS1$ of the first heat
 exchange tube segment 111; and
 $20 \times$ the length of the second header 23 $<$, the length
 of the first header 13 $<$, the length of the second
 header 23.

[0136] A heat exchanger 100 of a modification of the
 tenth embodiment is obtained by reducing the height H of
 the first heat exchanger core 1.

[0137] Characteristics of the heat exchanger 100 in the
 modification are as follows:

$30\% \times$ the height h of the second heat exchanger core
 2 $<$, the height H of the first heat exchanger core 1 $\leq$
 $90\% \times$ the height h of the second heat exchanger core
 2;
 when the outer diameter of the first header 13 is
 equal to the outer diameter of the second header
 23, $30\% \times$ the length tl of the second heat exchange
 tube 21 $<$, the size TL of the first heat exchange tube
 11 $\leq 90\% \times$ the length tl of the second heat exchange
 tube 21;
 the size TL of the first heat exchange tube 11 = the
 length $TL1$ of the first heat exchange tube segment +
 the size $TL2$ of the second heat exchange tube
 segment + the length $TL3$ of the third heat exchange
 tube segment;
 the structure of the first fin 12 is the same as the
 structure of the second fin 22;
 $50 \times$ the length $TL1$ of the first heat exchange tube
 segment 111 $<$, the length FL of the first fin 12 $<$, the
 length $TL1$ of the first heat exchange tube segment
 111;
 $30\% \times$ the size TL of the first heat exchange tube 11 $<$,
 the length $TL1$ of the first heat exchange tube seg-
 ment 111 $\leq 90\% \times$ the size TL of the first heat ex-
 change tube 11;
 the thickness TD of the first heat exchange tube 11 $<$,
 the spacing $TS2$ of the third heat exchange tube
 segment 113 $<$ the spacing $TS1$ of the first heat

exchange tube segment 111; and
 $20 \times$ the length of the second header 23 $<$, the length
 of the first header 13 $<$, the length of the second
 header 23.

[0138] The second heat exchange tube segment 112
 of the heat exchanger 100 may adopt the following
 structure.

[0139] As shown in Figs. 26 and 27, with respect to a
 plane perpendicular to the second direction $D2$ and lo-
 cated in the middle of the first header 13, the second heat
 exchange tube segments 112 on each side of the plane
 extend obliquely towards the plane in a direction towards
 the first header 13, and the second heat exchange tube
 segment 112 of one first heat exchange tube 11 in the
 middle of the first header 13 may extend parallel to the
 plane. The first heat exchanger core 1 may further include
 a refrigerant distribution device 131 provided in the first
 header 13, such as a fluid distribution tube or a fluid
 distributor.

[0140] As shown in Figs. 28 and 29, with respect to a
 plane perpendicular to the second direction $D2$ and lo-
 cated at an end of the first header 13, the second heat
 exchange tube segments 112 extend obliquely towards
 the plane in a direction towards the first header 13, and
 the second heat exchange tube segment 112 of one first
 heat exchange tube 11 at the end of the first header 13
 may extend parallel to the plane. The first heat exchanger
 core 1 may further include the refrigerant distribution
 device 131 provided in the first header 13, such as a fluid
 distribution tube or a fluid distributor.

[0141] As shown in Figs. 30 to 32, with respect to a
 plane perpendicular to the second direction $D2$ and lo-
 cated in the middle of the first header 13, the second heat
 exchange tube segments 112 on each side of the plane
 extend obliquely away from the plane in a direction to-
 wards the first header 13. The second heat exchange
 tube segments 112 of the two first heat exchange tubes
 11 located at two ends of the first header 13 may extend
 parallel to the plane, respectively. In the heat exchanger
 100 shown in Fig. 30, the first heat exchanger core 1 may
 further include the refrigerant distribution device 131
 provided in the first header 13, such as a fluid distribution
 tube or a fluid distributor. In the heat exchanger 100
 shown in Fig. 31, the first header 13 includes a partition
 135 provided in the first header 13, the first header 13
 being divided into two sub-headers 13A, 13B. The first
 heat exchanger core 1 may further include: refrigerant
 distribution devices 131A, 131B (such as fluid distribution
 tubes or fluid distributors) provided in the two sub-head-
 ers 13A, 13B, respectively; and refrigerant inlet connec-
 tion tubes 132A, 132B provided on the two sub-headers
 13A, 13B and connected with the refrigerant distribution
 devices 131A, 131B, respectively. In the heat exchanger
 100 shown in Fig. 32, the first heat exchanger core 1 may
 further include: a refrigerant distribution device 131 pro-
 vided in the first header 13, such as a fluid distribution
 tube or a fluid distributor; and a refrigerant inlet connec-

tion tube 132 connected to the refrigerant distribution device 131 at the middle of the first header 13.

Eleventh embodiment

[0142] Fig. 33 is a schematic perspective view of a heat exchanger 100 according to an eleventh embodiment of the present invention; and Figs. 34 to 37 are schematic front views of a portion of a first heat exchanger core 1 of the heat exchanger 100 according to the eleventh embodiment of the present invention.

[0143] The main difference between the heat exchanger 100 according to the eleventh embodiment of the present invention and the heat exchanger 100 according to the first embodiment of the present invention is that the first heat exchanger core 1 includes a plurality of heat exchanger sub-cores.

[0144] Referring to Figs. 33 to 37, the heat exchanger 100 according to the eleventh embodiment of the present invention includes: the first heat exchanger core 1 and the second heat exchanger core 2. The first heat exchanger core 1 includes the plurality of heat exchanger sub-cores, for example, the first heat exchanger core 1 includes two heat exchanger sub-cores, i.e., a first heat exchanger sub-core 1A and a second heat exchanger sub-core 1B. For example, the first heat exchanger core 1 is divided into a plurality of core segments arranged in the second direction D2 by a plane perpendicular to the second direction D2, and the first heat exchange tubes 11 of each core segment are connected and fluidly communicated with one of the plurality of sub-headers of the first header 13, thereby forming a plurality of heat exchanger sub-cores. For the comb fin and drainage insertion sheet of the above-mentioned embodiments, in addition to adopting the structure of the above-mentioned embodiments, each core segment may also have individual comb fin and drainage insertion sheet. The parameters of each core segment may be the same as the corresponding parameters of other core segments, or the parameters of each core segment may also be different from the corresponding parameters of other core segments. The parameters of the core segment may include a type and a size of the first fin in the core segment, a size of the core segment in the third direction D3, an angle between a portion of the first main segment in the core segment and the second main segment 20 of the second heat exchanger core 2, and a size of a portion of the first and second wind resistance regions of the first main segment in the core segment in the third direction D3. For example, the plurality of heat exchanger sub-cores may be located in one plane and arranged in the second direction D2. The first connection segment 19 of the first heat exchanger core 1 and the second connection segment 29 of the second heat exchanger core 2 of the heat exchanger 100 in this embodiment may be the same as the first connection segment 19 of the first heat exchanger core 1 and the second connection segment 29 of the second heat exchanger core 2 of the heat exchanger 100

in the above-mentioned embodiments.

[0145] The first heat exchanger sub-core 1A of the first heat exchanger core 1 includes: a first main segment 10A including a plurality of first heat exchange tubes 11A arranged in the second direction D2 and a first fin 12A connected with the first heat exchange tubes 11A; a first connection segment 19A connected with the first main segment 10A; and a first sub-header 13A of the first header 13 connected and fluidly communicated with the plurality of first heat exchange tubes 11A on a side of the first main segment 10A of the first heat exchanger sub-core 1A opposite to the first connection segment 19A.

[0146] The second heat exchanger sub-core 1B of the first heat exchanger core 1 includes: a first main segment 10B including a plurality of first heat exchange tubes 11B arranged in the second direction D2 and a first fin 12B connected with the first heat exchange tubes 11B; a first connection segment 19B connected with the first main segment 10B, and a second sub-header 13B of the first header 13 connected and fluidly communicated with the plurality of first heat exchange tubes 11B on a side of the first main segment 10B of the second heat exchanger sub-core 1B opposite to the first connection segment 19B.

[0147] The first connection segment 19A and the first connection segment 19B compose the first connection segment 19. The first main segment 10A and the first main segment 10B compose the first main segment 10, and the plurality of first heat exchange tubes 11A and the plurality of first heat exchange tubes 11B compose the plurality of first heat exchange tubes 11. The first fin 12A and the first fin 12B compose the first fin 12.

[0148] The second heat exchanger core 2 includes: a second main segment 20 including a plurality of second heat exchange tubes 21 arranged in the second direction D2; a second connection segment 29 connected with the second main segment 20; and a second header 23 connected and fluidly communicated with the plurality of second heat exchange tubes 21 on a side of the second main segment 20 of the second heat exchanger core 2 opposite to the second connection segment 29. The plurality of first heat exchange tubes 11 of the first main segment 10 of the first heat exchanger core 1 and the plurality of second heat exchange tubes 21 of the second main segment 20 of the second heat exchanger core 2 are connected and fluidly communicated with each other by the first connection segment 19 of the first heat exchanger core 1 and the second connection segment 29 of the second heat exchanger core 2.

[0149] The first main segment 10A of the first heat exchanger sub-core 1A includes a first wind resistance region 17A and a second wind resistance region 18A arranged in the third direction D3 or in the first heat exchanger core extension direction C1. The second wind resistance region 18A is adjacent to the first sub-header 13A of the first header 13, and the wind resistance of the second wind resistance region 18A is smaller than that of

the first wind resistance region 17A.

[0150] The first main segment 10B of the second heat exchanger sub-core 1B includes a first wind resistance region 17B and a second wind resistance region 18B arranged in the third direction D3 or in the first heat exchanger core extension direction C1. The second wind resistance region 18B is adjacent to the second sub-header 13B of the first header 13, and the wind resistance of the second wind resistance region 18B is smaller than that of the first wind resistance region 17B.

[0151] The first wind resistance region 17A of the first main segment 10A of the first heat exchanger sub-core 1A and the first wind resistance region 17B of the first main segment 10B of the second heat exchanger sub-core 1B compose the first wind resistance region 17, and the second wind resistance region 18A of the first main segment 10A of the first heat exchanger sub-core 1A and the second wind resistance region 18B of the first main segment 10B of the second heat exchanger sub-core 1B compose the second wind resistance region 18.

[0152] The first heat exchange tube 11A includes: a first heat exchange tube segment 111A located in the first wind resistance region 17A, and a second heat exchange tube segment 112A and a third heat exchange tube segment 113A located in the second wind resistance region 18A, wherein the third heat exchange tube segment 113A may be used as an end of the first heat exchange tube 11A or may include the end of the first heat exchange tube 11A. Certain angles are formed between the second heat exchange tube segment 112A and the first heat exchange tube segment 111A and between the second heat exchange tube segment 112A and the third heat exchange tube segment 113A by bending, respectively, the first heat exchange tube segment 111A and the third heat exchange tube segment 113A may be parallel to the first heat exchanger core extension direction C1, and the second heat exchange tube segment 112A is inclined relative to the first heat exchanger core extension direction C1. The first heat exchange tube segment 111A, the second heat exchange tube segment 112A, and the third heat exchange tube segment 113A may be located in a first plane in which the first main segment 10 of the first heat exchanger core 1 is located or in a plane in which the first main segment 10A of the first heat exchanger sub-core 1A is located.

[0153] The first heat exchange tube 11B includes: a first heat exchange tube segment 111B located in the first wind resistance region 17B, and a second heat exchange tube segment 112B and a third heat exchange tube segment 113B located in the second wind resistance region 18B, wherein the third heat exchange tube segment 113B may be used as an end of the first heat exchange tube 11B or may include the end of the first heat exchange tube 11B. Certain angles are formed between the second heat exchange tube segment 112B and the first heat exchange tube segment 111B and between the second heat exchange tube segment

112B and the third heat exchange tube segment 113B by bending, respectively, the first heat exchange tube segment 111B and the third heat exchange tube segment 113B may be parallel to the first heat exchanger core extension direction C1, and the second heat exchange tube segment 112B is inclined relative to the first heat exchanger core extension direction C1. The first heat exchange tube segment 111B, the second heat exchange tube segment 112B, and the third heat exchange tube segment 113B may be located in the first plane in which the first main segment 10 of the first heat exchanger core 1 is located or in a plane in which the first main segment 10B of the second heat exchanger sub-core 1B is located.

[0154] In the embodiment shown in the figures, the first heat exchange tube 11A includes the first heat exchange tube segment 111A, the second heat exchange tube segment 112A and the third heat exchange tube segment 113A. Certain angles are formed between the second heat exchange tube segment 112A and the first heat exchange tube segment 111A and between the second heat exchange tube segment 112A and the third heat exchange tube segment 113A by bending, respectively. The first heat exchange tube 11A is arranged at intervals in the axial direction of the first sub-header 13A, while the first fins 12A are arranged at intervals between the first heat exchange tubes 11A connected with the first sub-header 13A. The first heat exchange tube 11B includes the first heat exchange tube segment 111B, the second heat exchange tube segment 112B and the third heat exchange tube segment 113B. Certain angles are formed between the second heat exchange tube segment 112B and the first heat exchange tube segment 111B and between the second heat exchange tube segment 112B and the third heat exchange tube segment 113B by bending, respectively. The first heat exchange tubes 11B are arranged at intervals in the axial direction of the second sub-header 13B, while the first fins 12B are arranged at intervals between the first heat exchange tubes 11B connected with the first sub-header 13B. The second heat exchanger core 2 includes: the second main segment 20 and the second header 23. The second main segment 20 includes the plurality of second heat exchange tubes 21 and the plurality of second fins 22, the second heat exchange tubes 21 being arranged at intervals in the axial direction of the second header 23, while the second fins 22 being arranged at intervals between the second heat exchange tubes 21 connected with the second header 23. The heat exchange tube may be a flat tube.

[0155] The first heat exchanger core 1 and the second heat exchanger core 2 form the passage through which the refrigerant flows. For example, the first heat exchange tubes 11A, 11B of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 are connected with each other to form the flow passages. The first heat exchange tubes 11A, 11B of the first heat exchanger core 1 and the

second heat exchange tubes 21 of the second heat exchanger core 2 may also be connected with each other by adapters to form the flow passages, respectively, or the first heat exchange tubes 11A, 11B of the first heat exchanger core 1 and the second heat exchange tubes 21 of the second heat exchanger core 2 may be connected with each other by an adapter, instead of being connected in one-to-one correspondence. The first heat exchanger core 1 and the second heat exchanger core 2 are arranged in a front-to-back arrangement in the thickness direction of heat exchanger 100. The first heat exchanger core 1 may be on the leeward side, the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2 may be arranged in parallel, and a certain angle may also be formed between the first main segment 10 of the first heat exchanger core 1 and the second main segment 20 of the second heat exchanger core 2.

[0156] A size of the first heat exchange tube 11A of the first heat exchanger sub-core 1A in the first heat exchanger core extension direction C1 or the third direction D3 is TLA, a thickness of the first heat exchange tube 11A is TDA, a peak-to-peak distance of the first fin 12A is FPA, a length of the first fin 12A is FLA, a length of the first heat exchange tube segment 111A is TL1A, a spacing between the first heat exchange tube segments 111A is TS1A, a size of the second heat exchange tube segment 112A in the first heat exchanger core extension direction C1 or the third direction D3 is TL2A, a length of the third heat exchange tube segment 113A is TL3A, and a spacing between the third heat exchange tube segments 113B is TS2A.

[0157] A size of the first heat exchange tube 11B of the second heat exchanger sub-core 1B in the first heat exchanger core extension direction C1 or the third direction D3 is TLB, a thickness of the first heat exchange tube 11B is TDB, a peak-to-peak distance of the first fin 12B is FPB, a length of the first fin 12B is FLB, a length of the first heat exchange tube segment 111B is TL1B, a spacing between the first heat exchange tube segments 111B is TS1B, a size of the second heat exchange tube segment 112B in the first heat exchanger core extension direction C1 or the third direction D3 is TL2B, a length of the third heat exchange tube segment 113B is TL3B, and a spacing between the third heat exchange tube segments 113B is TS2B.

[0158] The first heat exchange tube segment 111A, the second heat exchange tube segment 112B, and the third heat exchange tube segment 113A of the first heat exchanger sub-core 1A and the first heat exchange tube segment 111B, the second heat exchange tube segment 112B, and the third heat exchange tube segment 113B of the second heat exchanger sub-core 1B, respectively, compose the first heat exchange tube segment, the second heat exchange tube segment, and the third heat exchange tube segment of the heat exchanger 100.

[0159] A length of the second heat exchange tube 21 of the second heat exchanger core 2 is tl, a peak-to-peak

distance of the second fin 22 is fp, and a length of the second fin 22 is fl.

[0160] In the eleventh embodiment, the heat exchange amount of the first heat exchanger core 1 on the air side is adjusted by reducing the heat exchange area of the first heat exchanger core 1, ultimately achieving the reduction in the amount of condensation water of the heat exchanger 100.

[0161] Characteristics of the heat exchanger 100 in the eleventh embodiment are as follows:

the height H of the first heat exchanger core 1 = the height h of the second heat exchanger core 2;
when the outer diameters of the first sub-header 13A and the second sub-header 13B of the first header 13 (when the outer diameter of the first sub-header 13A is the same as that of the second sub-header 13B) are equal to the outer diameter of the second header 23, the size TL of the first heat exchange tube 11 = the length tl of the second heat exchange tube 21;
the sizes of the first heat exchange tube segment 111A, the second heat exchange tube segment 112B, and the third heat exchange tube segment 113A of the first heat exchanger sub-core 1A are the same as the sizes of the first heat exchange tube segment 111B, the second heat exchange tube segment 112B, and the third heat exchange tube segment 113B of the second heat exchanger sub-core 1B, respectively;
the size TL of the first heat exchange tube 11 = the length TL1 of the first heat exchange tube segment + the size TL2 of the second heat exchange tube segment + the length TL3 of the third heat exchange tube segment;
the structure of the first fin 12 is the same as the structure of the second fin 22;
 $50\% \times \text{the length TL1 of the first heat exchange tube segment} < \text{the length FL of the first fin 12} < \text{the length TL1 of the first heat exchange tube segment}$;
 $30\% \times \text{the size TL of the first heat exchange tube 11} < \text{the length TL1 of the first heat exchange tube segment} \leq 90\% \times \text{the size TL of the first heat exchange tube 11}$;
the thickness TD of the first heat exchange tube < the spacing TS2 of the third heat exchange tube segments < the spacing TS1 of the first heat exchange tube segments; and
the first header includes the first sub-header 13A and the second sub-header 13B, wherein $20\% \times \text{the length of the second header 23} < \text{the length of the first sub-header 13A} \leq 80\% \times \text{the length of the second header 23}$, $20\% \times \text{the length of the second header 23} \leq \text{the length of the second sub-header 13B} \leq 80\% \times \text{the length of the second header 23}$.

[0162] A heat exchanger 100 of a modification of the eleventh embodiment is obtained by adjusting the heights H of the first heat exchanger sub-core 1A and

the second heat exchanger sub-core 1B of the first heat exchanger core 1.

[0163] Characteristics of the heat exchanger 100 in the eleventh embodiment are as follows:

30% * the height h of the second heat exchanger core 2 <, the height H_A of the first heat exchanger sub-core 1A $\leq$ the height h of the second heat exchanger core 2;

30% * the height h of the second heat exchanger core 2 <, the height H_B of the second heat exchanger sub-core 1B $\leq$ the height h of the second heat exchanger core 2;

when the outer diameter of the first sub-header 13A is equal to the outer diameter of the second header 23, 30% * the length tl of the second heat exchange tube 21 <, the size TLA of the first heat exchange tube 11A $\leq$ 90% * the length tl of the second heat exchange tube 21;

when the outer diameter of the second sub-header 13B is equal to the outer diameter of the second header 23, 30% * the length tl of the second heat exchange tube 21 <, the size TLB of the first heat exchange tube 11B $\leq$ 90% * the length tl of the second heat exchange tube 21;

the size TLA of the first heat exchange tube 11A = the length $TL1A$ of the first heat exchange tube segment 111A + the size $TL2A$ of the second heat exchange tube segment 112A + the length $TL3A$ of the third heat exchange tube segment 113A;

the size TLB of the first heat exchange tube 11B = the length $TL1B$ of the first heat exchange tube segment 111B + the size $TL2B$ of the second heat exchange tube segment 112B + the length $TL3B$ of the third heat exchange tube segment 113B;

the structure of the first fin 12A, the structure of the first fin 12B, and the structure of the second fin 22 are the same;

50% * the length $TL1A$ of the first heat exchange tube segment 111A $\leq$ the length FLA of the first fin 12A $\leq$ the length $TL1A$ of the first heat exchange tube segment 111A;

50% * the length $TL1B$ of the first heat exchange tube segment 111B $\leq$ the length FLB of the first fin 12B $\leq$ the length $TL1B$ of the first heat exchange tube segment 111B;

30% * the size TLA of the first heat exchange tube 11A $\leq$ the length $TL1A$ of the first heat exchange tube segment 111A $\leq$ 90% * the size TLA of the first heat exchange tube 11A;

30% * the size TLB of the first heat exchange tube 11B <, the length $TL1B$ of the first heat exchange tube segment 111B $\leq$ 90% * the size TLB of the first heat exchange tube 11B;

the thickness TDA of the first heat exchange tube 11A $\leq$ the spacing $TS2A$ of the third heat exchange tube segments 113A < the spacing $TS1A$ of the first heat exchange tube segments 111A;

the thickness TDB of the first heat exchange tube 11B $\leq$ the spacing $TS2B$ of the third heat exchange tube segment 113B < the spacing $TS1B$ of the first heat exchange tube segment 111B;

20% * the length of the second header 23 <, the length of the first sub-header 13A <, the length of the second header 23; and

20% * the length of the second header 23 <, the length of the first sub-header 13B $\leq$ the length of the second header 23.

[0164] The second heat exchange tube segment 112 of the heat exchanger 100 may adopt the following structure.

[0165] As shown in Figs. 33 to 37, for the first heat exchanger sub-core 1A, with respect to a plane perpendicular to the second direction $D2$ and located in the middle of the first sub-header 13A, the second heat exchange tube segments 112A on each side of the plane extend obliquely towards the plane in a direction towards the first sub-header 13A, and the second heat exchange tube segment 112A of one first heat exchange tube 11A in the middle of the first sub-header 13A may extend parallel to the plane. The first heat exchanger sub-core 1A may also include a refrigerant distribution device 131A provided in the first sub-header 13A, such as a fluid distribution tube or a fluid distributor. As shown in Figs. 33 to 37, for the second heat exchanger sub-core 1B, with respect to a plane perpendicular to the second direction $D2$ and located in the middle of the second sub-header 13B, the second heat exchange tube segments 112B on each side of the plane extend obliquely towards the plane in a direction towards the second sub-header 13B, and the second heat exchange tube segment 112B of one first heat exchange tube 11B in the middle of the second sub-header 13B may extend parallel to the plane. The second heat exchanger sub-core 1B may also include a refrigerant distribution device 131B provided in the second sub-header 13B, such as a fluid distribution tube or a fluid distributor.

[0166] Referring to Figs. 33 to 37 and Figs. 28 to 29, for the first heat exchanger sub-core 1A, with respect to a plane perpendicular to the second direction $D2$ and located at an end of the first sub-header 13A away from or close to the second heat exchanger sub-core 1B, the second heat exchange tube segments 112A extend obliquely towards the plane in a direction towards the first sub-header 13A, and the second heat exchange tube segment 112A of one first heat exchange tube 11A at the end of the first sub-header 13A may extend parallel to this plane. The first heat exchanger sub-core 1A may further include a refrigerant distribution device 131A provided in the first sub-header 13A, such as a fluid distribution tube or a fluid distributor. Referring to Figs. 33 to 37 and Figs. 28 to 29, for the second heat exchanger sub-core 1B, with respect to a plane perpendicular to the second direction $D2$ and located at an end of the second heat exchanger sub-core 1B away from or close to the first heat exchanger

ger sub-core 1A, the second heat exchange tube segments 112B extend obliquely towards the plane in a direction towards the second heat exchanger core 13B, and the second heat exchange tube segment 112B of one first heat exchange tube 11B at the end of the second heat exchanger sub-core 1B may extend parallel to this plane. The second heat exchanger sub-core 1B may further include a refrigerant distribution device 131B provided in the second sub-header 13B, such as a fluid distribution tube or a fluid distributor.

[0167] Referring to Figs. 33 to 37 and Figs. 30 to 32, for the first heat exchanger sub-core 1A, with respect to a plane perpendicular to the second direction D2 and located in the middle of the first sub-header 13A, the second heat exchange tube segments 112A on each side of the plane extend obliquely away from the plane in a direction towards the first sub-header 13A. The second heat exchange tube segments 12A of two first heat exchange tubes 11A located at two ends of the first sub-header 13A, respectively, may extend parallel to the plane. Referring to Figs. 33 to 37 and Figs. 30 to 32, for the second heat exchanger sub-core 1B, with respect to a plane perpendicular to the second direction D2 and located in the middle of the second sub-header 13B, the second heat exchange tube segments 112B on each side of the plane extend obliquely away from the plane in a direction towards the second sub-header 13B. The second heat exchange tube segments 112B of two first heat exchange tubes 11B located at the two ends of the second sub-header 13B, respectively, may extend parallel to this plane.

[0168] In the embodiment shown in Fig. 34, the first heat exchanger sub-core 1A further includes the refrigerant distribution device 131A provided in the first sub-header 13A, such as a fluid distribution tube or a fluid distributor, and the second heat exchanger sub-core 1B further includes the refrigerant distribution device 131B provided in the second sub-header 13B, such as a fluid distribution tube or a fluid distributor. In the embodiment shown in Figs. 35 and 36, the first heat exchanger sub-core 1A further includes the refrigerant distribution device 131A provided in the first sub-header 13A, such as a fluid distribution tube or a fluid distributor, and the second heat exchanger sub-core 1B further includes the refrigerant distribution device 131B provided in the second sub-header 13B, such as a fluid distribution tube or a fluid distributor. And the refrigerant distribution devices 131A, 131B are connected together by a connecting tube between the first sub-header 13A and the second sub-header 13B. In the embodiment shown in Fig. 35, a common inlet of the refrigerant distribution device 131A and the refrigerant distribution device 131B, namely the refrigerant inlet connecting tube 132, is provided between the first sub-header 13A and the second sub-header 13B. In the embodiment shown in Fig. 36, a common inlet of the refrigerant distribution device 131A and the refrigerant distribution device 131B, namely the refrigerant inlet connecting tube 132, is provided on a

side of the first sub-header 13A away from the second sub-header 13B. In the embodiment shown in Fig. 37, the first heat exchanger sub-core 1A and the second heat exchanger sub-core 1B have no refrigerant distribution device, the first heat exchanger sub-core 1A further includes a refrigerant inlet connection tube 132A provided on the first sub-header 13A, and the second heat exchanger sub-core 1B further includes a refrigerant inlet connection tube 132B provided on the second sub-header 13B.

[0169] An air conditioning system according to an embodiment of the present invention includes: the above-mentioned heat exchanger 100. More specifically, the air conditioning system includes: a compressor, a condenser, an evaporator, an expansion valve, etc.. At least one of the condenser and the evaporator is the heat exchanger 100. The first header 13 and the second header 23 of the heat exchanger 100 may be horizontally arranged in use. In use, the second heat exchanger core 2 of the heat exchanger 100 may be positioned upstream of the first heat exchanger core 1 in a direction in which air flow through the heat exchanger.

[0170] A heat exchange system according to an embodiment of the present invention includes a pump, an exothermic heat exchanger, and an endothermic heat exchanger. At least one of the exothermic heat exchanger and the endothermic heat exchanger is the above-mentioned heat exchanger 100.

[0171] According to the embodiments of the present invention, the heat exchanger may reasonably adjust the heat transfer intensity of the first heat exchanger core, thereby adjusting the amount of the condensation water of the heat exchanger, and the problem of blowing water in the air conditioning system may be solved by reducing the amount of the condensation water of the first heat exchanger core.

[0172] Although the above embodiments are described and illustrated, 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 (100) comprising:

a first heat exchanger core (1) and a second heat exchanger core (2) arranged side by side in a first direction (D1),

the first heat exchanger core (1) comprising:

a first main segment (10, 10A, 10B), the first main segment (10, 10A, 10B) of the first heat exchanger core (1) comprising a plurality of first heat exchange tubes (11, 11A, 11B) arranged in a second direction (D2) perpendicular to the first direction (D1);
a first connection segment (19, 19A, 19B)

connected with the first main segment (10, 10A, 10B); and
 a first header (13) connected and fluidly communicated with the plurality of first heat exchange tubes (11, 11A, 11B) on a side of the first main segment (10, 10A, 10B) of the first heat exchanger core (1) opposite to the first connection segment (19, 19A, 19B),

the second heat exchanger core (2) comprising:

a second main segment (20), the second main segment (20) of the second heat exchanger core (2) comprising a plurality of second heat exchange tubes (21) arranged in the second direction (D2);
 a second connection segment (29) connected with the second main segment (20); and
 a second header (23) connected and fluidly communicated with the plurality of second heat exchange tubes (21) on a side of the second main segment (20) of the second heat exchanger core (2) opposite to the second connection segment (29),

wherein the plurality of first heat exchange tubes (11, 11A, 11B) of the first main segment (10, 10A, 10B) of the first heat exchanger core (1) and the plurality of second heat exchange tubes (21) of the second main segment (20) of the second heat exchanger core (2) are interconnected and in fluid communication by the first connection segment (19, 19A, 19B) of the first heat exchanger core (1) and the second connection segment (29) of the second heat exchanger core (2), and wherein the first main segment (10, 10A, 10B) of the first heat exchanger core (1) comprises a first wind resistance region (17, 17A, 17B) and a second wind resistance region (18, 18A, 18B) arranged in a third direction (D3) perpendicular to the first direction (D1) and the second direction (D2), or in a first heat exchanger core extension direction (C1) perpendicular to the second direction (D2) and parallel to a first plane in which the first main segment (10, 10A, 10B) of the first heat exchanger core (1) is located, the second wind resistance region (18, 18A, 18B) being adjacent to the first header (13), and a wind resistance of the second wind resistance region (18, 18A, 18B) being smaller than that of the first wind resistance region (17, 17A, 17B).

2. The heat exchanger (100) according to claim 1, wherein

the first wind resistance region (17, 17A, 17B) has a size in the first heat exchanger core ex-

tension direction (C1), the first main segment (10, 10A, 10B) of the first heat exchanger core (1) has a size in the first heat exchanger core extension direction (C1), and a ratio of the size of the first wind resistance region (17, 17A, 17B) to the size of the first main segment (10, 10A, 10B) is greater than or equal to 20% and less than or equal to 90%; or

a ratio of a size of the first wind resistance region (17, 17A, 17B) in the third direction (D3) to a size of the first main segment (10, 10A, 10B) of the first heat exchanger core (1) in the third direction (D3) is greater than or equal to 20% and less than or equal to 90%; or

a ratio of a length of a portion of the first heat exchange tube (11, 11A, 11B) occupied by the first wind resistance region (17, 17A, 17B) to a length (TL) of the first heat exchange tube (11, 11A, 11B) is greater than or equal to 20% and less than or equal to 90%.

3. The heat exchanger (100) according to claim 1, wherein
 the first heat exchanger core (1) has a first orthographic projection on a second plane in which the second main segment (20) of the second heat exchanger core (2) is located, the second heat exchanger core (2) has a second orthographic projection on the second plane in which the second main segment (20) of the second heat exchanger core (2) is located, and a ratio of an overlapping area between the first orthographic projection of the first heat exchanger core (1) and the second orthographic projection of the second heat exchanger core (2) to an area of the second orthographic projection of the second heat exchanger core (2) is greater than or equal to 50% and less than or equal to 100%.
4. The heat exchanger (100) according to claim 1, wherein
 an angle between the first main segment (10, 10A, 10B) of the first heat exchanger core (1) and the second main segment (20) of the second heat exchanger core (2) is greater than or equal to 0 degree and less than or equal to 45 degrees.
5. The heat exchanger according to claim 1, wherein

the first heat exchanger core (1) has a size in the first heat exchanger core extension direction (C1), the second heat exchanger core (2) has a size in a second heat exchanger core extension direction (C2) perpendicular to the second direction (D2) and parallel to a second plane in which the second main segment (20) of the second heat exchanger core (2) is located, and a ratio of the size of the first heat exchanger core (1) and the size of the second heat exchan-

ger core (2) is greater than or equal to 30% and less than or equal to 100%; or

a ratio of a size of the first heat exchanger core (1) in the third direction (D3) to a size of the second heat exchanger core (2) in the third direction (D3) is greater than or equal to 30% and less than or equal to 100%. 5

6. The heat exchanger (100) according to claim 1, wherein 10

the first heat exchanger core (1) has a size in the first heat exchanger core extension direction (C1), the second heat exchanger core (2) has a size in a second heat exchanger core extension direction (C2) perpendicular to the second direction (D2) and parallel to a second plane in which the second main segment (20) of the second heat exchanger core (2) is located, and a ratio of the size of the first heat exchanger core (1) to the size of the second heat exchanger core (2) is greater than or equal to 60% and less than or equal to 100%; or 15 20

a ratio of a size of the first heat exchanger core in the third direction (D3) to a size of the second heat exchanger core (2) in the third direction (D3) is greater than or equal to 60% and less than or equal to 100%. 25

7. The heat exchanger (100) according to claim 1, wherein 30

the first main segment (10) of the first heat exchanger core (1) further comprises: a first fin (12) connected with the first heat exchange tubes (11) and provided in the first wind resistance region (17), there is no fin in the second wind resistance (18) region of the first main segment (10) of the first heat exchanger core (1); the second main segment (20) of the second heat exchanger core (2) further comprises: a second fin (22) connected with the second heat exchange tubes (21), the second wind resistance region (18) of the first main segment (10) of the first heat exchanger core (1) has a size in the first heat exchanger core extension direction (C1), the second main segment (20) of the second heat exchanger core (2) has a size in a second heat exchanger core extension (C2) direction perpendicular to the second direction (D2) and parallel to a second plane in which the second main segment (20) of the second heat exchanger core (2) is located, and a ratio of the size of the second wind resistance region (18) to the size of the second main segment (20) of the second heat exchanger core (2) is greater than or equal to 10% and less than or equal to 70%; or the first main segment (10) of the first heat 35 40 45 50 55

exchanger core (1) further comprises: a first fin (12) connected with the first heat exchange tubes (11) and provided in the first wind resistance region (17), there is no fin in the second wind resistance region (18) of the first main segment (10) of the first heat exchanger core (1); the second main segment (20) of the second heat exchanger core (2) further comprises: a second fin (22) connected with the second heat exchange tubes (21), the second wind resistance region (18) of the first main segment (10) of the first heat exchanger core (1) has a size in the third direction (D3), the second main segment (20) of the second heat exchanger core (2) has a size in the third direction (D3), and a ratio of the size of the second wind resistance region (18) to the size of the second main segment (20) of the second heat exchanger core (2) is greater than or equal to 10% and less than or equal to 70%.

8. The heat exchanger (100) according to claim 1, wherein

the first main segment (10) of the first heat exchanger core (1) further comprises: a first fin (12) connected with the first heat exchange tubes (11) and provided in the first wind resistance region (17), there is no fin in the second wind resistance region (18) of the first main segment (10) of the first heat exchanger core (1); the second main segment (20) of the second heat exchanger core (2) further comprises: a wavy second fin (22) connected with the second heat exchange tubes (21) and alternately arranged with the second heat exchange tubes (21), the second wind resistance region (18) of the first main segment (10) of the first heat exchanger core (1) has a size in the first heat exchanger core extension direction (C1), the second fin (22) has a size in a second heat exchanger core extension direction (C2) perpendicular to the second direction (D2) and parallel to a second plane in which the second main segment (20) of the second heat exchanger core (2) is located, and a ratio of the size of the second wind resistance region (18) to the size of the second fin (22) is greater than or equal to 10% and less than or equal to 70%; or the first main segment (10) of the first heat exchanger core (1) further comprises: a first fin (12) connected with the first heat exchange tubes (11) and provided in the first wind resistance region (17), there is no fin in the second wind resistance region (18) of the first main segment (10) of the first heat exchanger core (1); the second main segment (20) of the second heat exchanger core (2) further comprises: a 35 40 45 50 55

- wavy second fin (22) connected with the second heat exchange tubes (21) and alternately arranged with the second heat exchange tubes (21), the second wind resistance region (18) of the first main segment (10) of the first heat exchanger core (1) has a size in the third direction (D3), the second fin (22) has a size in the third direction (D3), and a ratio of the size of the second wind resistance region (18) to the size of the second fin (22) is greater than or equal to 10% and less than or equal to 70%. 5 10
9. The heat exchanger (100) according to claim 1, wherein the first main segment (10) of the first heat exchanger core (1) further comprises: a first fin (12) connected with the first heat exchange tubes (11), the first fin (12) comprising a first sub-fin (121) located in the first wind resistance region (17), and a second sub-fin (122) located in the second wind resistance region (18) and being different from the first sub-fin (121). 15 20
10. The heat exchanger (100) according to claim 9, wherein the first sub-fin (121) and the second sub-fin (122) of the first fin (12) are wavy fins, and a peak-to-peak distance (FP1) of the first sub-fin (121) is greater than or equal to 50% of a peak-to-peak distance (FP2) of the second sub-fin (122) and less than or equal to 90% of the peak-to-peak distance (FP2) of the second sub-fin (122). 25 30
11. The heat exchanger (100) according to claim 1, wherein the first wind resistance region (17) is adjacent to the second wind resistance region (18), the first main segment (10) of the first heat exchanger core (1) further comprises: a first fin (12) connected with the first heat exchange tubes (11), the first fin (12) comprising a first sub-fin (121) extending in the first wind resistance region (17) and extending to a boundary between the first wind resistance region (17) and the second wind resistance region (18) or near the boundary, and a second sub-fin (122) extending in the first wind resistance region (17) and the second wind resistance region (18). 35 40 45
12. The heat exchanger (100) according to claim 11, wherein the first sub-fin (121) and the second sub-fin (122) of the first fin (12) are wavy fins and have sizes in the first heat exchanger core extension direction (C1), and the size of the first sub-fin (121) of the first fin (12) is greater than or equal to 50% of the size of the second sub-fin (122) of the 50 55
- first fin (12) and less than the size of the second sub-fin (122) of the first fin (12); or the first sub-fin (121) and the second sub-fin (122) of the first fin (12) are wavy fins and have sizes in the third direction (D3), and the size of the first sub-fin (121) of the first fin (12) is greater than or equal to 50% of the size of the second sub-fin (122) of the first fin (12) and less than the size of the second sub-fin (122) of the first fin (12); or a number (N1) of the first sub-fins (121) of the first fin (12) is greater than or equal to 10% of a number (N2) of the second sub-fins (122) of the first fin (12) and less than or equal to 80% of the number (N2) of second sub-fins (122) of the first fin (12). 60
13. The heat exchanger (100) according to claim 1, wherein the second heat exchanger core (2) further comprises an outlet header (24) connected and fluidly communicated with the second header (23), the first heat exchanger core (1) further comprises a refrigerant distribution device (131) provided in the first header (13), and/or the second heat exchanger core (2) further comprises a refrigerant collection device provided in the second header (23). 65
14. The heat exchanger (100) according to claim 1, wherein a wind resistance of the second wind resistance region (18, 18A, 18B) of the first main segment (10, 10A, 10B) of the first heat exchanger core (1) is smaller than that of the second main segment (20) of the second heat exchanger core (2). 70
15. The heat exchanger (100) according to claim 1, wherein the second wind resistance region (18, 18A, 18B) has a size in the first heat exchanger core extension direction (C1), the first main segment (10, 10A, 10B) of the first heat exchanger core (1) has a size in the first heat exchanger core extension direction (C1), and a ratio of the size of the second wind resistance region (18, 18A, 18B) to the size of the first main segment (10, 10A, 10B) is greater than or equal to 20% and less than or equal to 50%; or a ratio of a size of the second wind resistance region (18, 18A, 18B) in the third direction (D3) to a size of the first main segment (10, 10A, 10B) of the first heat exchanger core (1) in the third direction (D3) is greater than or equal to 20% and less than or equal to 50%. 75 80 85 90

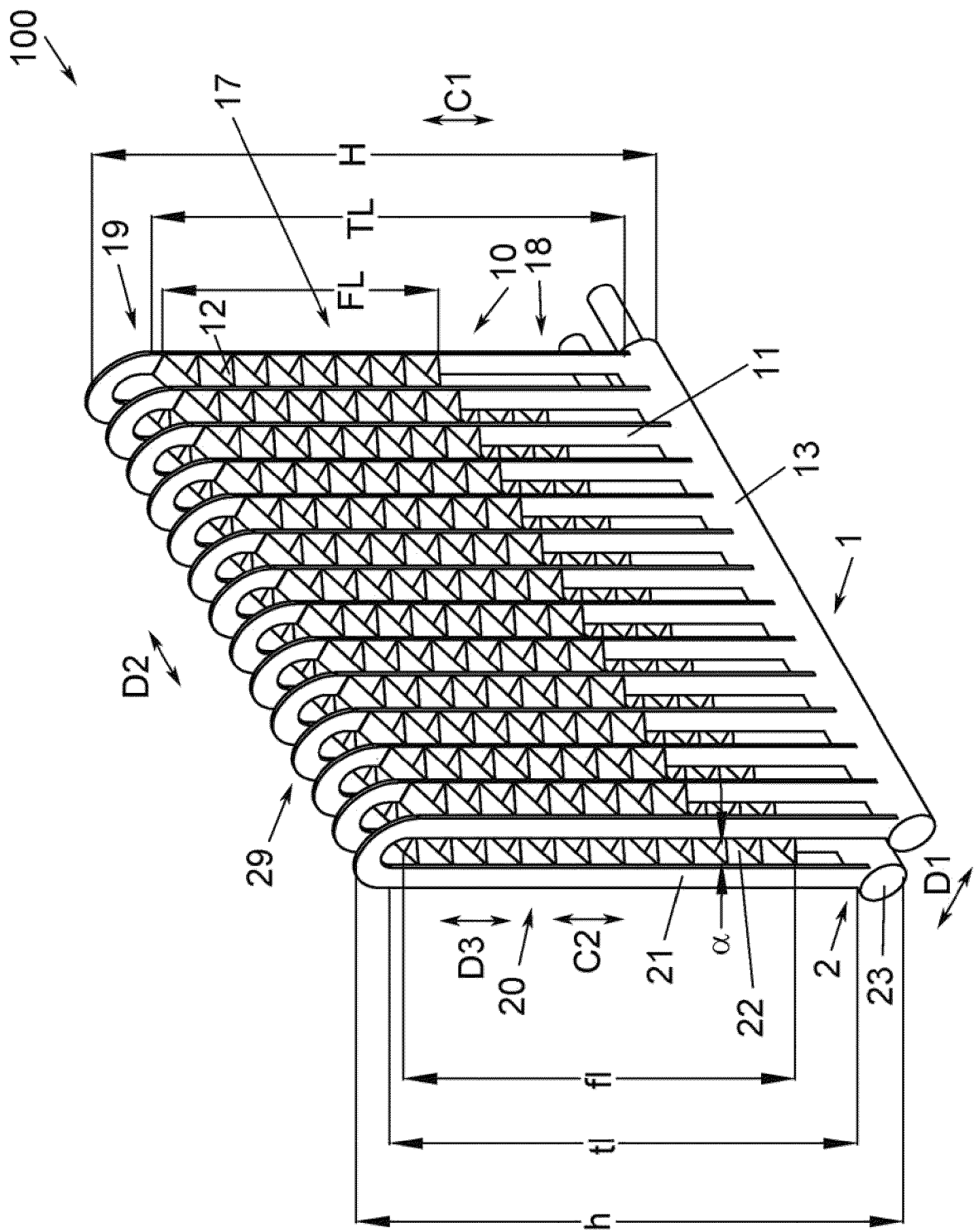


Fig. 1

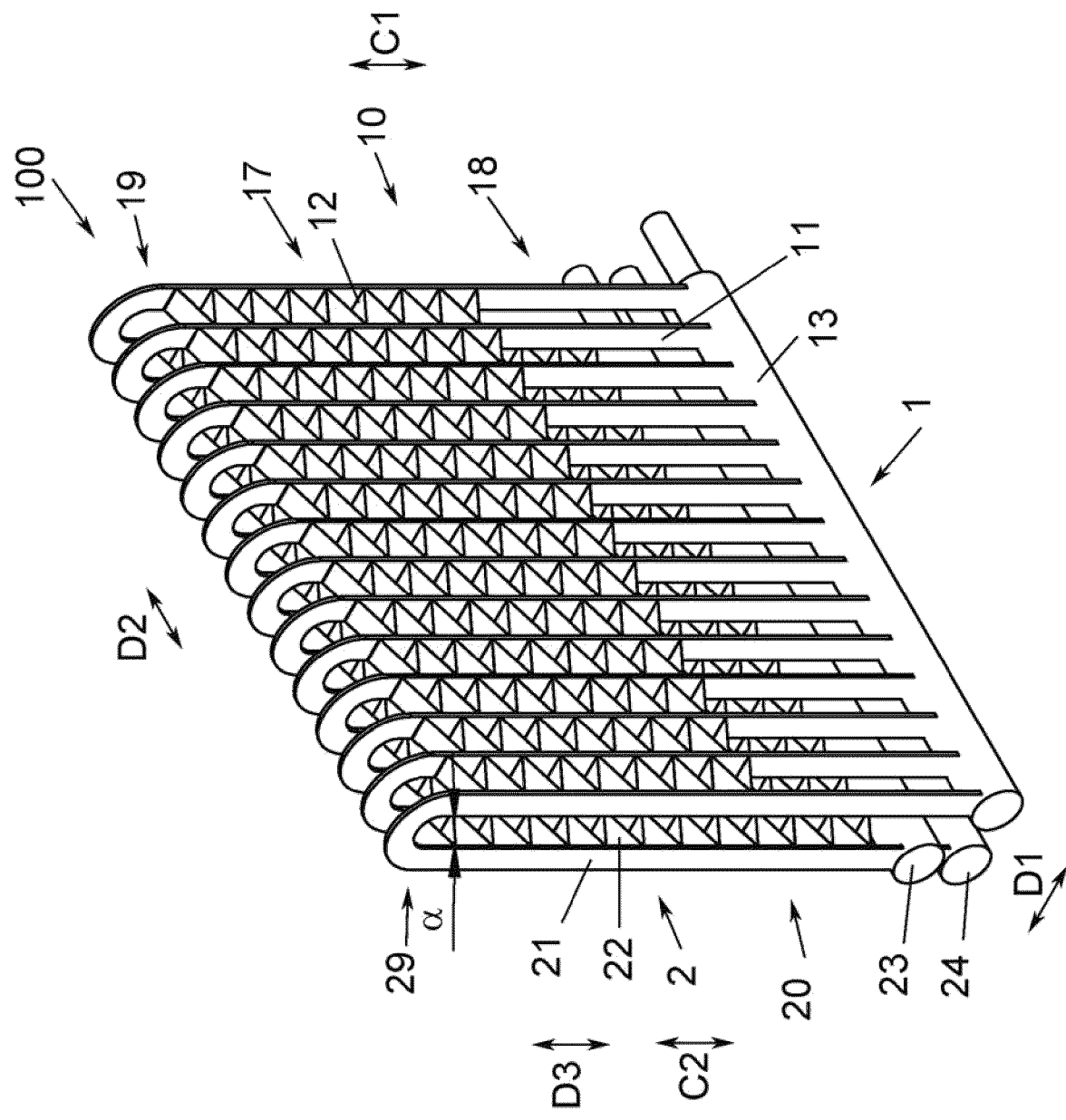


Fig. 2

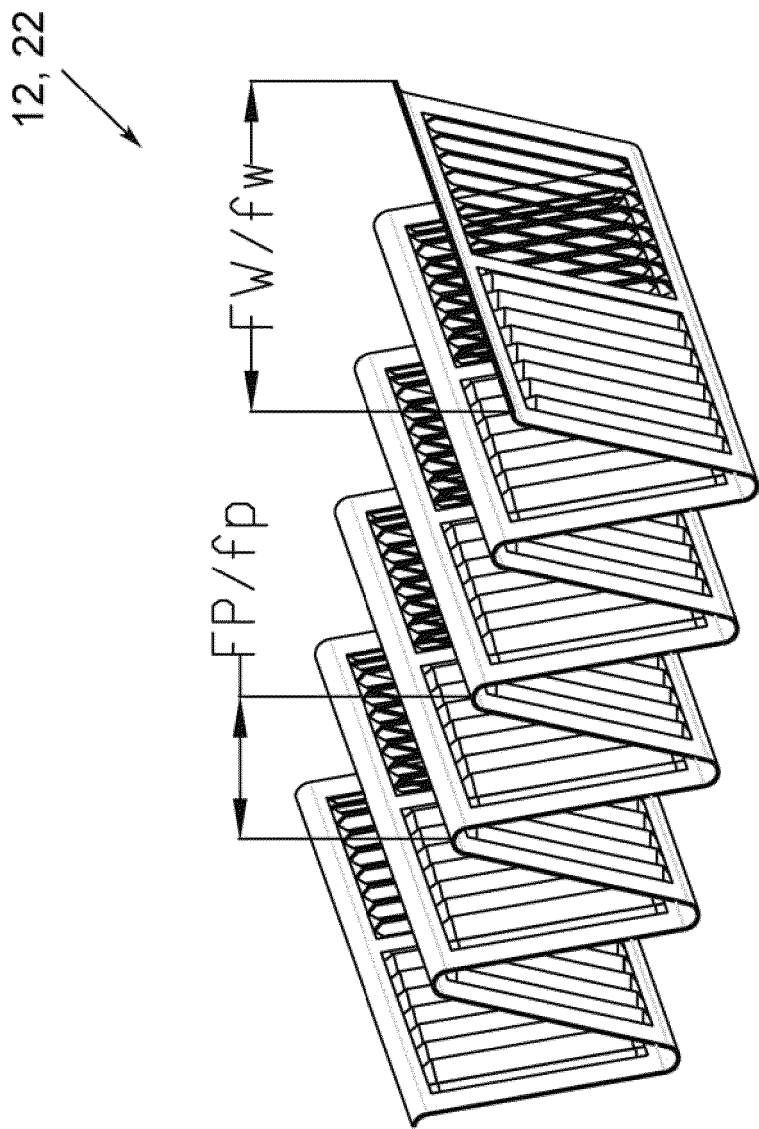
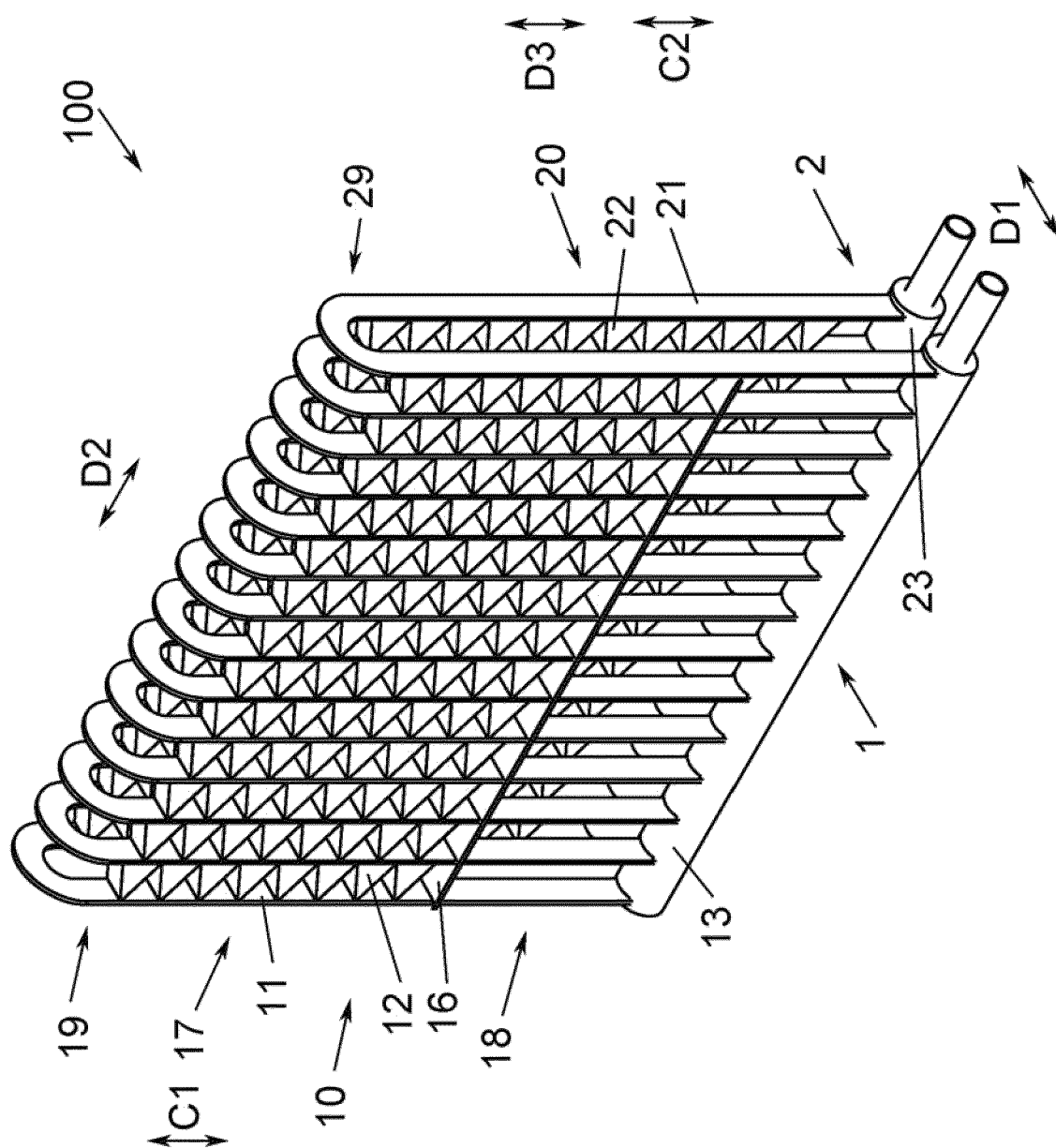


Fig. 3

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F. 5.

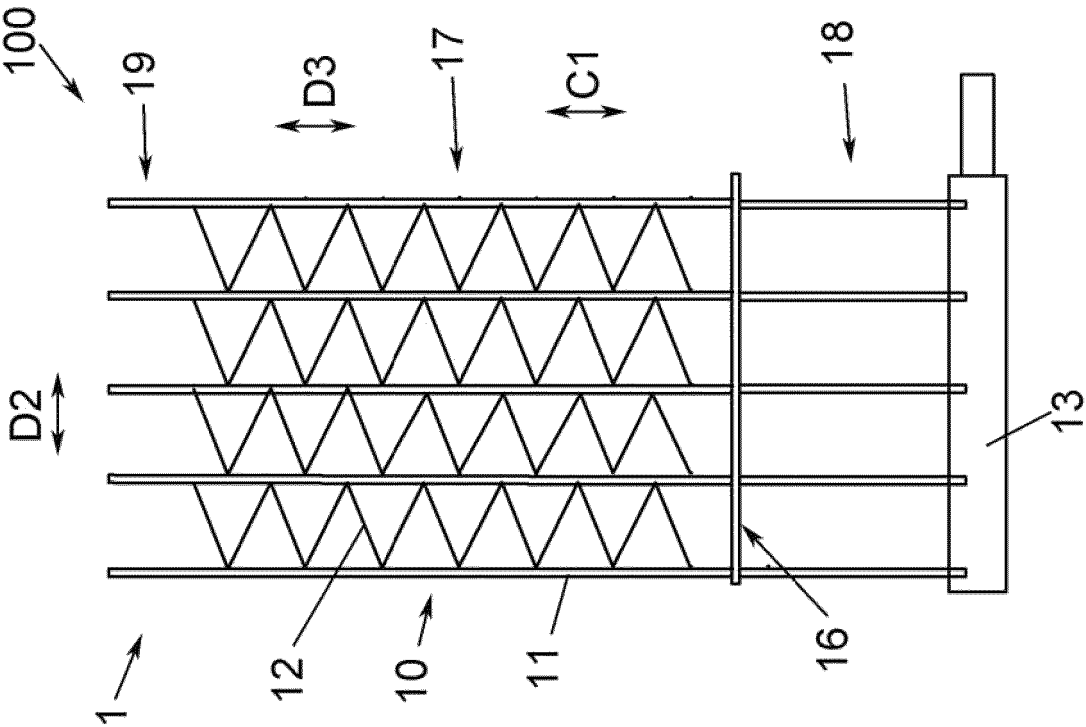


Fig. 5

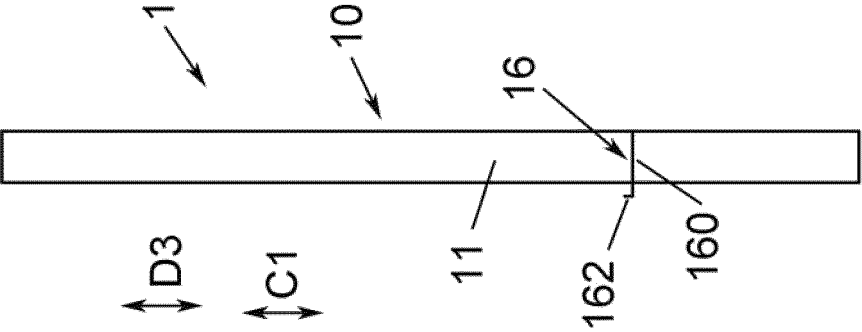


Fig. 6

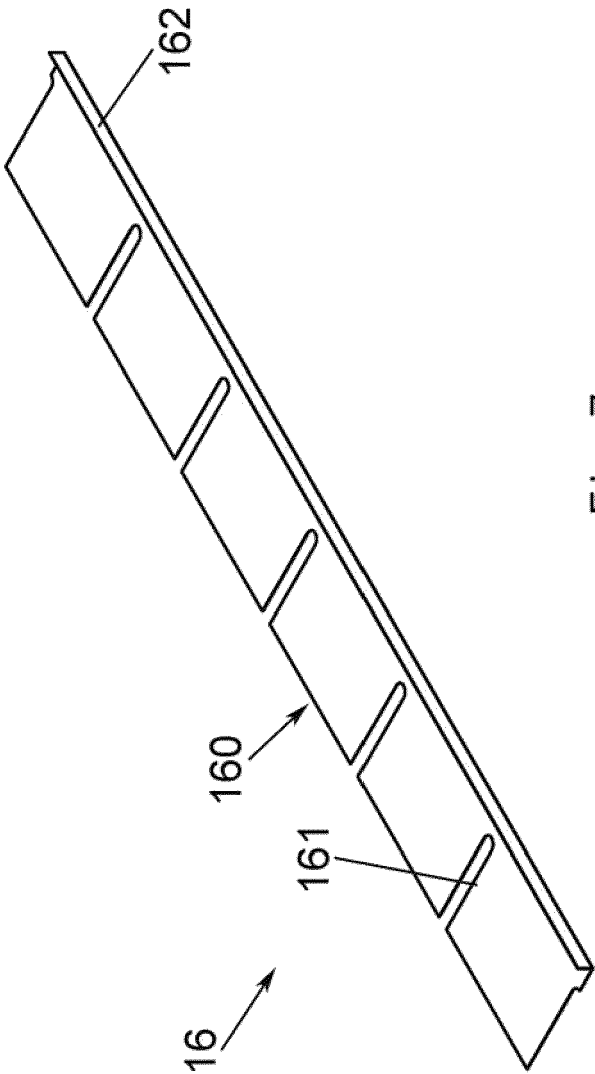


Fig. 7

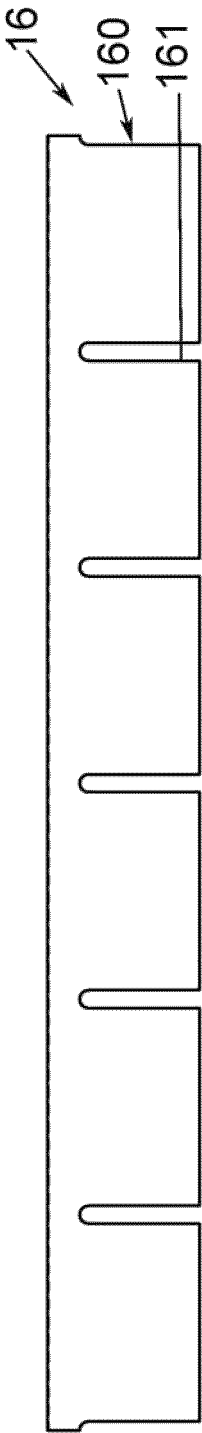


Fig. 8

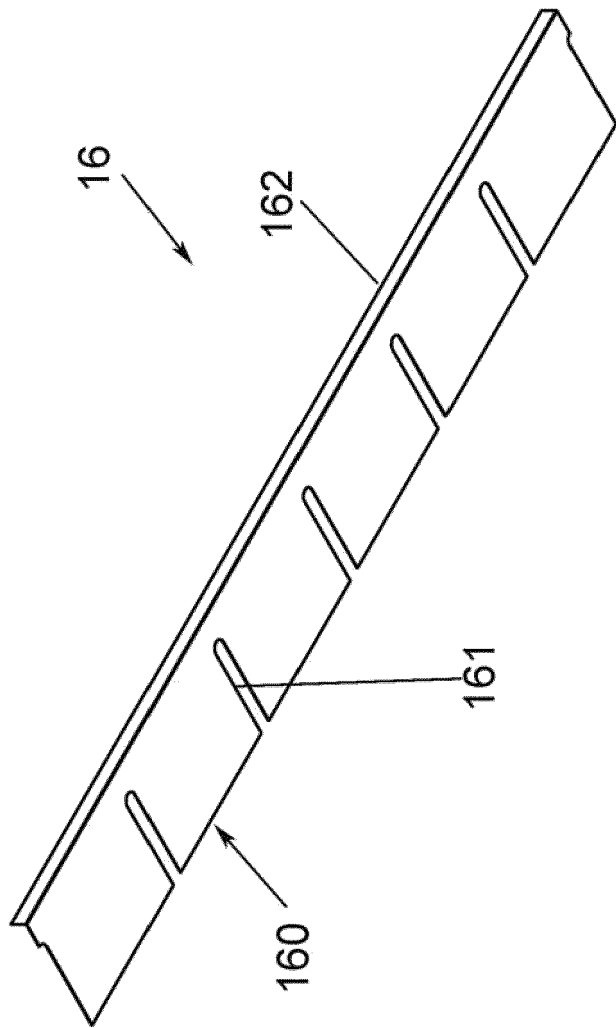


Fig. 9

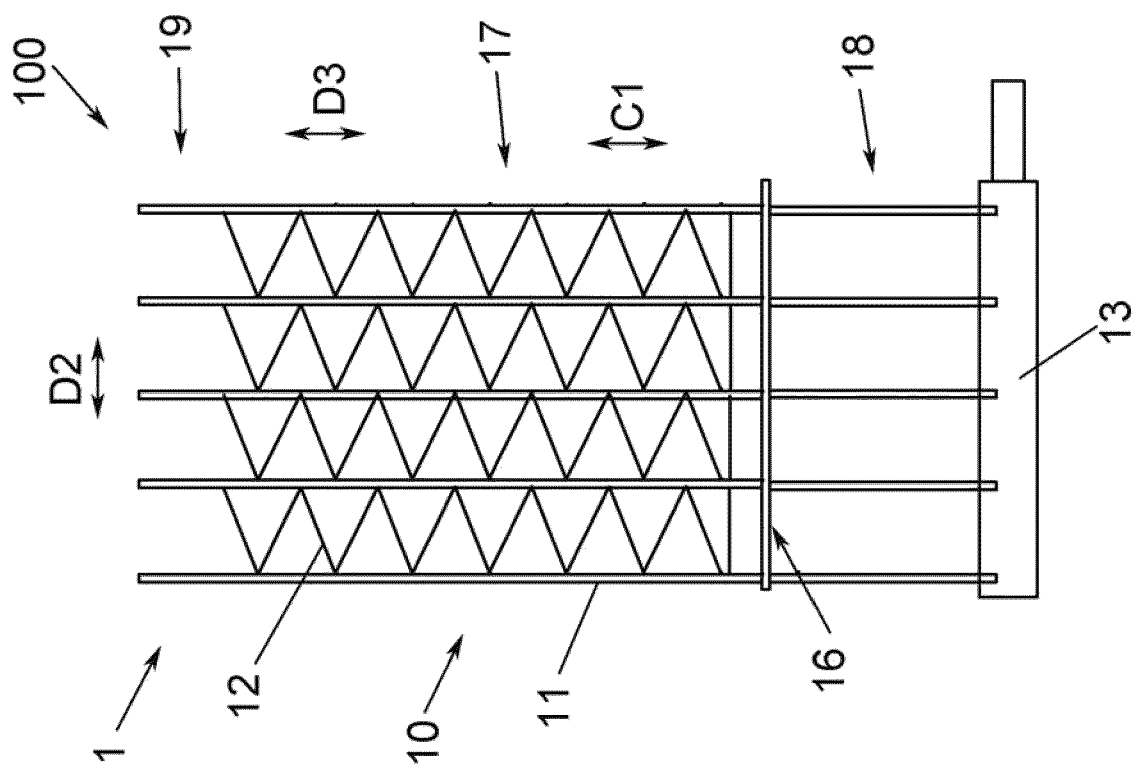


Fig. 10

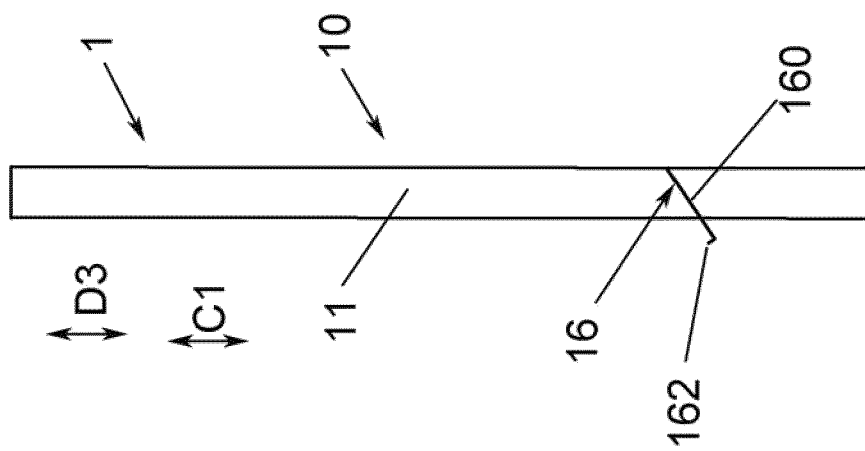


Fig. 11

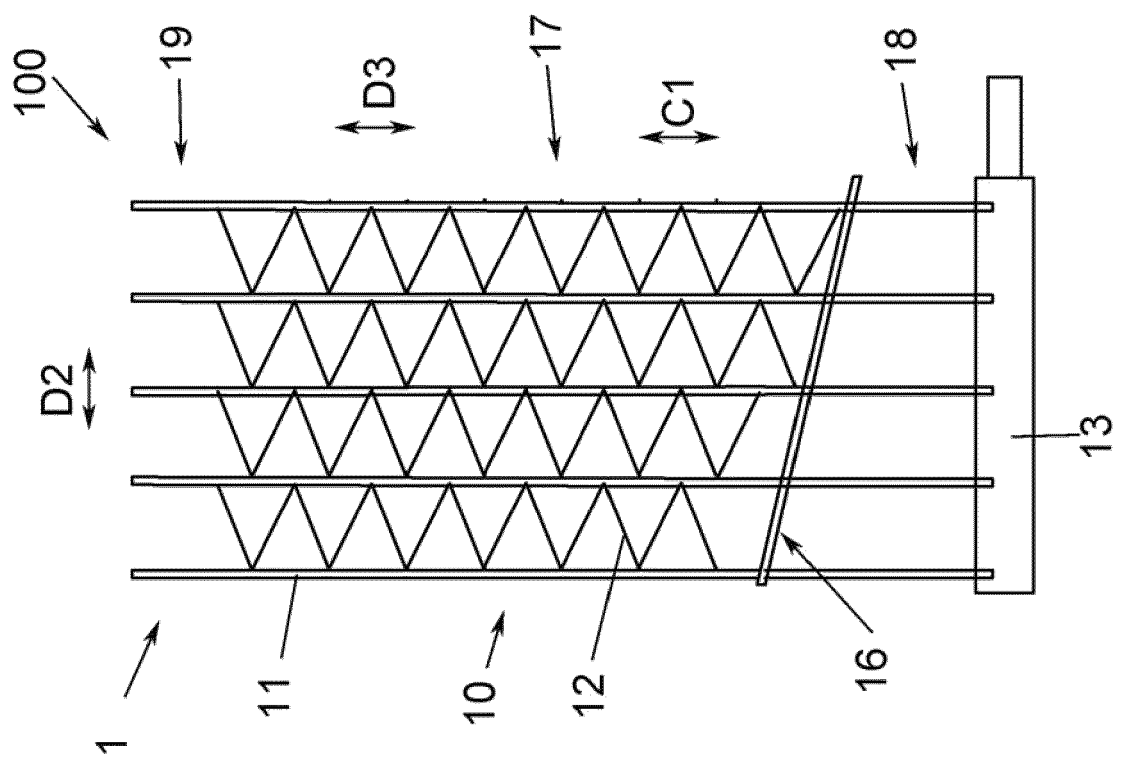


Fig. 12

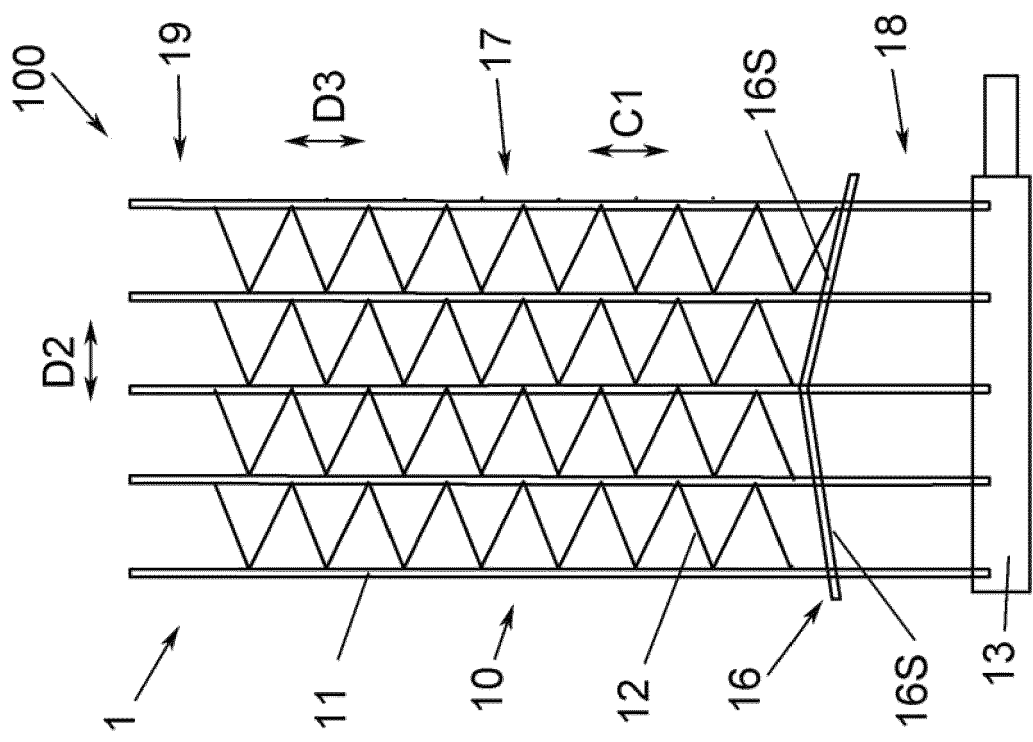


Fig. 13

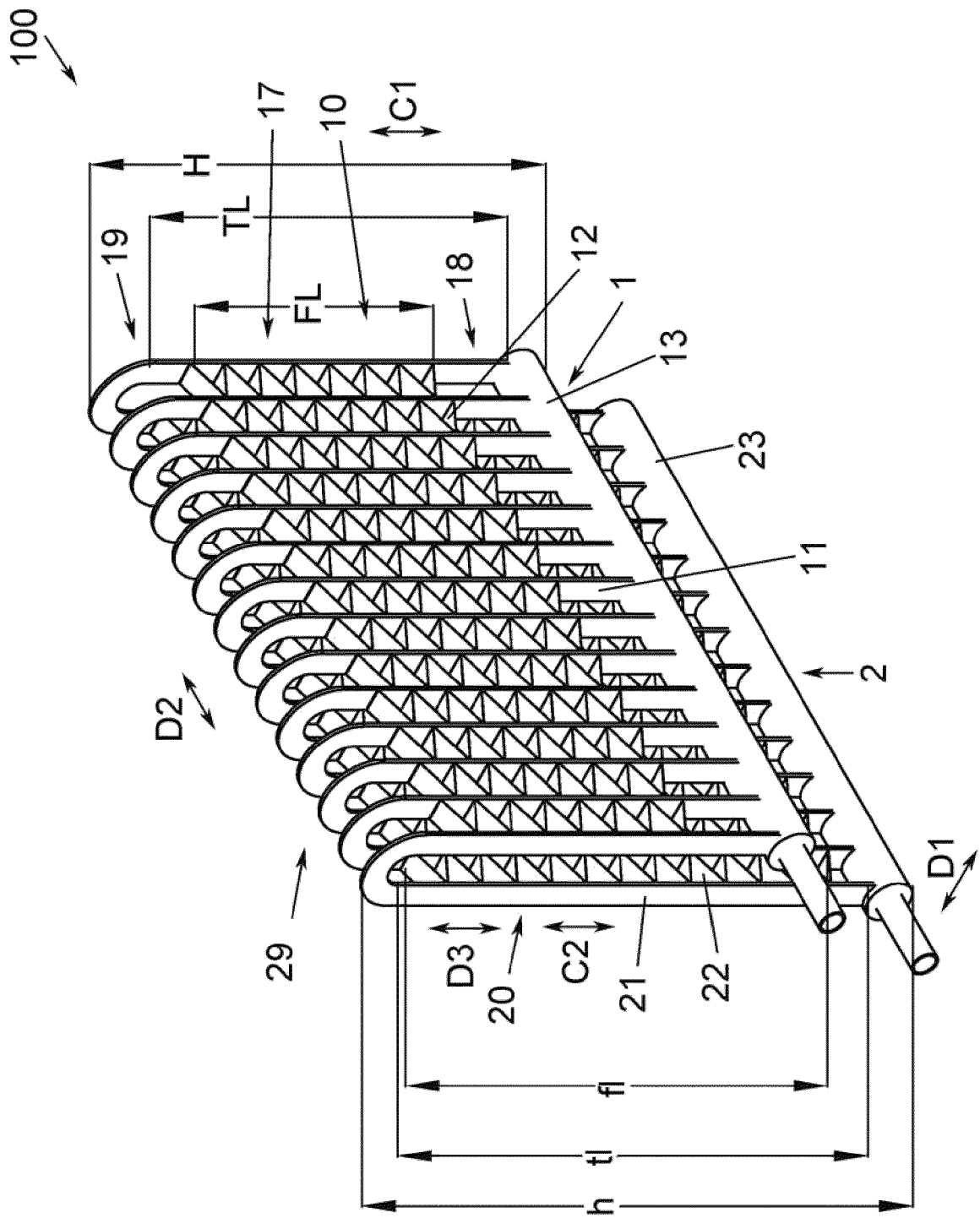
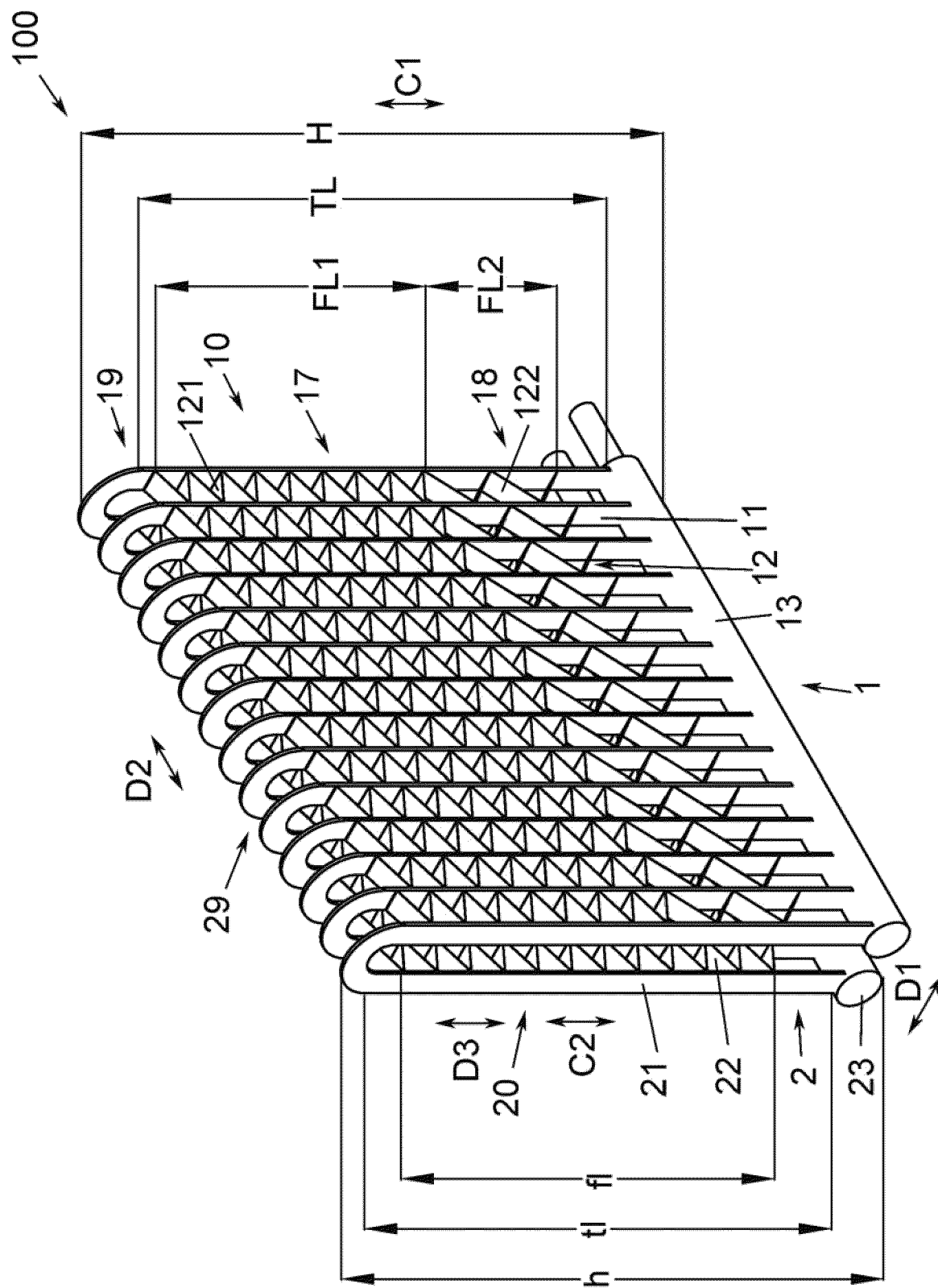


Fig. 14



Fi. 15

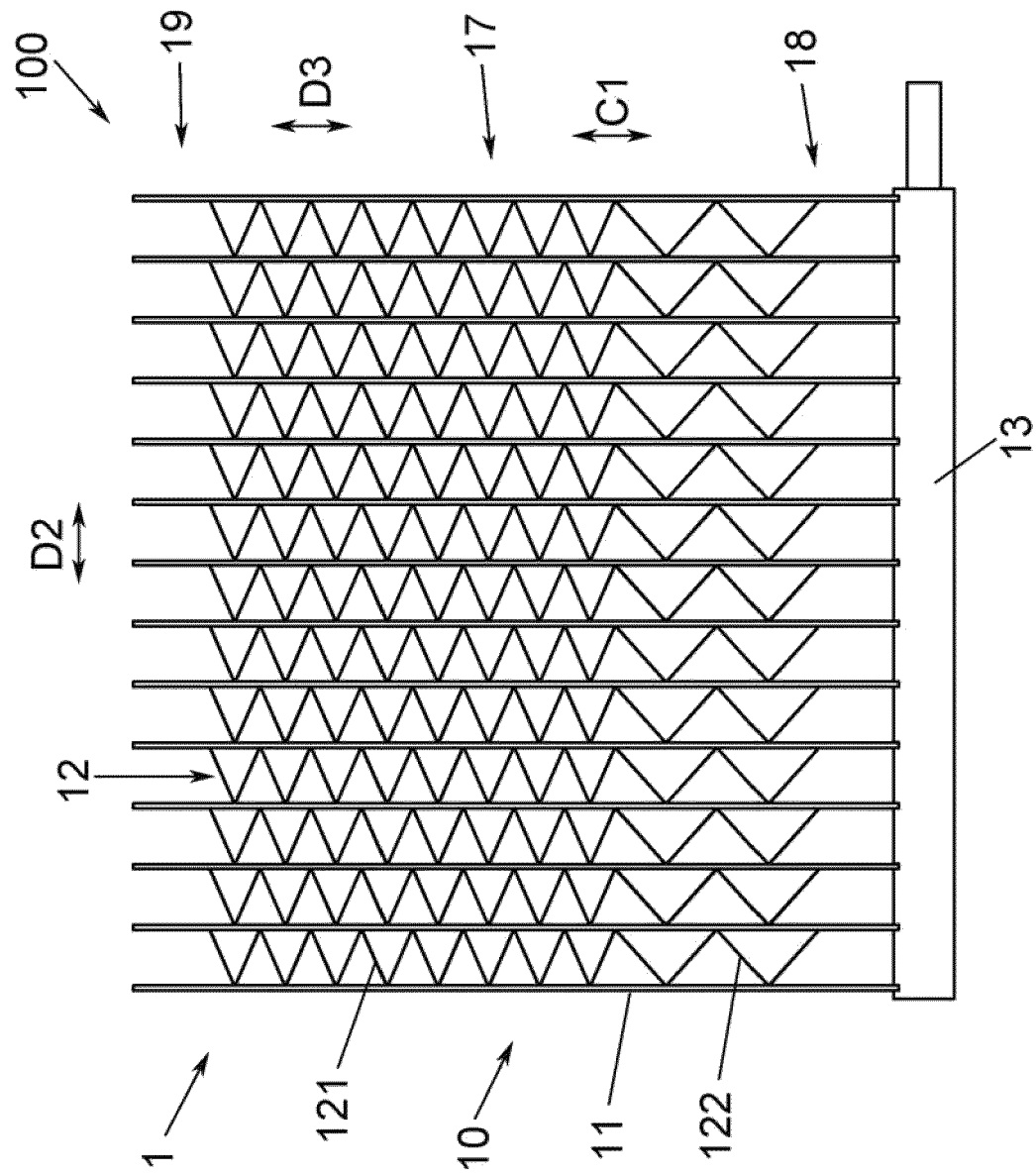
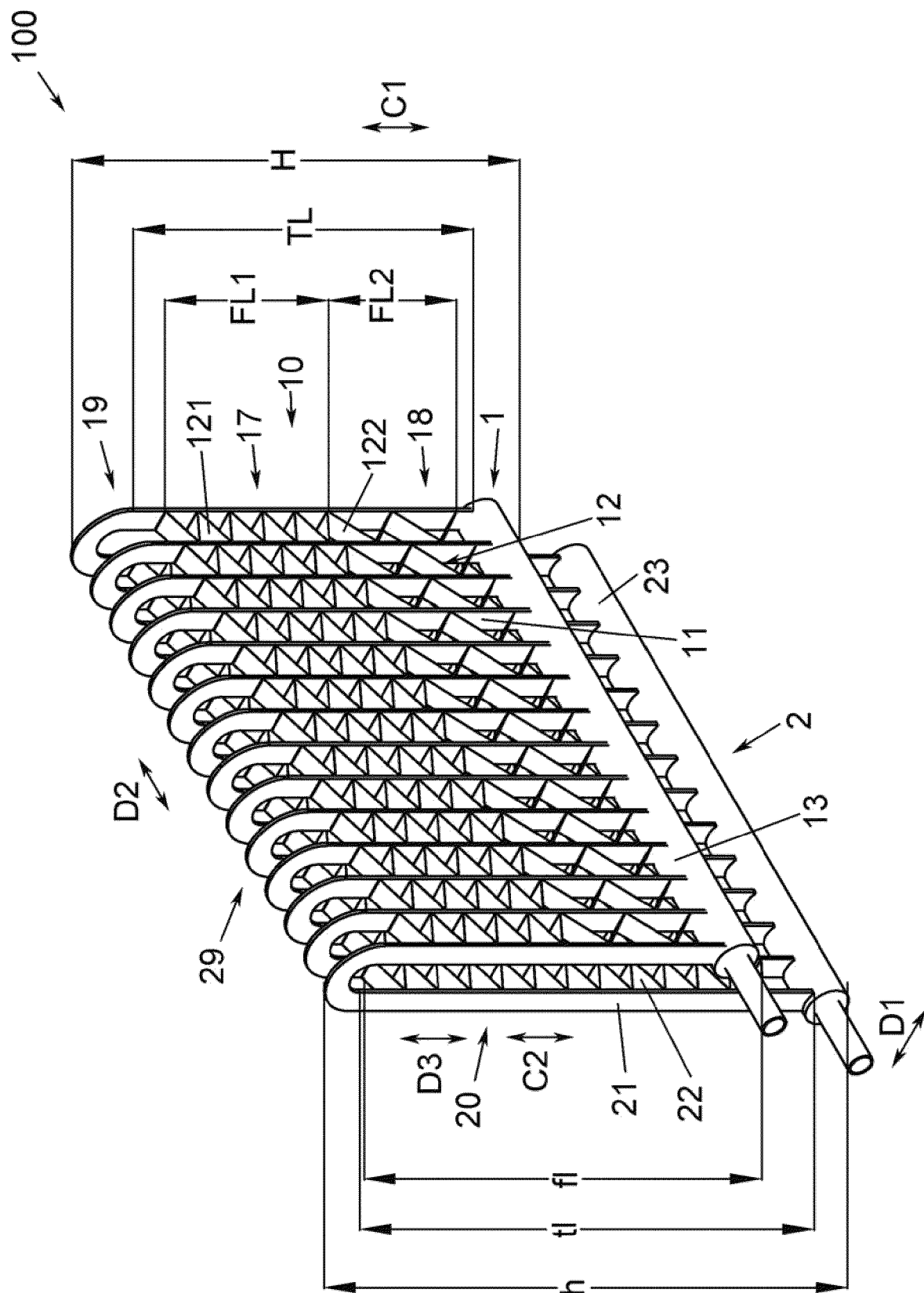


Fig. 16



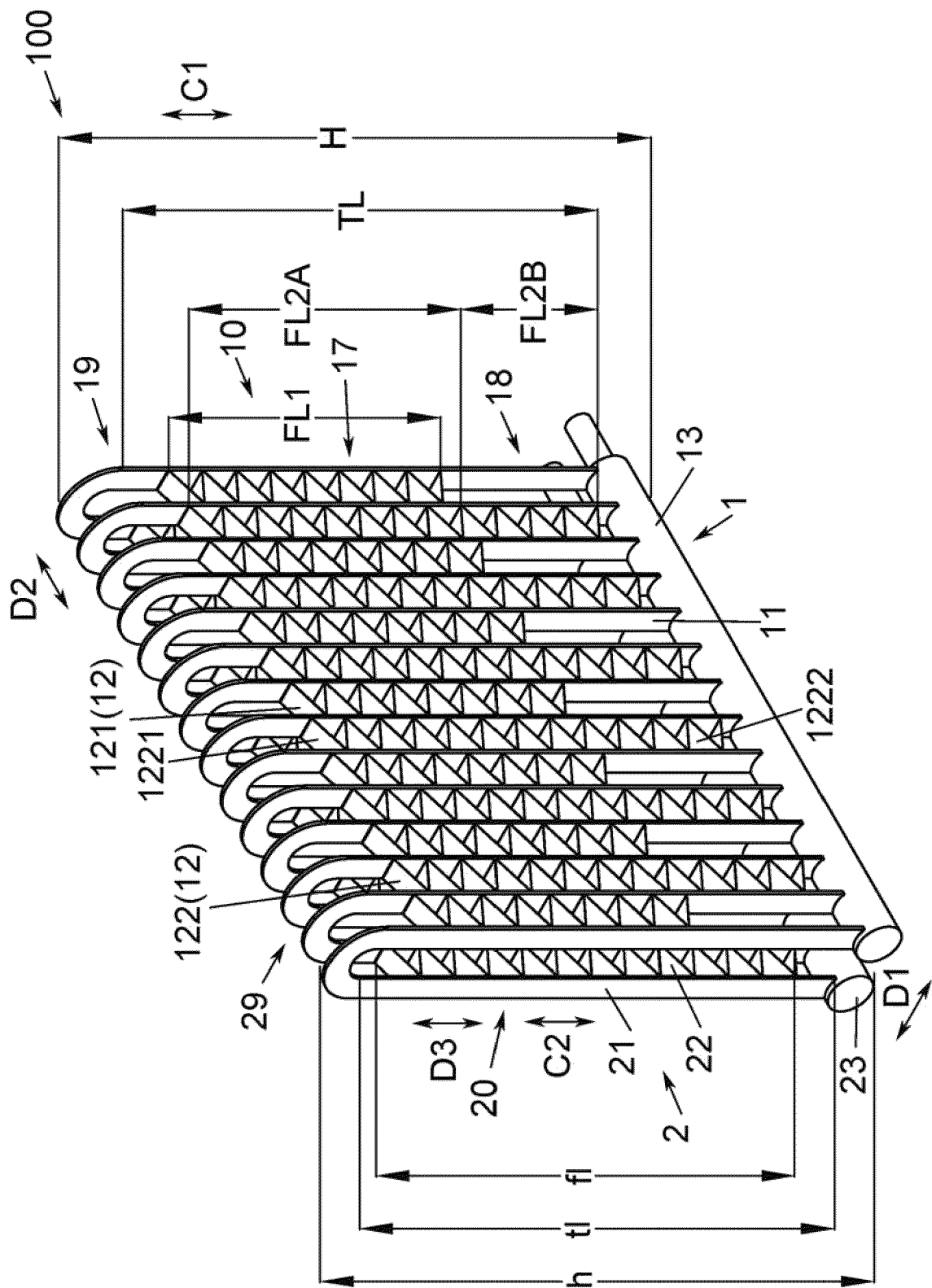


Fig. 18

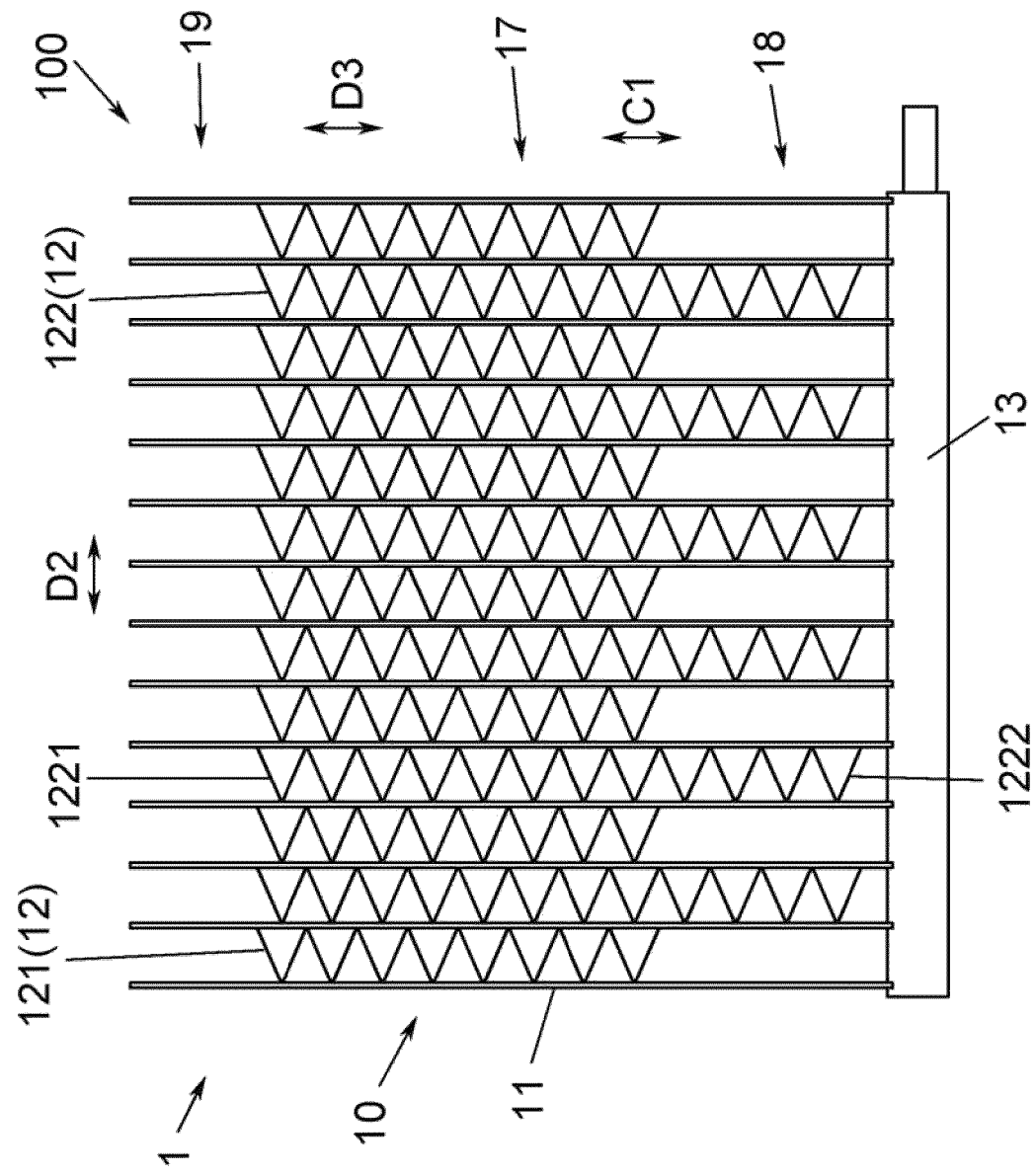


Fig. 19

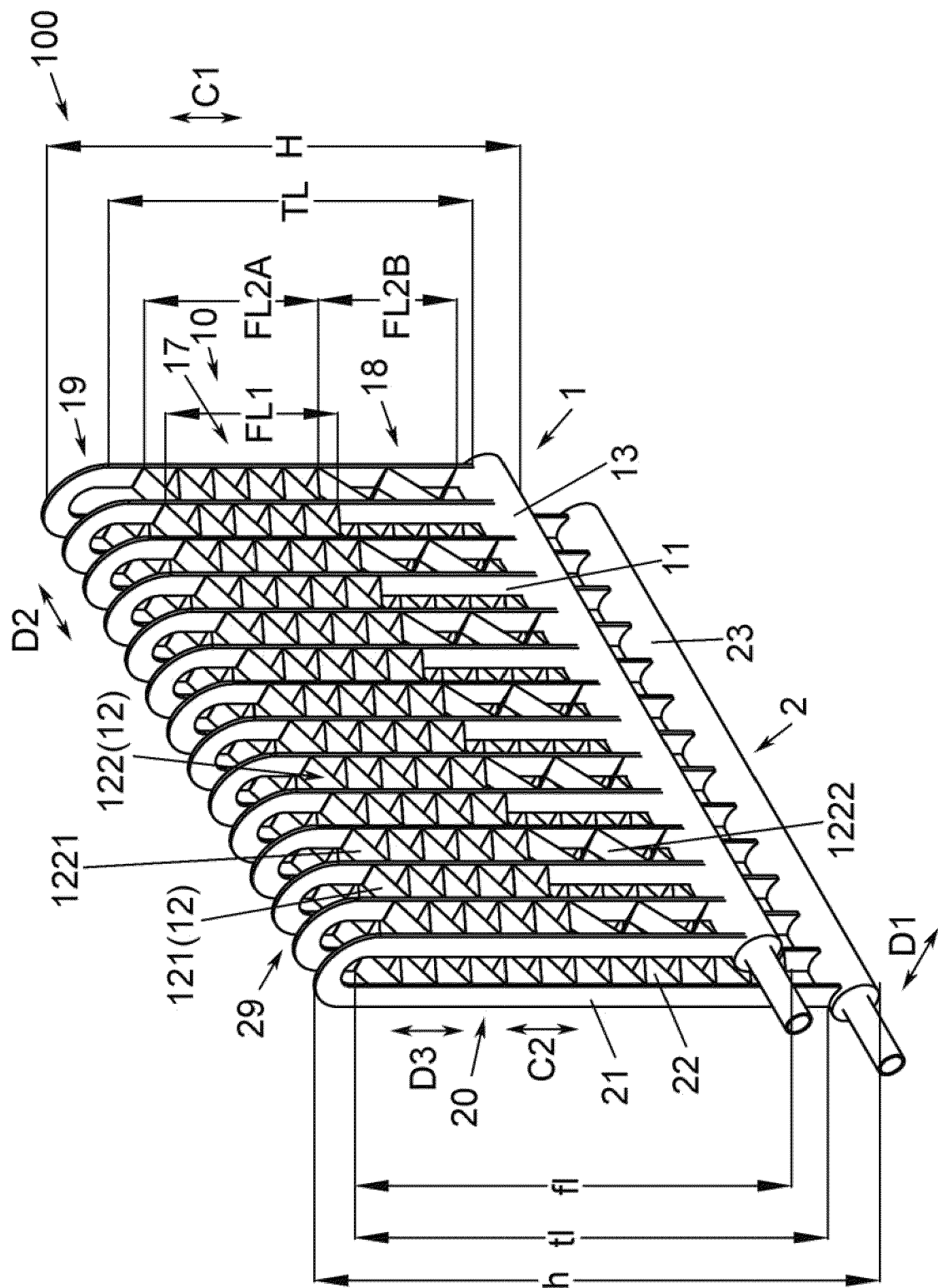


Fig. 20

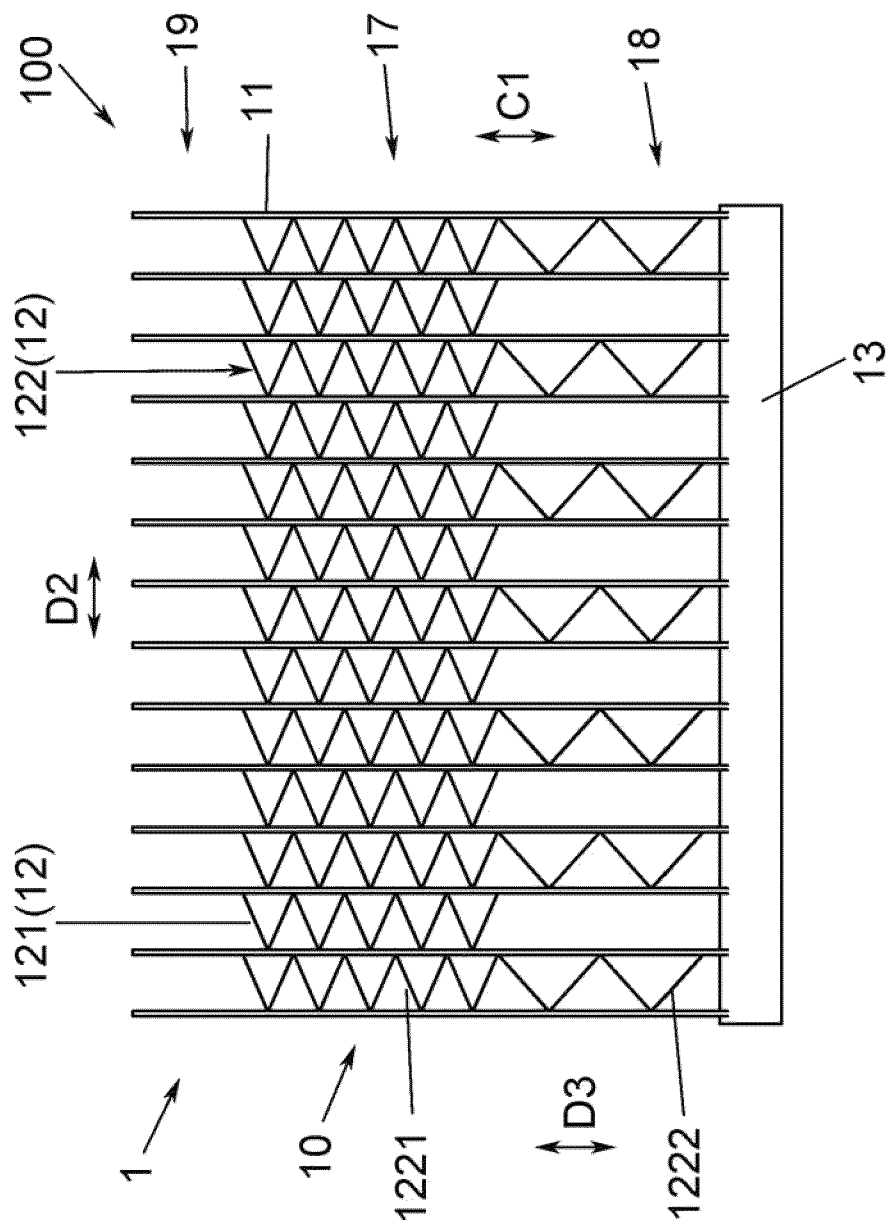


Fig. 21

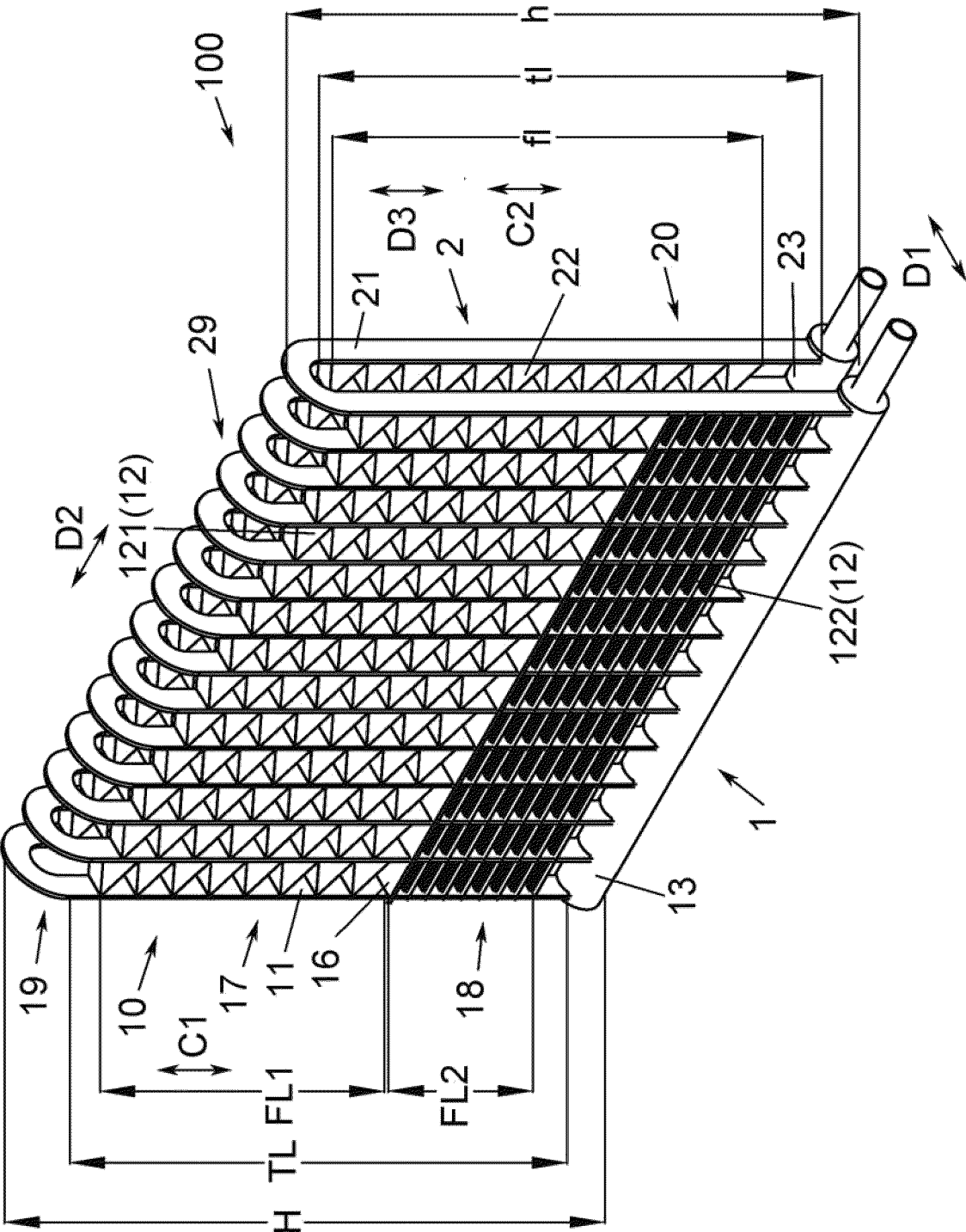


Fig. 22

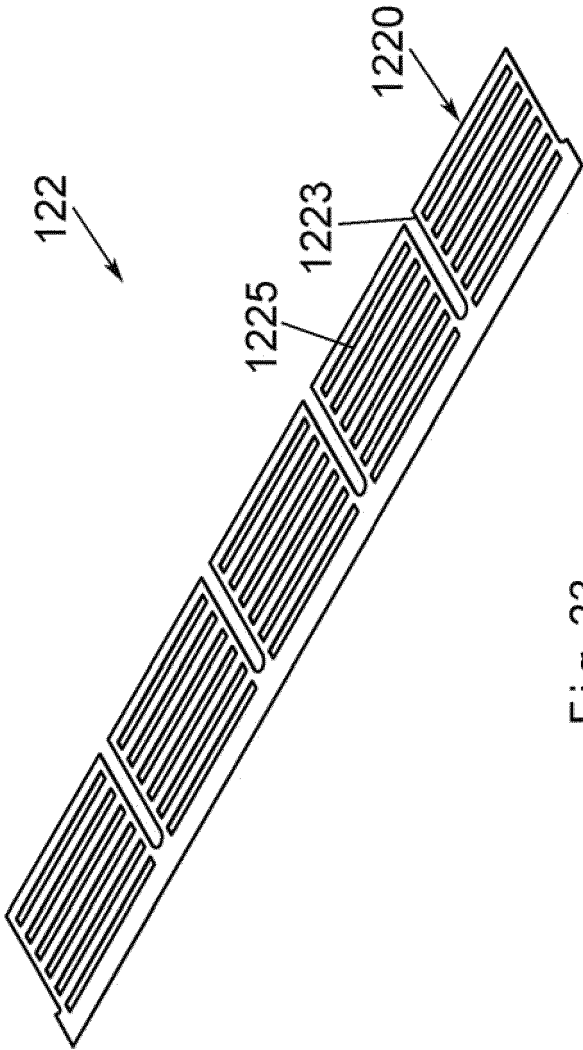


Fig. 23

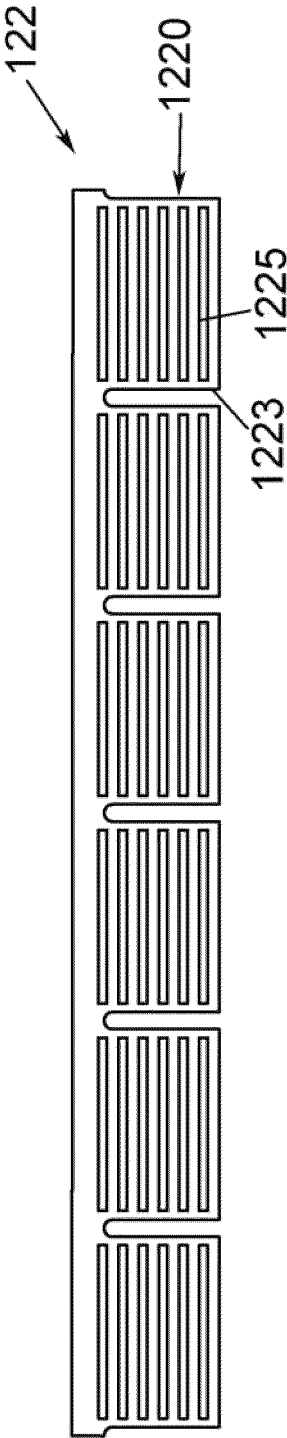


Fig. 24

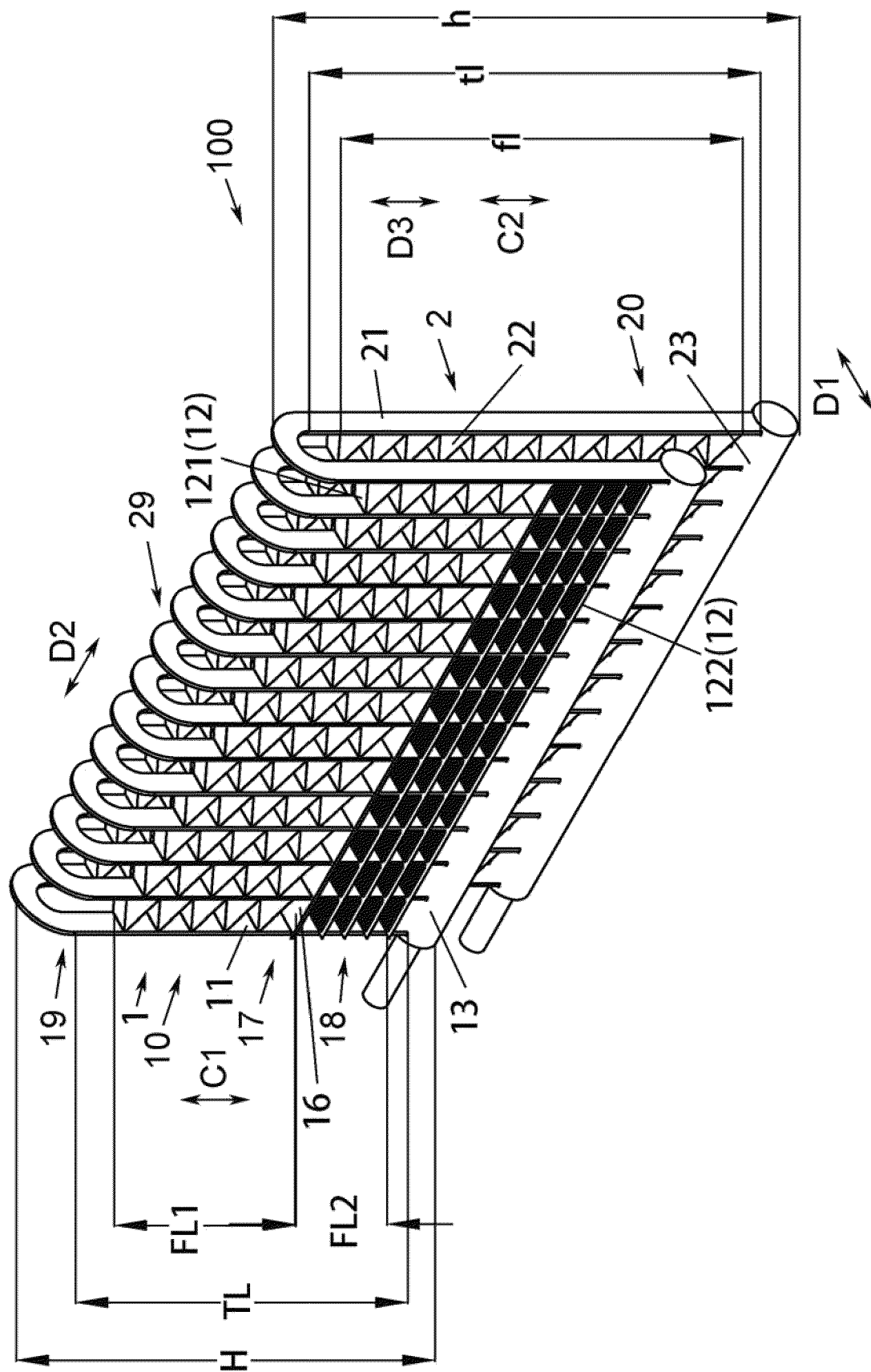


Fig. 25

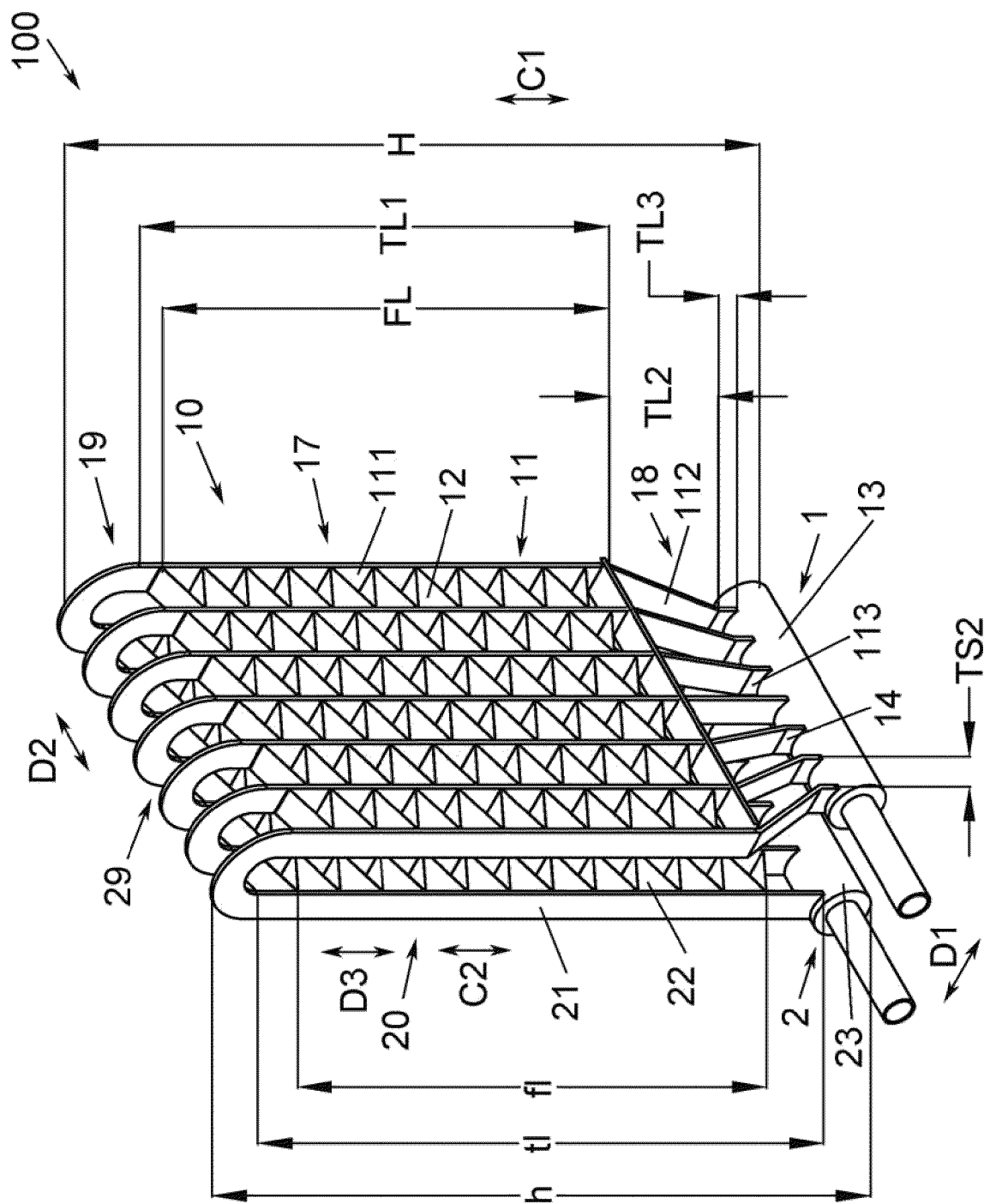


Fig. 26

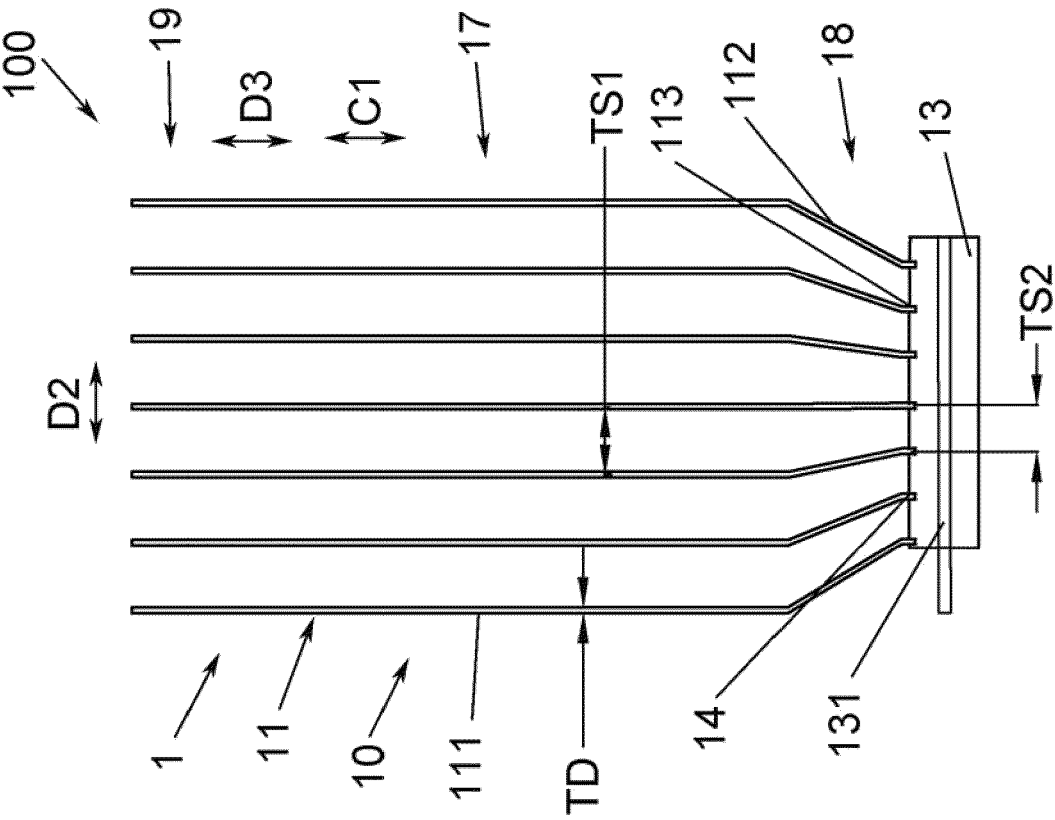


Fig. 27

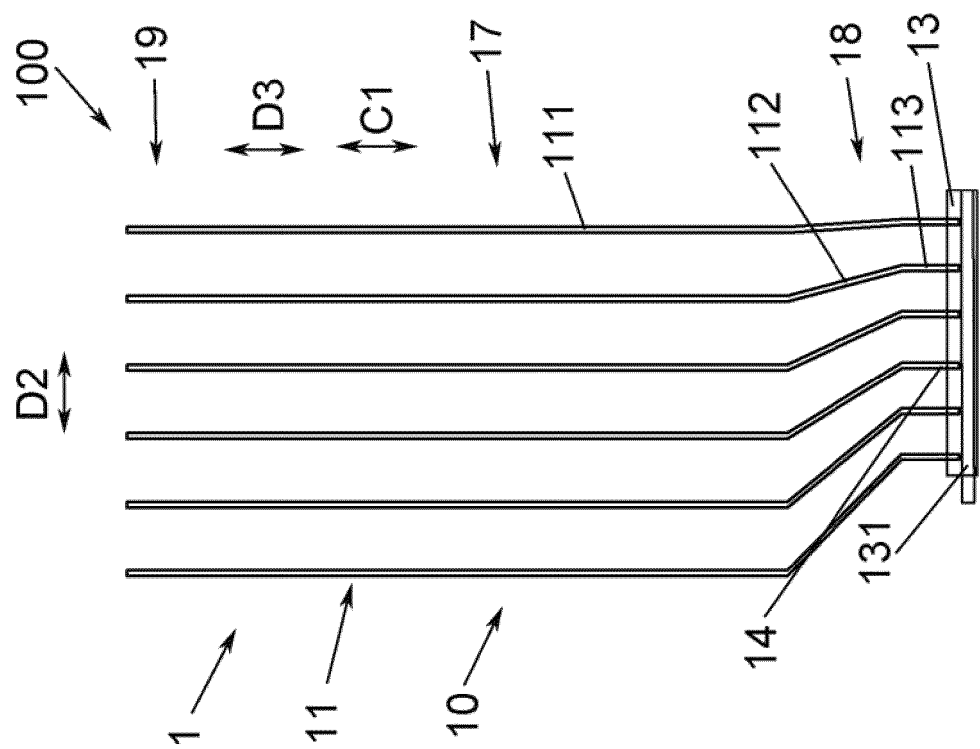


Fig. 28

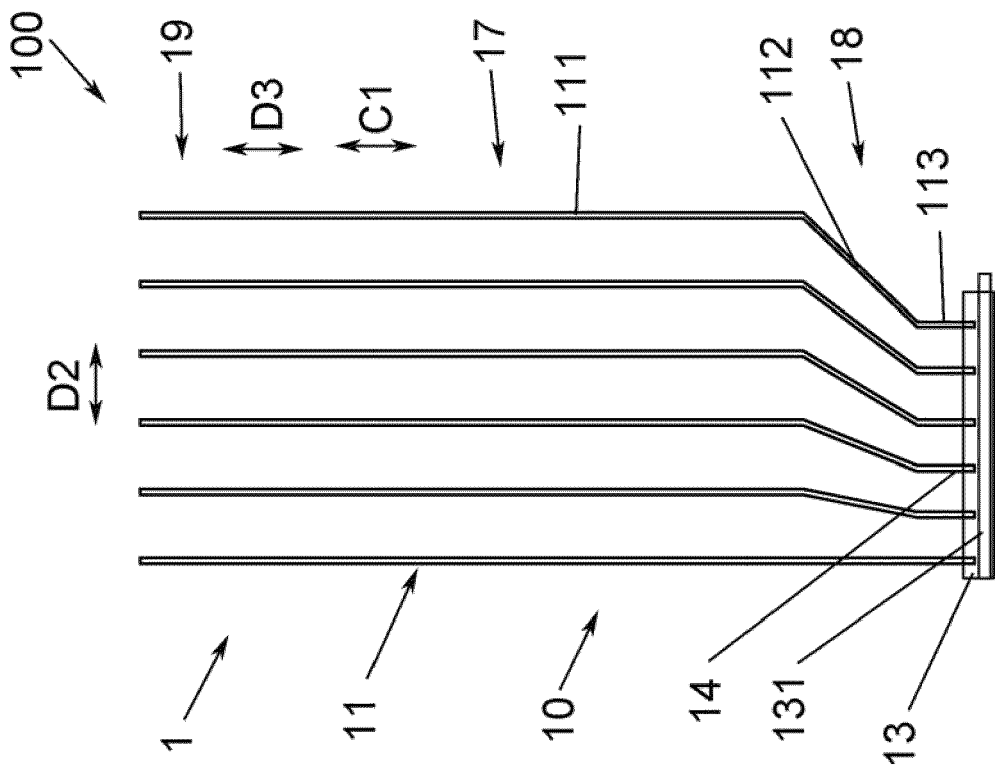


Fig. 29

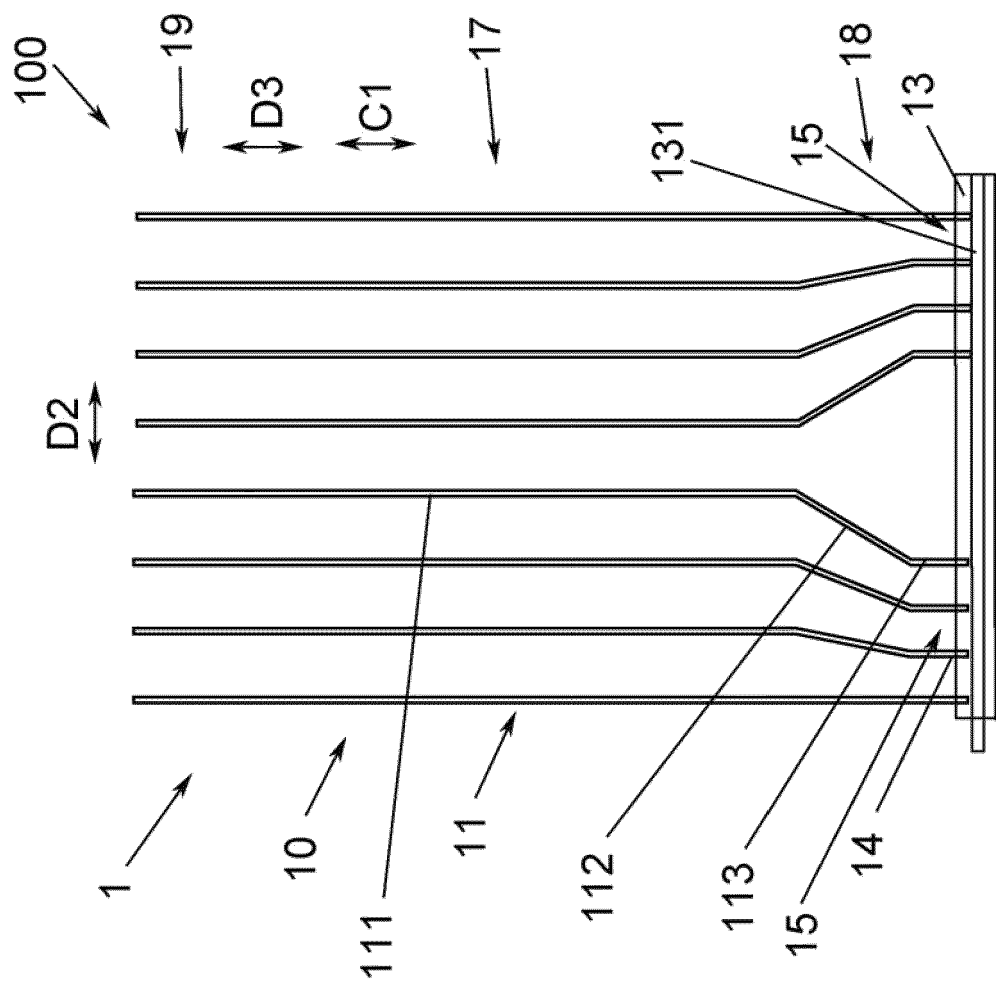


Fig. 30

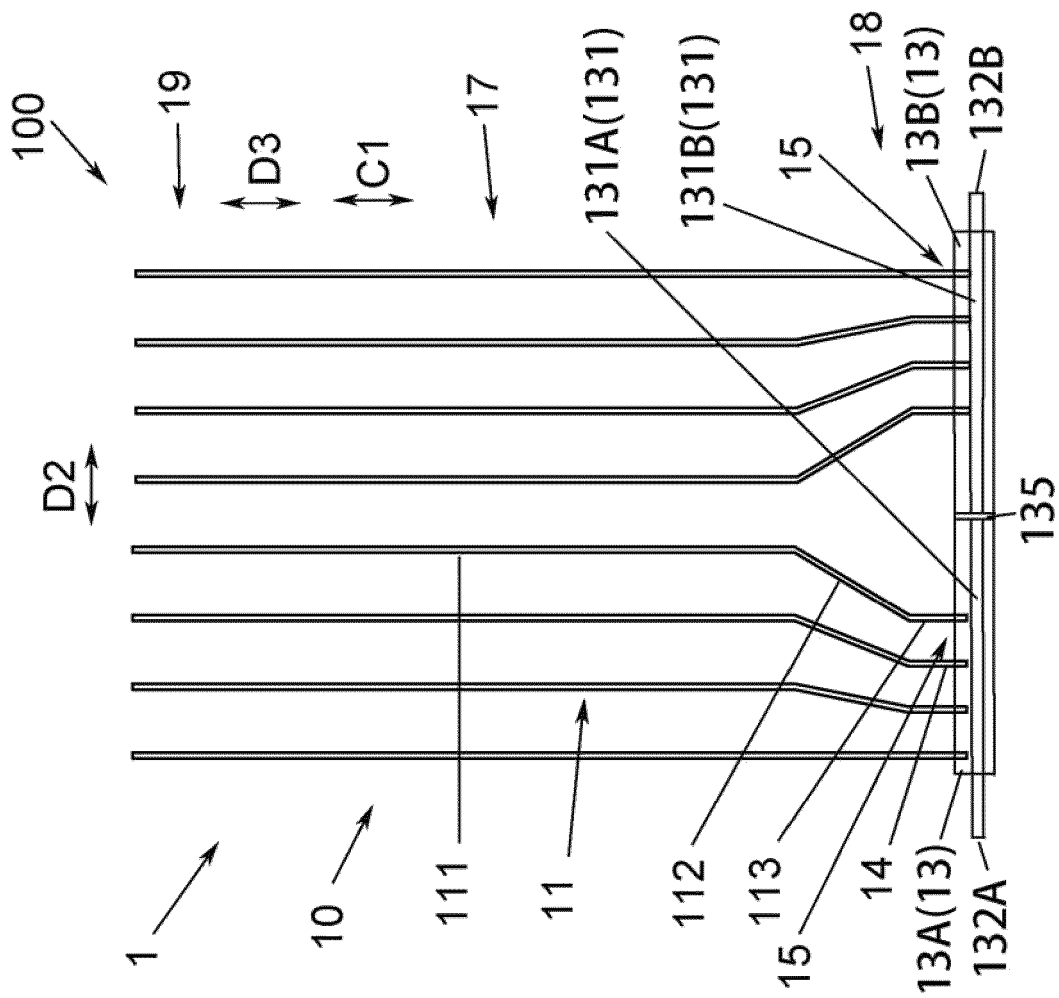
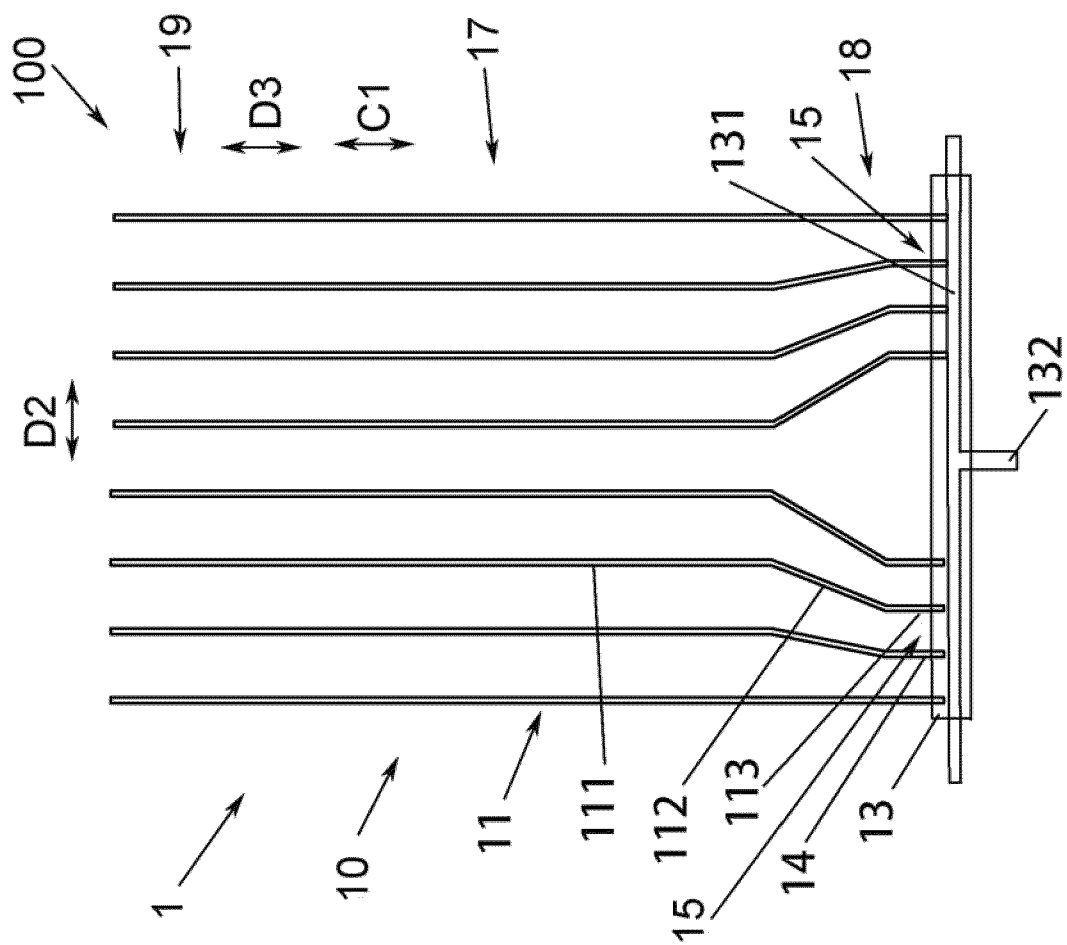


Fig. 31



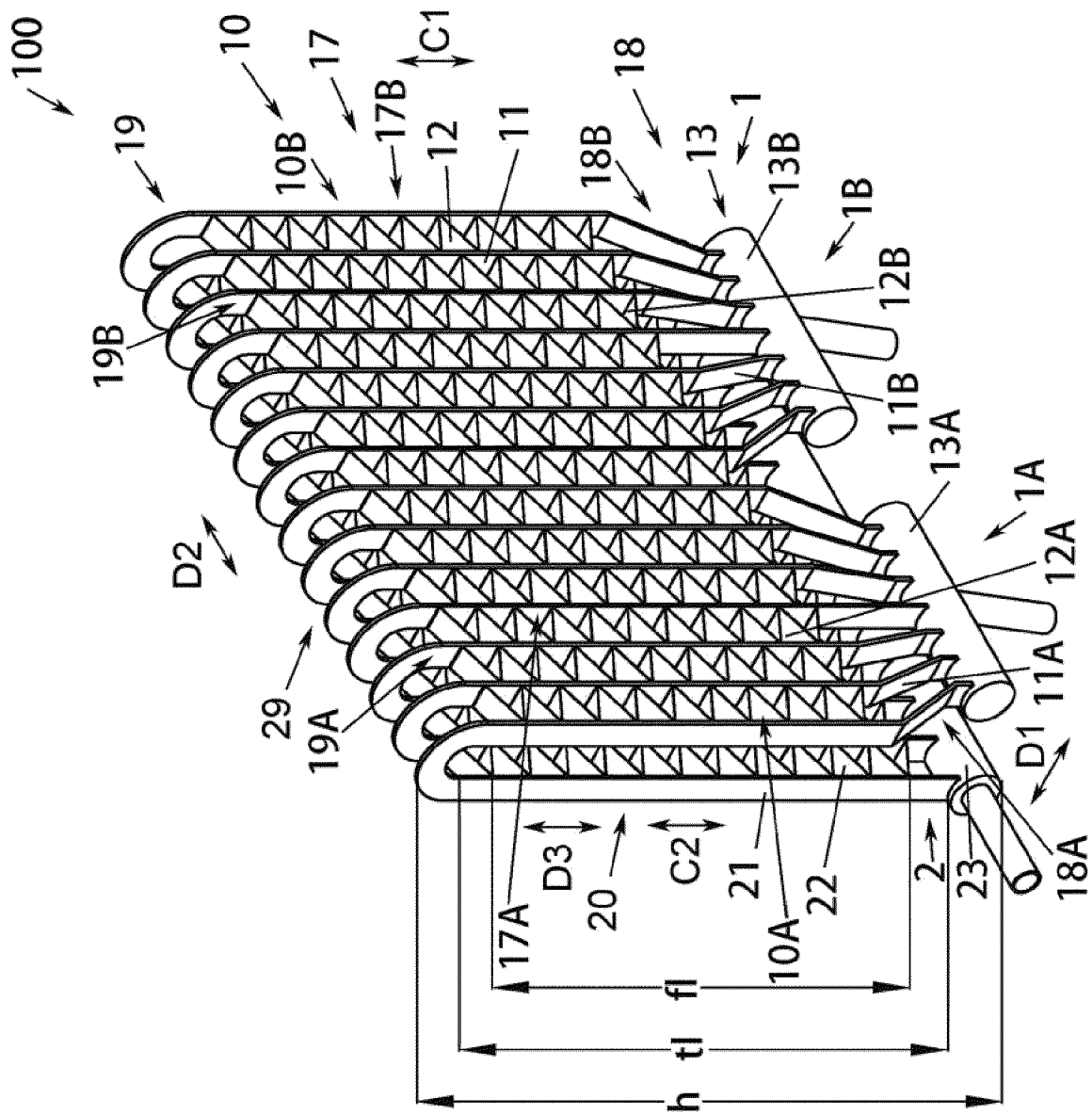


Fig. 33

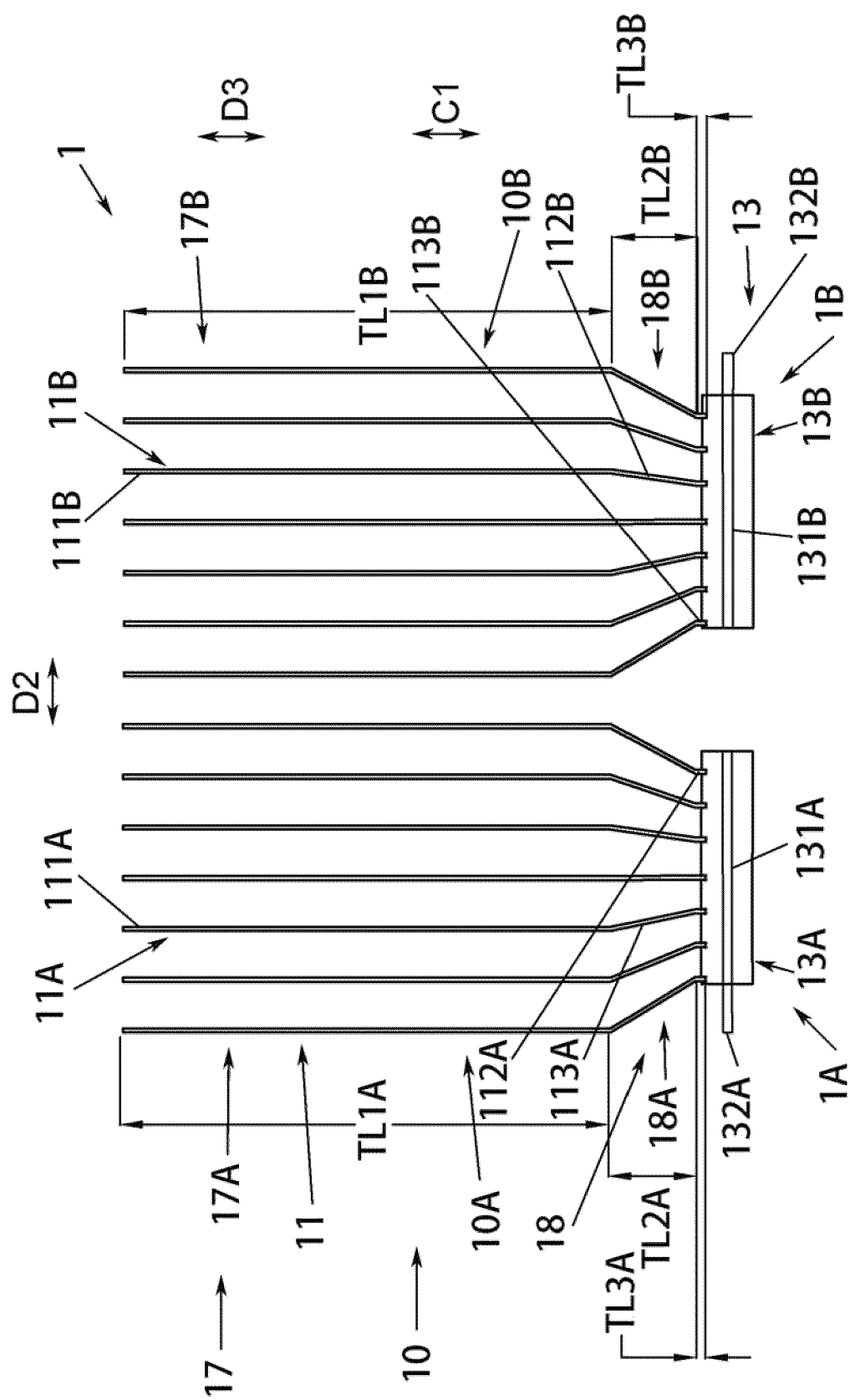


Fig. 34

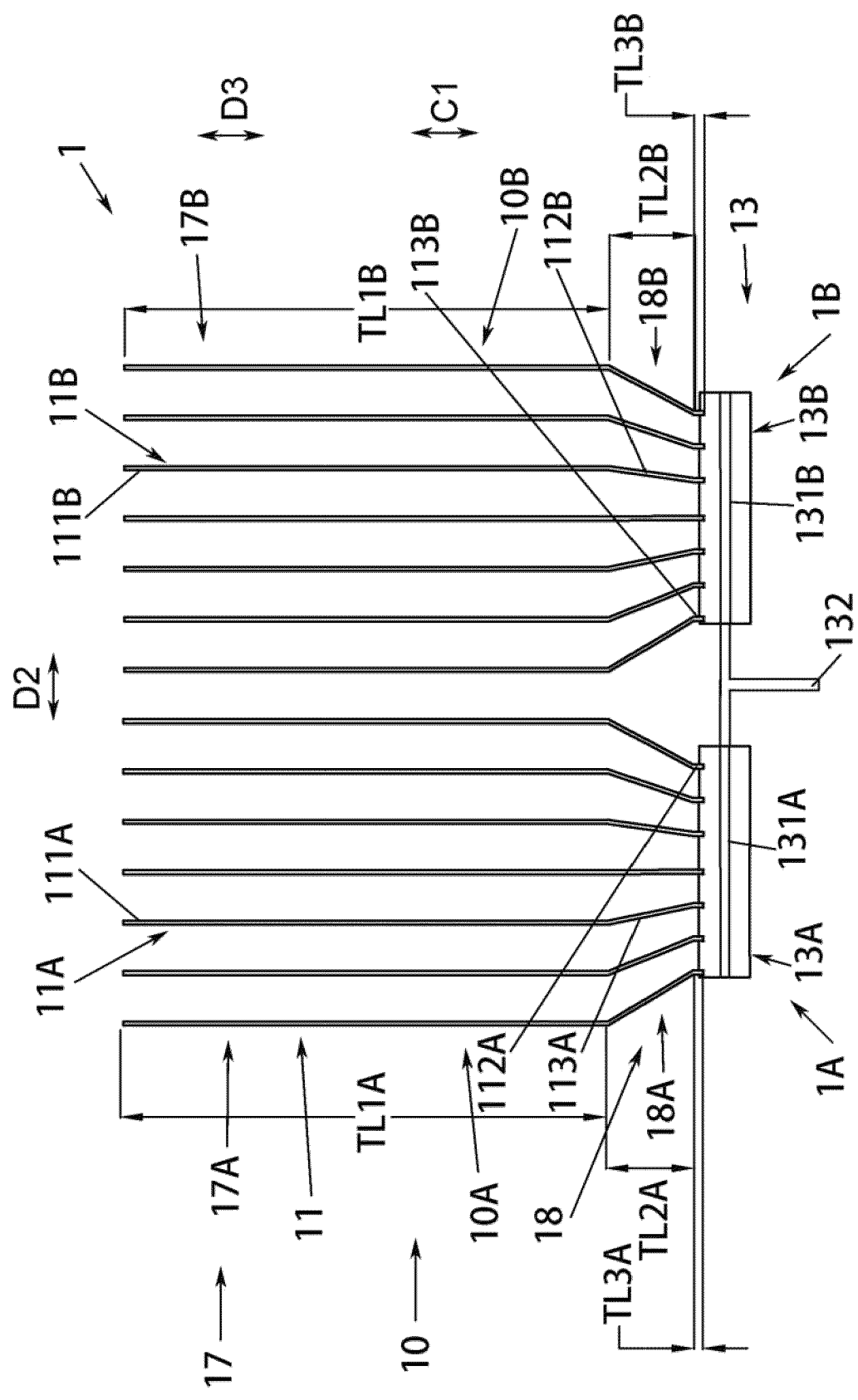


Fig. 35

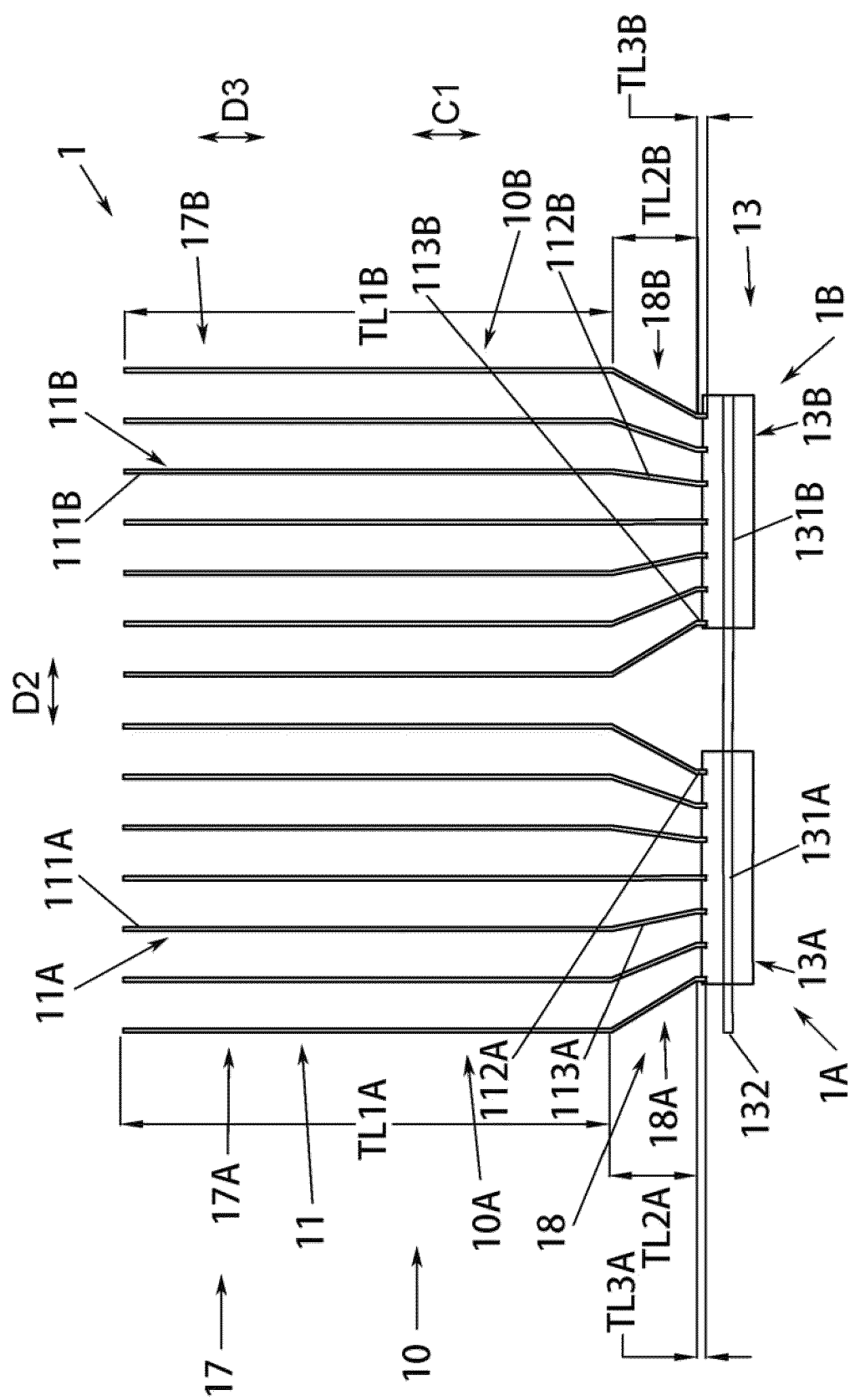


Fig. 36

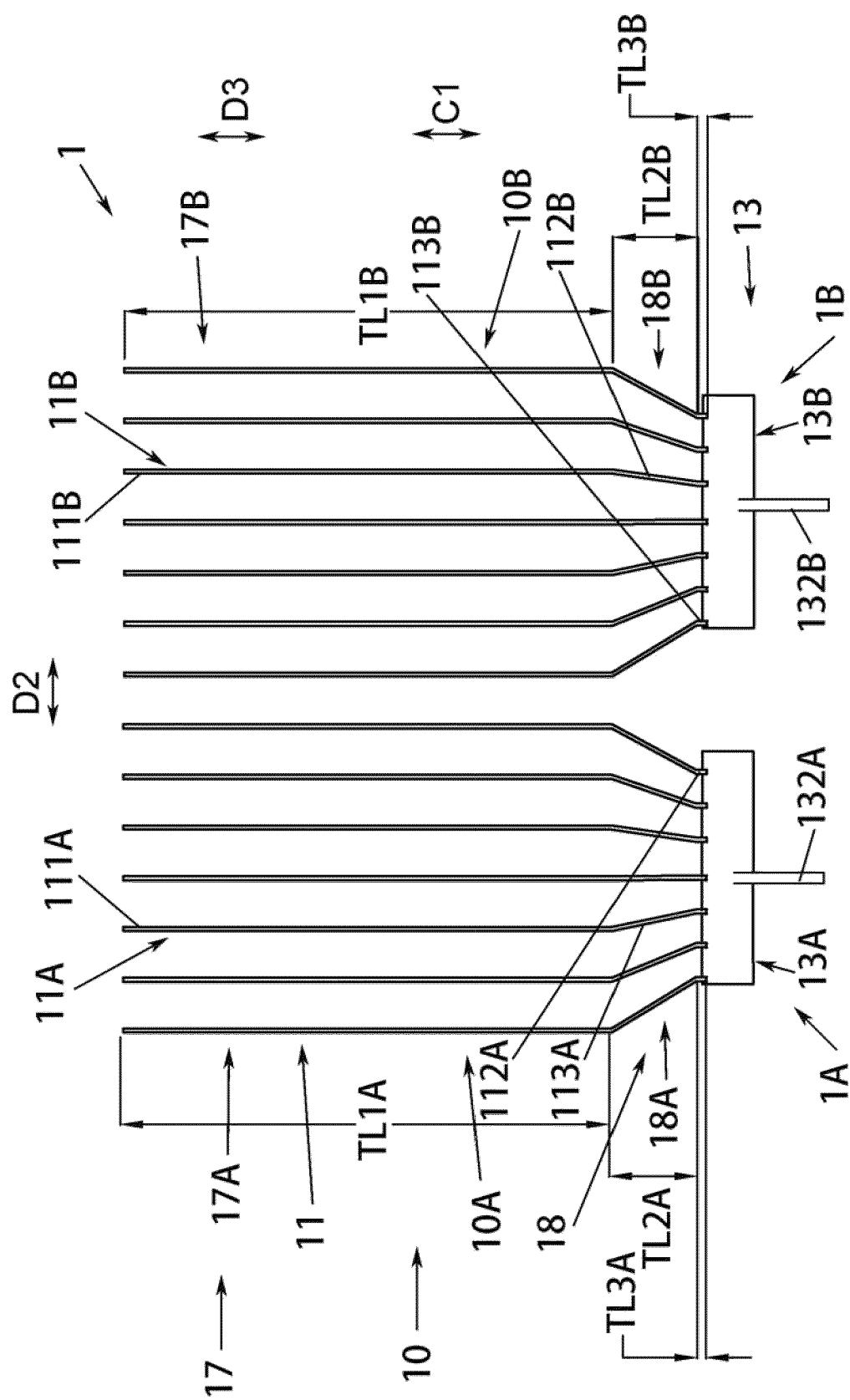


Fig. 37



EUROPEAN SEARCH REPORT

Application Number

EP 24 21 4568

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 0 654 645 A2 (SHOWA ALUMINUM CORP [JP]) 24 May 1995 (1995-05-24) * columns 4-6; figures 1-2 *	1-15	INV. F28D1/047 F28F1/02 F28F1/12 F28F1/32 F28F17/00
A	EP 1 519 133 A2 (SANDEN CORP [JP]) 30 March 2005 (2005-03-30) * paragraphs [0017] - [0023]; figures 2,6 *	1-15	
A	US 7 549 465 B2 (LENNOX INTERNAT INC [US]) 23 June 2009 (2009-06-23) * column 6; figure 4 *	1-15	
A	DE 602 19 538 T2 (MODINE MFG CO [US]) 20 December 2007 (2007-12-20) * paragraph [0045]; figure 7 *	1-15	
A	US 10 718 534 B2 (SAMSUNG ELECTRONICS CO LTD [KR]) 21 July 2020 (2020-07-21) * column 8; figures 2-3 *	1-15	
A	EP 2 369 285 B1 (SANHUA HANGZHOU MICRO CHANNEL HEAT EXCHANGER CO LTD [CN] ET AL.) 19 August 2020 (2020-08-19) * paragraphs [0047] - [0049]; figures 1-5 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) F28D F28F
A	WO 2022/257776 A1 (ZHEJIANG DUNAN ARTIFICIAL ENV CO LTD [CN]) 15 December 2022 (2022-12-15) * pages 3-4; figure 4 *	1	
A	JP H04 136690 A (SHOWA ALUMINUM CORP) 11 May 1992 (1992-05-11) * page 3; figures 1-4 *	1	
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		2 April 2025	Merkt, Andreas
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Application Number
EP 24 21 4568

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 0 559 983 B1 (MODINE MFG CO [US]) 10 April 1996 (1996-04-10) * columns 5-10; figures 1-3 *	1	
A	DE 10 2018 103412 A1 (VOLKSWAGEN AG [DE]) 22 August 2019 (2019-08-22) * paragraphs [0040] - [0041]; figures 1-3 *	1	
A	JP 2002 090083 A (JAPAN CLIMATE SYSTEMS CORP) 27 March 2002 (2002-03-27) * paragraphs [0013], [0018]; figures 1-3 *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 2 April 2025	Examiner Merkt, Andreas
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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30

35

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45

50

55

Patent document cited in search report		Publication date		Patent family member(s)		Publication date
EP 0654645	A2	24-05-1995	AT	E175492 T1		15-01-1999
			AU	678620 B2		05-06-1997
			CN	1107221 A		23-08-1995
			DE	69415779 T2		27-05-1999
			EP	0654645 A2		24-05-1995
			ES	2127358 T3		16-04-1999
			JP	3305460 B2		22-07-2002
			JP	H07146089 A		06-06-1995
			KR	950014830 A		16-06-1995
			US	5531268 A		02-07-1996

EP 1519133	A2	30-03-2005	CN	1629590 A		22-06-2005
			EP	1519133 A2		30-03-2005
			JP	2005106328 A		21-04-2005

US 7549465	B2	23-06-2009	US	2007246206 A1		25-10-2007
			WO	2007127716 A2		08-11-2007

DE 60219538	T2	20-12-2007	AR	035737 A1		07-07-2004
			AR	044266 A2		07-09-2005
			AT	E360183 T1		15-05-2007
			AU	783870 B2		15-12-2005
			BR	0200330 A		29-10-2002
			CA	2368871 A1		07-08-2002
			CN	1369680 A		18-09-2002
			DE	60219538 T2		20-12-2007
			EP	1231448 A2		14-08-2002
			EP	1691160 A1		16-08-2006
			JP	4050910 B2		20-02-2008
			JP	2002318087 A		31-10-2002
			KR	20020065840 A		14-08-2002
			MX	PA02001239 A		19-09-2002
			TW	522215 B		01-03-2003
			US	2002134537 A1		26-09-2002
			US	2004149424 A1		05-08-2004

US 10718534	B2	21-07-2020	AU	2016340648 A1		22-02-2018
			BR	112018003360 A2		25-09-2018
			CN	108139088 A		08-06-2018
			EP	3322940 A1		23-05-2018
			KR	20170047684 A		08-05-2017
			RU	2689857 C1		29-05-2019
			US	2017115011 A1		27-04-2017
			WO	2017069484 A1		27-04-2017

EP 2369285	B1	19-08-2020	CN	101806550 A		18-08-2010

EPO FORM P0459

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		EP 2369285 A2	28-09-2011
		US 2011232884 A1	29-09-2011
-----		-----	
WO 2022257776 A1	15-12-2022	CN 115451748 A	09-12-2022
		EP 4354067 A1	17-04-2024
		JP 2024520278 A	24-05-2024
		KR 20240012500 A	29-01-2024
		US 2024263891 A1	08-08-2024
		WO 2022257776 A1	15-12-2022
-----		-----	
JP H04136690 A	11-05-1992	JP 3048614 B2	05-06-2000
		JP H04136690 A	11-05-1992
-----		-----	
EP 0559983 B1	10-04-1996	AT E136638 T1	15-04-1996
		AU 2742692 A	16-09-1993
		BR 9301124 A	14-09-1993
		CA 2081695 A1	12-09-1993
		DE 69209817 T2	22-08-1996
		EP 0559983 A1	15-09-1993
		JP 3340785 B2	05-11-2002
		JP H0611280 A	21-01-1994
		KR 930019339 A	18-10-1993
		US 5279360 A	18-01-1994
		US 5533259 A	09-07-1996
-----		-----	
DE 102018103412 A1	22-08-2019	NONE	
-----		-----	
JP 2002090083 A	27-03-2002	NONE	
-----		-----	