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(54) **PLATE HEAT EXCHANGER**

(57) The present invention discloses a plate heat exchanger. The plate heat exchanger includes a plurality of heat transfer plates, and heat exchange spaces formed between adjacent heat transfer plates of the plurality of heat transfer plates, the heat exchange spaces including a plurality of first heat exchange spaces for a first heat transfer medium, a plurality of second heat exchange spaces for a second heat transfer medium, and a plurality of third heat exchange spaces for a third heat transfer medium, and each of the plurality of first heat exchange spaces and the plurality of second heat exchange spaces being adjacent to one or two of the plurality of third heat exchange spaces in an overlapping direction of the heat transfer plates, wherein the number of the plurality of first heat exchange spaces is different from the number of the plurality of second heat exchange spaces. By using the plate heat exchanger according to the embodiments of the present invention, the heat transfer area of each circuit can be optimized, so as to improve the heat exchange efficiency.

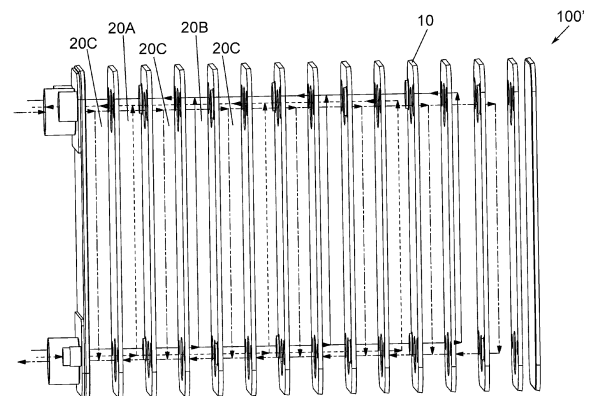


FIG. 2

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Description

Technical Field

[0001] The embodiments of the present invention relate to a plate heat exchanger.

Background Art

[0002] Referring to FIGS. 2 and 3, a conventional plate heat exchanger 100' includes a plurality of heat transfer plates 10, and heat exchange spaces formed between adjacent heat transfer plates 10 of the plurality of heat transfer plates 10, the heat exchange spaces including a plurality of first heat exchange spaces 20A for a first heat transfer medium, a plurality of second heat exchange spaces 20B for a second heat transfer medium, and a plurality of third heat exchange spaces 20C for a third heat transfer medium, and each of the plurality of first heat exchange spaces 20A and the plurality of second heat exchange spaces 20B being adjacent to one or two of the plurality of third heat exchange spaces 20C in an overlapping direction of the heat transfer plates 10. The ratio of the number of the plurality of first heat exchange spaces 20A to the number of the plurality of second heat exchange spaces 20B is 1. That is, the plurality of first heat exchange spaces 20A and the plurality of second heat exchange spaces 20B are alternately arranged. In FIG. 2, the flow of the first heat transfer medium is shown by a dashed line, the flow of the second heat transfer medium is shown by a solid line, and the flow of the third heat transfer medium is shown by a dash-dotted line. For the above plate heat exchanger, the performance of each circuit needs to be sacrificed when determining the size. Increasing the heat transfer area would be conducive to improving the efficiency, especially for a high-capacity circuit, however, it would cause the speed of the heat transfer medium in a low-capacity circuit to reduce, which may result in the problem of retention of the heat transfer medium in a partial load condition.

Summary of the Invention

[0003] An objective of the embodiments of the present invention is to provide a plate heat exchanger, so that the heat transfer area of each circuit can be optimized, so as to improve the heat exchange efficiency.

[0004] According to an embodiment of the present invention, provided is a plate heat exchanger, including a plurality of heat transfer plates, and heat exchange spaces formed between adjacent heat transfer plates of the plurality of heat transfer plates, the heat exchange spaces including a plurality of first heat exchange spaces for a first heat transfer medium, a plurality of second heat exchange spaces for a second heat transfer medium, and a plurality of third heat exchange spaces for a third heat transfer medium, and each of the plurality of first heat exchange spaces and the plurality of second heat

exchange spaces being adjacent to one or two of the plurality of third heat exchange spaces in an overlapping direction of the heat transfer plates, wherein the number of the plurality of first heat exchange spaces is different from the number of the plurality of second heat exchange spaces.

[0005] According to an embodiment of the present invention, the ratio of the greater one of the number of the plurality of first heat exchange spaces and the number of the plurality of second heat exchange spaces to the smaller one of the number of the plurality of first heat exchange spaces and the number of the plurality of second heat exchange spaces is greater than 1.05.

[0006] According to an embodiment of the present invention, the ratio of the greater one of the number of the plurality of first heat exchange spaces and the number of the plurality of second heat exchange spaces to the smaller one of the number of the plurality of first heat exchange spaces and the number of the plurality of second heat exchange spaces is between 1.1 and 5.

[0007] According to an embodiment of the present invention, a plurality of groups of first heat exchange spaces and a plurality of groups of second heat exchange spaces are alternately arranged in the overlapping direction of the heat transfer plates, each group of the plurality of groups of first heat exchange spaces includes one or more first heat exchange spaces, and each group of the plurality of groups of second heat exchange spaces includes one or more second heat exchange spaces.

[0008] According to an embodiment of the present invention, at least two groups of first heat exchange spaces of the plurality of groups of first heat exchange spaces include the same number or different numbers of first heat exchange spaces; and/or at least two groups of second heat exchange spaces of the plurality of groups of second heat exchange spaces include the same number or different numbers of second heat exchange spaces.

[0009] According to an embodiment of the present invention, with respect to the first heat exchange spaces and the second heat exchange spaces, the plurality of first heat exchange spaces are successively arranged in the overlapping direction of the heat transfer plates; and/or with respect to the first heat exchange spaces and the second heat exchange spaces, the plurality of second heat exchange spaces are successively arranged in the overlapping direction of the heat transfer plates.

[0010] According to an embodiment of the present invention, a plurality of heat exchange spaces, composed of the plurality of first heat exchange spaces and the plurality of second heat exchange spaces, and the plurality of third heat exchange spaces are alternately arranged in the overlapping direction of the heat transfer plates.

[0011] According to an embodiment of the present invention, the plate heat exchanger further includes: a pair of first heat transfer medium ports for the first heat transfer medium to flow into the plurality of first heat

exchange spaces and for the first heat transfer medium to flow out of the plurality of first heat exchange spaces, respectively; a pair of second heat transfer medium ports for the second heat transfer medium to flow into the plurality of second heat exchange spaces and for the second heat transfer medium to flow out of the plurality of second heat exchange spaces, respectively; and a pair of third heat transfer medium ports for the third heat transfer medium to flow into the plurality of third heat exchange spaces and for the third heat transfer medium to flow out of the plurality of third heat exchange spaces, respectively.

[0012] According to an embodiment of the present invention, one of the pair of first heat transfer medium ports is arranged at the upper left corner of the heat transfer plate, the other of the pair of first heat transfer medium ports is arranged at the lower left corner of the heat transfer plate, one of the pair of second heat transfer medium ports is arranged at the upper right corner of the heat transfer plate, and the other of the pair of second heat transfer medium ports is arranged at the lower right corner of the heat transfer plate; or one of the pair of first heat transfer medium ports is arranged at the upper left corner of the heat transfer plate, the other of the pair of first heat transfer medium ports is arranged at the lower right corner of the heat transfer plate, one of the pair of second heat transfer medium ports is arranged at the upper right corner of the heat transfer plate, and the other of the pair of second heat transfer medium ports is arranged at the lower left corner of the heat transfer plate.

[0013] According to an embodiment of the present invention, each of the pair of first heat transfer medium ports has a plurality of first openings leading to the plurality of first heat exchange spaces; each of the pair of second heat transfer medium ports has a plurality of second openings leading to the plurality of second heat exchange spaces; and each of the pair of third heat transfer medium ports has a plurality of third openings leading to the plurality of third heat exchange spaces.

[0014] According to an embodiment of the present invention, each of the plurality of first heat exchange spaces and the plurality of second heat exchange spaces is adjacent to the third heat exchange space on either side in the overlapping direction of the heat transfer plates; and/or each of the plurality of third heat exchange spaces is adjacent to the first heat exchange space or the second heat exchange space on either side in the overlapping direction of the heat transfer plates.

[0015] According to an embodiment of the present invention, the first heat transfer medium and the second heat transfer medium are refrigerants, and the third heat transfer medium is a secondary refrigerant.

[0016] According to an embodiment of the present invention, the first heat exchange space, the second heat exchange space, and the third heat exchange space are independent of each other.

[0017] By using the plate heat exchanger according to the embodiments of the present invention, the heat trans-

fer area of each circuit can be optimized, so as to improve the heat exchange efficiency.

Brief Description of the Drawings

[0018]

FIG. 1 is a schematic diagram of the outline of a plate heat exchanger according to an embodiment of the present invention;

FIG. 2 is a schematic diagram of a flow passage of a conventional plate heat exchanger;

FIG. 3 is a partial schematic diagram of the plate heat exchanger shown in FIG. 2, showing a first heat transfer medium port, a second heat transfer medium port, and a third heat transfer medium port;

FIG. 4 is a partial schematic diagram of a plate heat exchanger according to an embodiment of the present invention, showing a first heat transfer medium port, a second heat transfer medium port, and a third heat transfer medium port, with the ratio of the number of first heat exchange spaces to the number of second heat exchange spaces being 3;

FIG. 5 is a partial schematic diagram of a plate heat exchanger according to an embodiment of the present invention, showing a first heat transfer medium port, a second heat transfer medium port, and a third heat transfer medium port, with the ratio of the number of first heat exchange spaces to the number of second heat exchange spaces being 2;

FIG. 6 is a partial schematic diagram of a plate heat exchanger according to an embodiment of the present invention, showing a first heat transfer medium port, a second heat transfer medium port, and a third heat transfer medium port, with the ratio of the number of first heat exchange spaces to the number of second heat exchange spaces being 1.5;

FIG. 7 is a partial schematic diagram of a plate heat exchanger according to a variant of the embodiment shown in FIG. 6, showing a first heat transfer medium port, a second heat transfer medium port, and a third heat transfer medium port, with the ratio of the number of first heat exchange spaces to the number of second heat exchange spaces being 1.5, and the first heat exchange spaces and the second heat exchange spaces being arranged in another exemplary manner;

FIG. 8 is a partial schematic diagram of a plate heat exchanger according to another variant of the embodiment shown in FIG. 6, showing a first heat transfer medium port, a second heat transfer medium port, and a third heat transfer medium port, with the ratio of the number of first heat exchange spaces to the number of second heat exchange spaces being 1.5, and the first heat exchange spaces and the second heat exchange spaces being arranged in another exemplary manner; and

FIG. 9 is a partial schematic diagram of a plate heat

exchanger according to another variant of the embodiment shown in FIG. 6, showing a first heat transfer medium port, a second heat transfer medium port, and a third heat transfer medium port, with the ratio of the number of first heat exchange spaces to the number of second heat exchange spaces being 1.5, and the first heat exchange spaces and the second heat exchange spaces being arranged in another exemplary manner.

Detailed Description of the Embodiments

[0019] The present invention will be further described below in conjunction with the drawings and particular embodiments.

[0020] Referring to FIGS. 1 and 4 to 9, a plate heat exchanger 100 according to the embodiments of the present invention includes a plurality of heat transfer plates 10, and heat exchange spaces formed between adjacent heat transfer plates 10 of the plurality of heat transfer plates 10, the heat exchange spaces including a plurality of first heat exchange spaces 20A for a first heat transfer medium, a plurality of second heat exchange spaces 20B for a second heat transfer medium, and a plurality of third heat exchange spaces 20C for a third heat transfer medium, and each of the plurality of first heat exchange spaces 20A and the plurality of second heat exchange spaces 20B being adjacent to one or two of the plurality of third heat exchange spaces 20C, for example, adjacent to two of the plurality of third heat exchange spaces 20C, in an overlapping direction of the heat transfer plates 10. As an example, the number of the plurality of first heat exchange spaces 20A is greater than the number of the plurality of second heat exchange spaces 20B. The ratio of the number of the plurality of first heat exchange spaces 20A to the number of the plurality of second heat exchange spaces 20B is greater than 1, for example, greater than 1.05, 1.1, 1.15, etc. The ratio of the number of the plurality of first heat exchange spaces 20A to the number of the plurality of second heat exchange spaces 20B may be between 1.1 and 5. As shown in the figures, the plate heat exchanger 100 is a dual-circuit heat exchanger. The first heat exchange space 20A, the second heat exchange space 20B and the third heat exchange space 20C are independent of each other. Each of the plurality of first heat exchange spaces 20A and the plurality of second heat exchange spaces 20B is adjacent to one third heat exchange space 20C on either side in the overlapping direction of the heat transfer plates. Each of the plurality of third heat exchange spaces 20C is adjacent to the first heat exchange space 20A or the second heat exchange space 20B on either side in the overlapping direction of the heat transfer plates. The first heat transfer medium in the first heat exchange space 20A exchanges heat with a third heat exchange medium in the third heat exchange space 20C, and the second heat transfer medium in the second heat exchange space 20B exchanges heat with

the third heat exchange medium in the third heat exchange space 20C. Depending on operation requirements of a system, only a circuit where the first heat exchange spaces 20A are located or only a circuit where the second heat exchange spaces 20B are located, or both the circuit where the first heat exchange spaces 20A are located and the circuit where the second heat exchange spaces 20B are located may be operated. Theoretically, if the sum of the number of first heat exchange spaces 20A and the number of second heat exchange spaces 20B is N, there are (N-1) ratios of the number of first heat exchange spaces 20A to the number of second heat exchange spaces 20B.

[0021] Referring to FIGS. 4 to 7 and FIG. 9, according to the embodiments of the present invention, a plurality of groups of first heat exchange spaces and a plurality of groups of second heat exchange spaces are alternately arranged in the overlapping direction of the heat transfer plates 10. In this way, taking an evaporator as an example, for example, when only one circuit is operated, the third heat transfer medium in the third heat exchange space adjacent to the other circuit can be prevented from freezing. Each group of the plurality of groups of first heat exchange spaces includes one or more first heat exchange spaces 20A, and each group of the plurality of groups of second heat exchange spaces includes one or more second heat exchange spaces 20B. At least two groups of first heat exchange spaces of the plurality of groups of first heat exchange spaces may include the same number or different numbers of first heat exchange spaces 20A; and/or at least two groups of second heat exchange spaces of the plurality of groups of second heat exchange spaces may include the same number or different numbers of second heat exchange spaces 20B.

[0022] Referring to FIGS. 8 and 9, according to the embodiments of the present invention, with respect to the first heat exchange spaces 20A and the second heat exchange spaces 20B (i.e., without considering the third heat exchange spaces 20C), the plurality of first heat exchange spaces 20A are successively arranged in the overlapping direction of the heat transfer plates 10; and/or with respect to the first heat exchange spaces 20A and the second heat exchange spaces 20B (i.e., without considering the third heat exchange spaces 20C), the plurality of second heat exchange spaces 20B are successively arranged in the overlapping direction of the heat transfer plates 10.

[0023] Referring to FIGS. 4 to 9, according to embodiments of the present invention, a plurality of heat exchange spaces, composed of the plurality of first heat exchange spaces 20A and the plurality of second heat exchange spaces 20B, and the plurality of third heat exchange spaces 20C are alternately arranged in the overlapping direction of the heat transfer plates 10.

[0024] According to an embodiment of the present invention, if the ratio of the number of first heat exchange spaces 20A to the number of second heat exchange spaces 20B is defined as λ , the number of arrangement

modes of the first heat exchange spaces 20A and the

second heat exchange spaces 20B is $C_N^{\frac{N}{1+\lambda}}$

[0025] Referring to FIGS. 1 and 4 to 9, the plate heat exchanger 100 according to the embodiments of the present invention further includes: a pair of first heat transfer medium ports 30A for the first heat transfer medium to flow into the plurality of first heat exchange spaces 20A and for the first heat transfer medium to flow out of the plurality of first heat exchange spaces 20A, respectively; a pair of second heat transfer medium ports 30B for the second heat transfer medium to flow into the plurality of second heat exchange spaces 20B and for the second heat transfer medium to flow out of the plurality of second heat exchange spaces 20B, respectively; and a pair of third heat transfer medium ports 30C for the third heat transfer medium to flow into the plurality of third heat exchange spaces 20C and for the third heat transfer medium to flow out of the plurality of third heat exchange spaces 20C, respectively. In the example shown in FIG. 1, the first heat transfer medium port 30A and the second heat transfer medium port 30B located at a lower side of the plate heat exchanger 100 are heat transfer medium inflow ports, and the first heat transfer medium port 30A and the second heat transfer medium port 30B located at an upper side of the plate heat exchanger 100 are heat transfer medium outflow ports; and the third heat transfer medium port 30C located at the lower side of the plate heat exchanger 100 is a heat transfer medium outflow port, and the third heat transfer medium port 30C located at the upper side of the plate heat exchanger 100 is a heat transfer medium inflow port. The first heat transfer medium and the second heat transfer medium may be the same or different, the first heat transfer medium and the second heat transfer medium may be refrigerants, and the third heat transfer medium may be a secondary refrigerant, such as water, an ethylene glycol solution or an ethanol solution. There is a temperature difference between the temperature of the first heat transfer medium and the second heat transfer medium and the temperature of the third heat exchange medium such that heat exchange is performed when the plate heat exchanger 100 is in operation.

[0026] Referring to FIG. 1, according to an embodiment of the present invention, one of the pair of first heat transfer medium ports 30A is arranged at the upper left corner of the heat transfer plate 10, the other of the pair of first heat transfer medium ports 30A is arranged at the lower left corner of the heat transfer plate 10, one of the pair of second heat transfer medium ports 30B is arranged at the upper right corner of the heat transfer plate 10, and the other of the pair of second heat transfer medium ports 30B is arranged at the lower right corner of the heat transfer plate 10, thereby defining a parallel-flow heat exchange mode. Alternatively, one of the pair of first heat transfer medium ports 30A is arranged at the upper left corner of the heat transfer plate 10, the other of

the pair of first heat transfer medium ports 30A is arranged at the lower right corner of the heat transfer plate 10, one of the pair of second heat transfer medium ports 30B is arranged at the upper right corner of the heat transfer plate 10, and the other of the pair of second heat transfer medium ports 30B is arranged at the lower left corner of the heat transfer plate 10, thereby defining a cross-flow heat exchange mode. In the embodiment shown in the figure, the third heat transfer medium ports 30C are each arranged between the first heat transfer medium port 30A and the second heat transfer medium port 30B on the upper side of the plate heat exchanger 100 and the lower side of the plate heat exchanger 100.

[0027] Referring to FIGS. 4 to 9, according to the embodiments of the present invention, each of the pair of first heat transfer medium ports 30A has a plurality of first openings 31A leading to the plurality of first heat exchange spaces 20A; each of the pair of second heat transfer medium ports 30B has a plurality of second openings 31B leading to the plurality of second heat exchange spaces 20B; and each of the pair of third heat transfer medium ports 30C has a plurality of third openings 31C leading to the plurality of third heat exchange spaces 20C. In the figures, the positions of all the openings are indicated by arrows. At the ports, a blocking ring 5 is arranged between adjacent heat transfer plates 10 at positions without an opening, and each opening is formed between adjacent heat transfer plates 10 at positions without a blocking ring 5. Alternatively, a distributor is provided in the port, and the distributor has openings leading to the heat exchange spaces. In addition, the openings leading to the heat exchange spaces may also be formed in other suitable ways.

[0028] According to an embodiment of the present invention, the ratio of the number of first heat exchange spaces 20A to the number of second heat exchange spaces 20B is greater than 1, so that the heat transfer area of each circuit can be optimized, so as to improve the heat exchange efficiency. By optimizing the heat transfer area of each circuit according to the heat load of each circuit, the system efficiency can be improved by 5% to 10% under full load and partial load, and reliability problems such as retention of the heat transfer medium are also avoided. In addition, adjusting the ratio of the number of first heat exchange spaces 20A to the number of second heat exchange spaces 20B will not affect the feasibility of product manufacturing and will not cause an increase in costs.

[0029] Although the above embodiments describe the specific ratio of the number of first heat exchange spaces 20A to the number of second heat exchange spaces 20B and the specific arrangement mode of the first heat exchange spaces 20A and the second heat exchange spaces 20B, the present invention is not limited to the above embodiments, the ratio of the number of first heat exchange spaces 20A to the number of second heat exchange spaces 20B may be any other value greater than 1, and the first heat exchange spaces 20A and the

second heat exchange spaces 20B can be arranged in any other way.

Claims

1. A plate heat exchanger, comprising:

a plurality of heat transfer plates; and
heat exchange spaces formed between adjacent heat transfer plates of the plurality of heat transfer plates, the heat exchange spaces comprising a plurality of first heat exchange spaces for a first heat transfer medium, a plurality of second heat exchange spaces for a second heat transfer medium, and a plurality of third heat exchange spaces for a third heat transfer medium, and each of the plurality of first heat exchange spaces and the plurality of second heat exchange spaces being adjacent to one or two of the plurality of third heat exchange spaces in an overlapping direction of the heat transfer plates,
wherein the number of the plurality of first heat exchange spaces is different from the number of the plurality of second heat exchange spaces.

2. The plate heat exchanger of claim 1, wherein the ratio of the greater one of the number of the plurality of first heat exchange spaces and the number of the plurality of second heat exchange spaces to the smaller one of the number of the plurality of first heat exchange spaces and the number of the plurality of second heat exchange spaces is greater than 1.05.

3. The plate heat exchanger of claim 1, wherein the ratio of the greater one of the number of the plurality of first heat exchange spaces and the number of the plurality of second heat exchange spaces to the smaller one of the number of the plurality of first heat exchange spaces and the number of the plurality of second heat exchange spaces is between 1.1 and 5.

4. The plate heat exchanger of claim 1, wherein a plurality of groups of first heat exchange spaces and a plurality of groups of second heat exchange spaces are alternately arranged in the overlapping direction of the heat transfer plates, each group of the plurality of groups of first heat exchange spaces comprises one or more first heat exchange spaces, and each group of the plurality of groups of second heat exchange spaces comprises one or more second heat exchange spaces.

5. The plate heat exchanger of claim 4, wherein

at least two groups of first heat exchange spaces of the plurality of groups of first heat exchange spaces comprise the same number or different numbers of first heat exchange spaces; and/or at least two groups of second heat exchange spaces of the plurality of groups of second heat exchange spaces comprise the same number or different numbers of second heat exchange spaces.

6. The plate heat exchanger of claim 1, wherein

with respect to the first heat exchange spaces and the second heat exchange spaces, the plurality of first heat exchange spaces are successively arranged in the overlapping direction of the heat transfer plates; and/or with respect to the first heat exchange spaces and the second heat exchange spaces, the plurality of second heat exchange spaces are successively arranged in the overlapping direction of the heat transfer plates.

7. The plate heat exchanger of claim 1, wherein a plurality of heat exchange spaces, composed of the plurality of first heat exchange spaces and the plurality of second heat exchange spaces, and the plurality of third heat exchange spaces are alternately arranged in the overlapping direction of the heat transfer plates.

8. The plate heat exchanger of claim 1, further comprising:

a pair of first heat transfer medium ports for the first heat transfer medium to flow into the plurality of first heat exchange spaces and for the first heat transfer medium to flow out of the plurality of first heat exchange spaces, respectively;
a pair of second heat transfer medium ports for the second heat transfer medium to flow into the plurality of second heat exchange spaces and for the second heat transfer medium to flow out of the plurality of second heat exchange spaces, respectively; and
a pair of third heat transfer medium ports for the third heat transfer medium to flow into the plurality of third heat exchange spaces and for the third heat transfer medium to flow out of the plurality of third heat exchange spaces, respectively.

9. The plate heat exchanger of claim 8, wherein

one of the pair of first heat transfer medium ports is arranged at the upper left corner of the heat transfer plate, the other of the pair of first heat

transfer medium ports is arranged at the lower left corner of the heat transfer plate, one of the pair of second heat transfer medium ports is arranged at the upper right corner of the heat transfer plate, and the other of the pair of second heat transfer medium ports is arranged at the lower right corner of the heat transfer plate; or one of the pair of first heat transfer medium ports is arranged at the upper left corner of the heat transfer plate, the other of the pair of first heat transfer medium ports is arranged at the lower right corner of the heat transfer plate, one of the pair of second heat transfer medium ports is arranged at the upper right corner of the heat transfer plate, and the other of the pair of second heat transfer medium ports is arranged at the lower left corner of the heat transfer plate.

10. The plate heat exchanger of claim 8, wherein

each of the pair of first heat transfer medium ports has a plurality of first openings leading to the plurality of first heat exchange spaces; each of the pair of second heat transfer medium ports has a plurality of second openings leading to the plurality of second heat exchange spaces; and each of the pair of third heat transfer medium ports has a plurality of third openings leading to the plurality of third heat exchange spaces.

11. The plate heat exchanger of any one of claims 1 to 10, wherein each of the plurality of first heat exchange spaces and the plurality of second heat exchange spaces is adjacent to the third heat exchange space on either side in the overlapping direction of the heat transfer plates; and/or each of the plurality of third heat exchange spaces is adjacent to the first heat exchange space or the second heat exchange space on either side in the overlapping direction of the heat transfer plates.

12. The plate heat exchanger of any one of claims 1 to 10, wherein the first heat transfer medium and the second heat transfer medium are refrigerants, and the third heat transfer medium is a secondary refrigerant.

13. The plate heat exchanger of any one of claims 1 to 10, wherein the first heat exchange space, the second heat exchange space and the third heat exchange space are independent of each other.

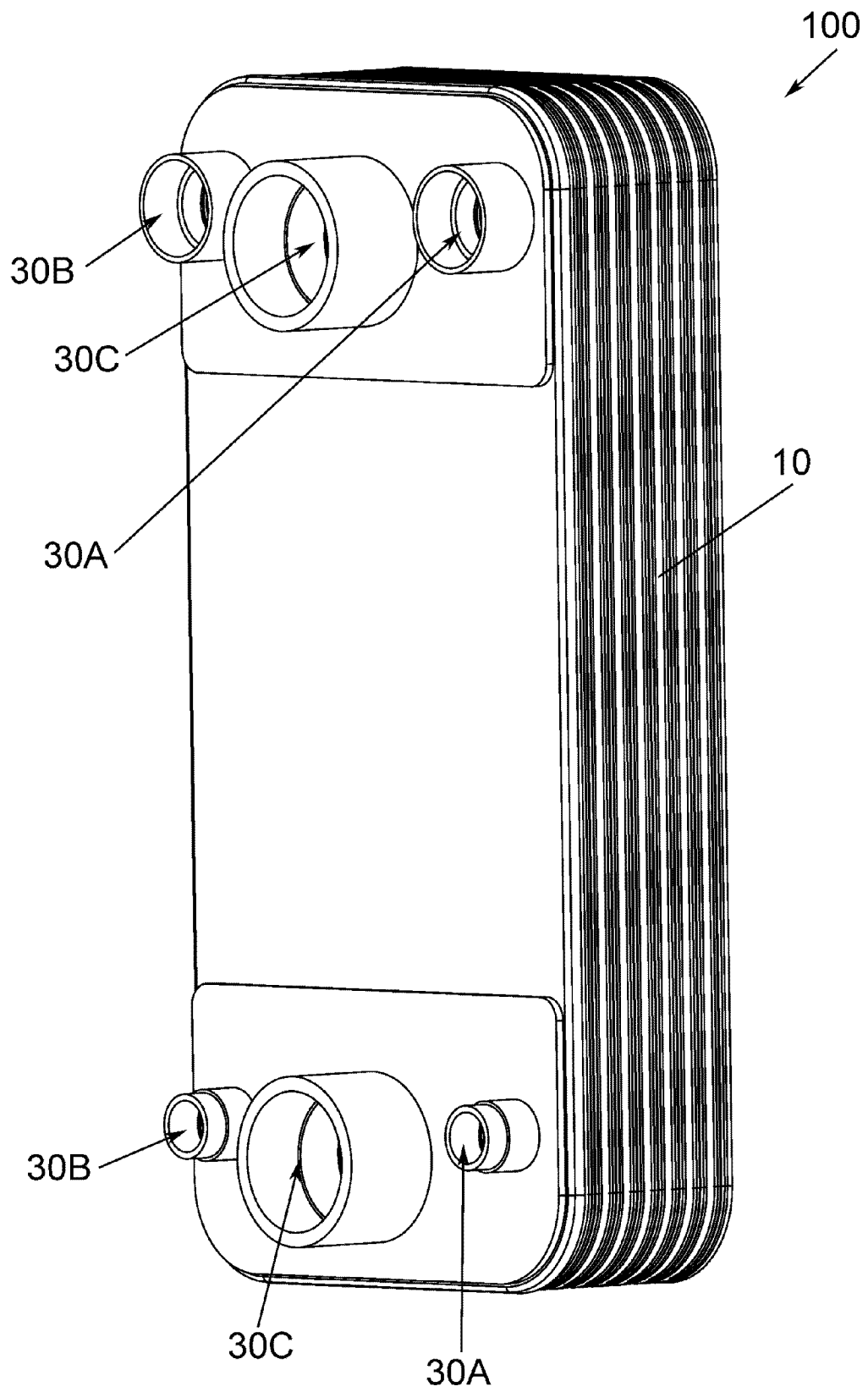


FIG. 1

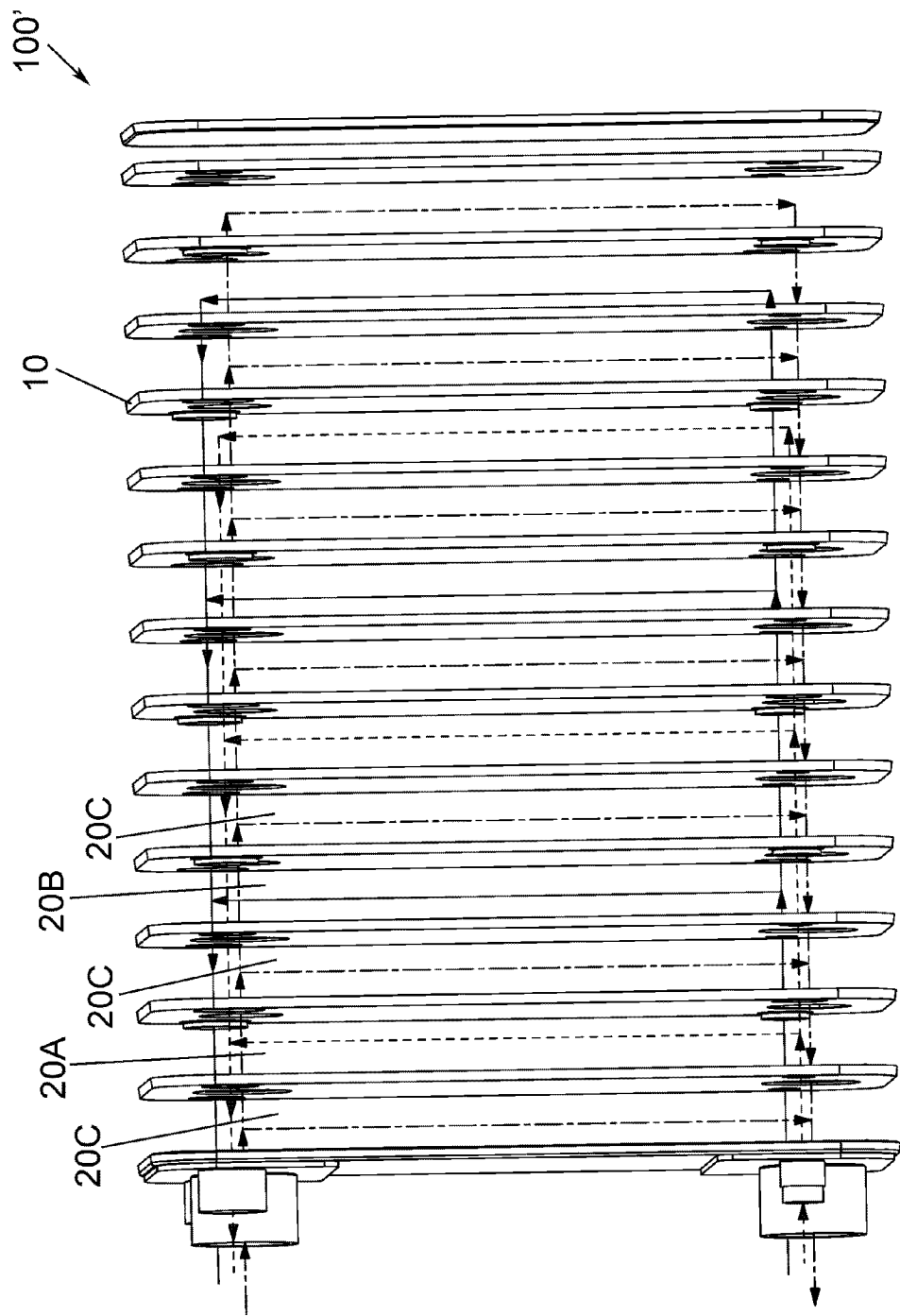


FIG. 2

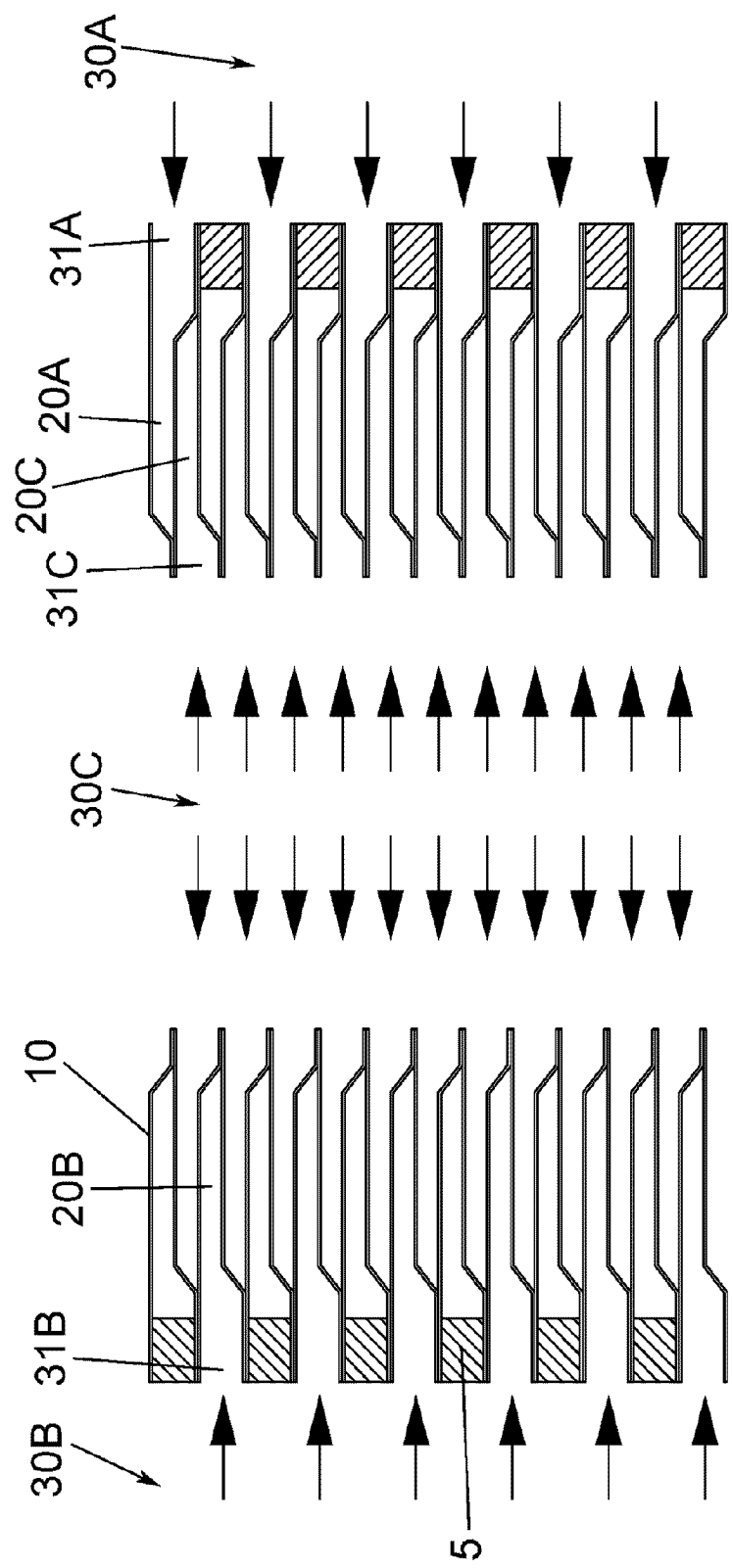


FIG. 3

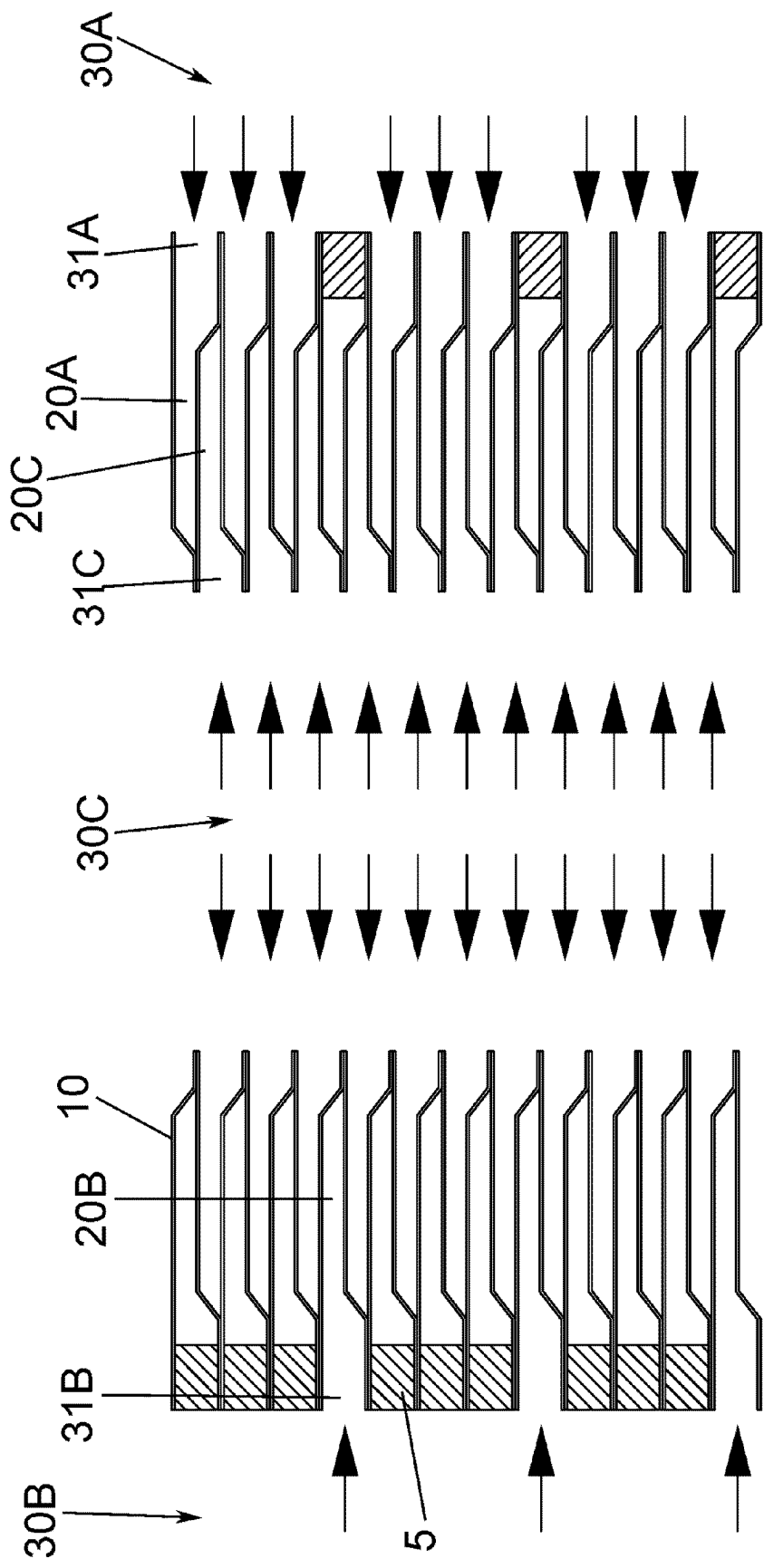


FIG. 4

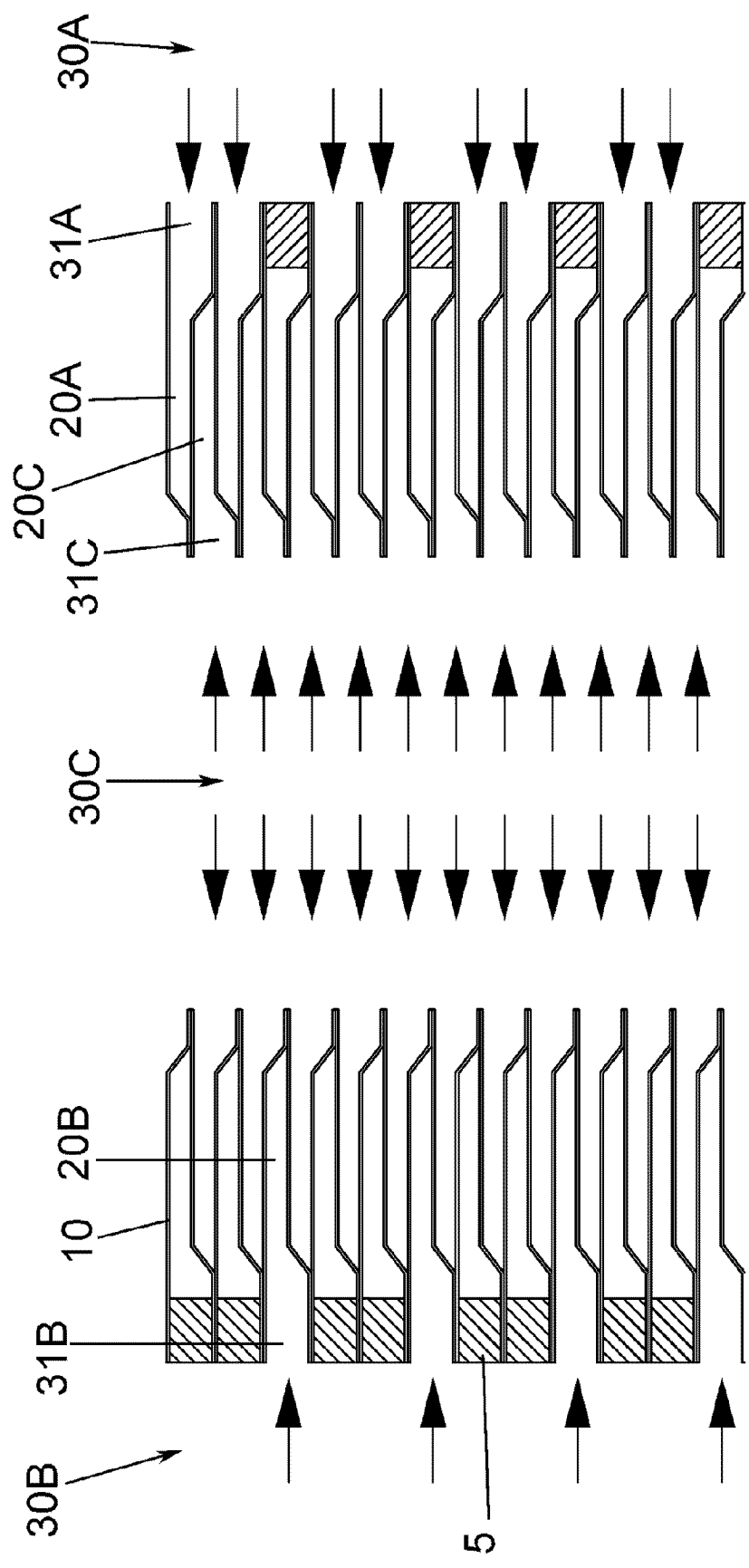


FIG. 5

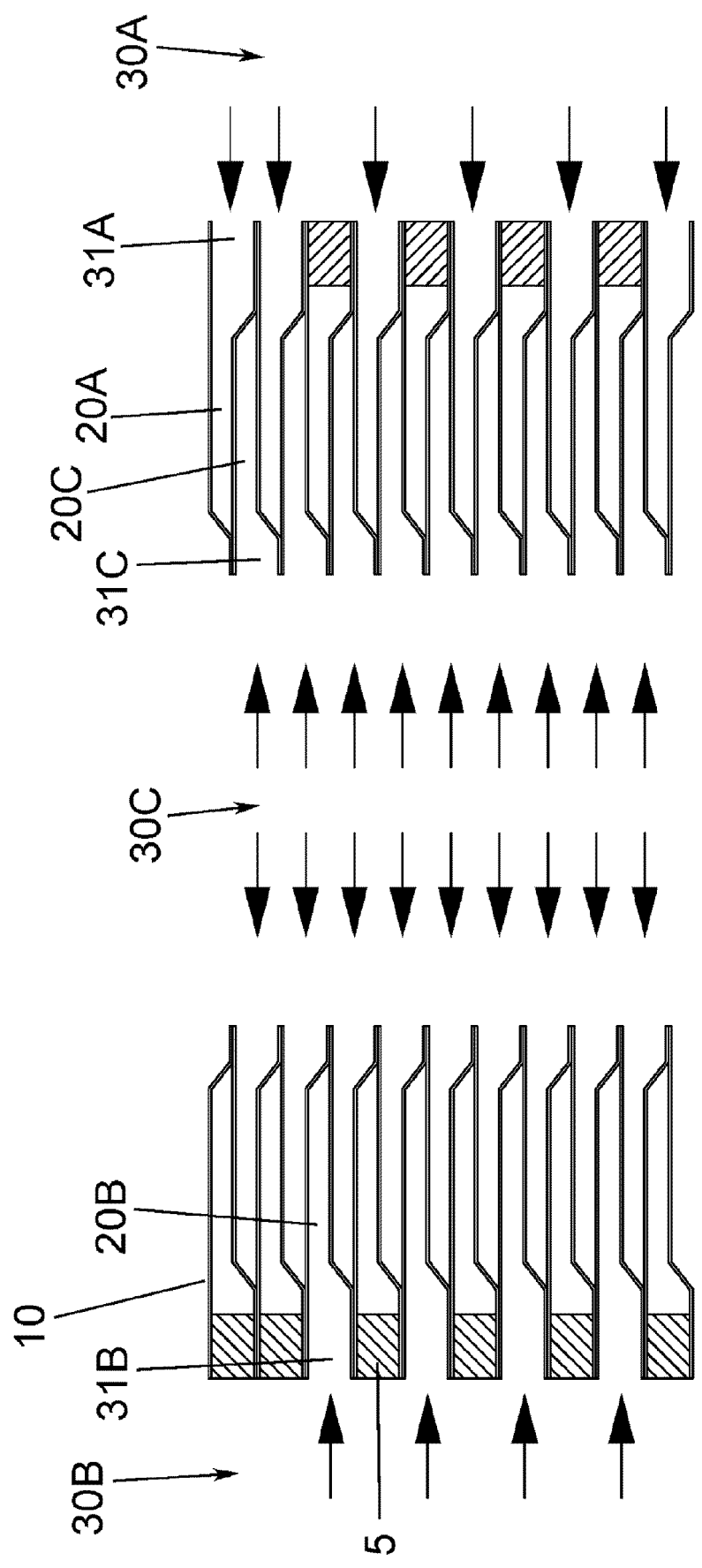


FIG. 6

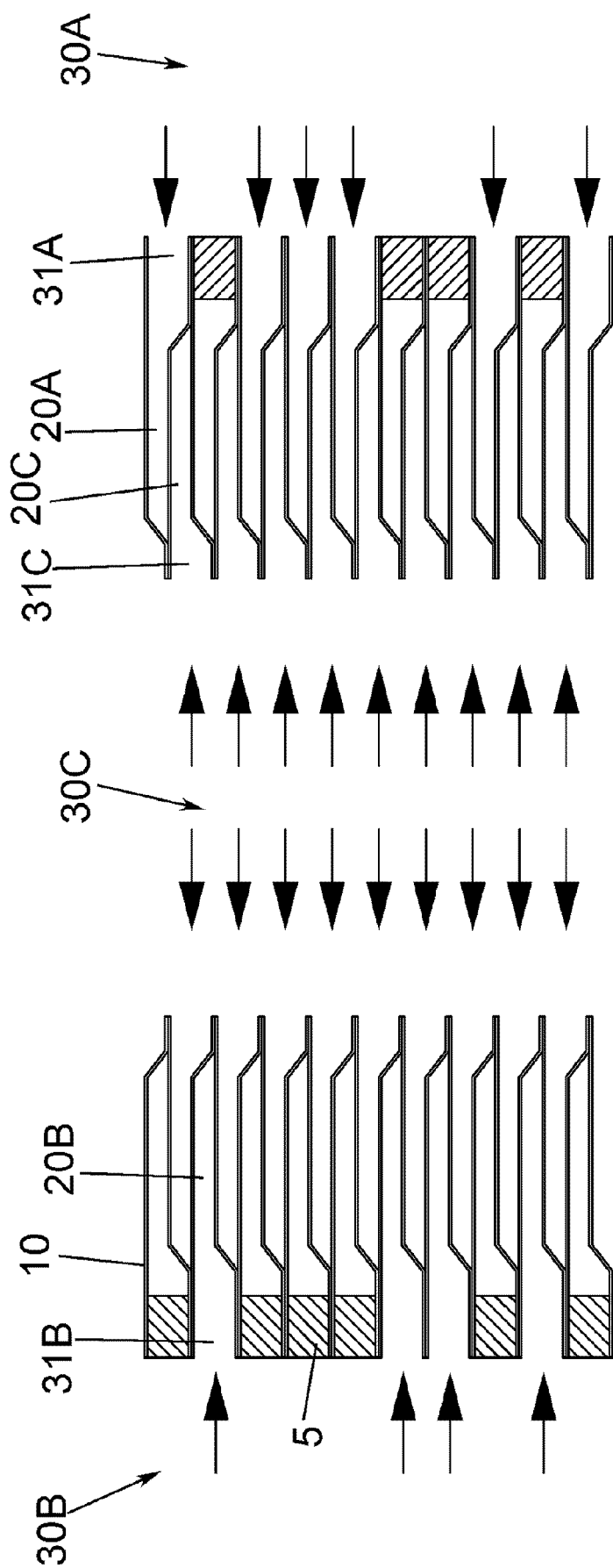


FIG. 7

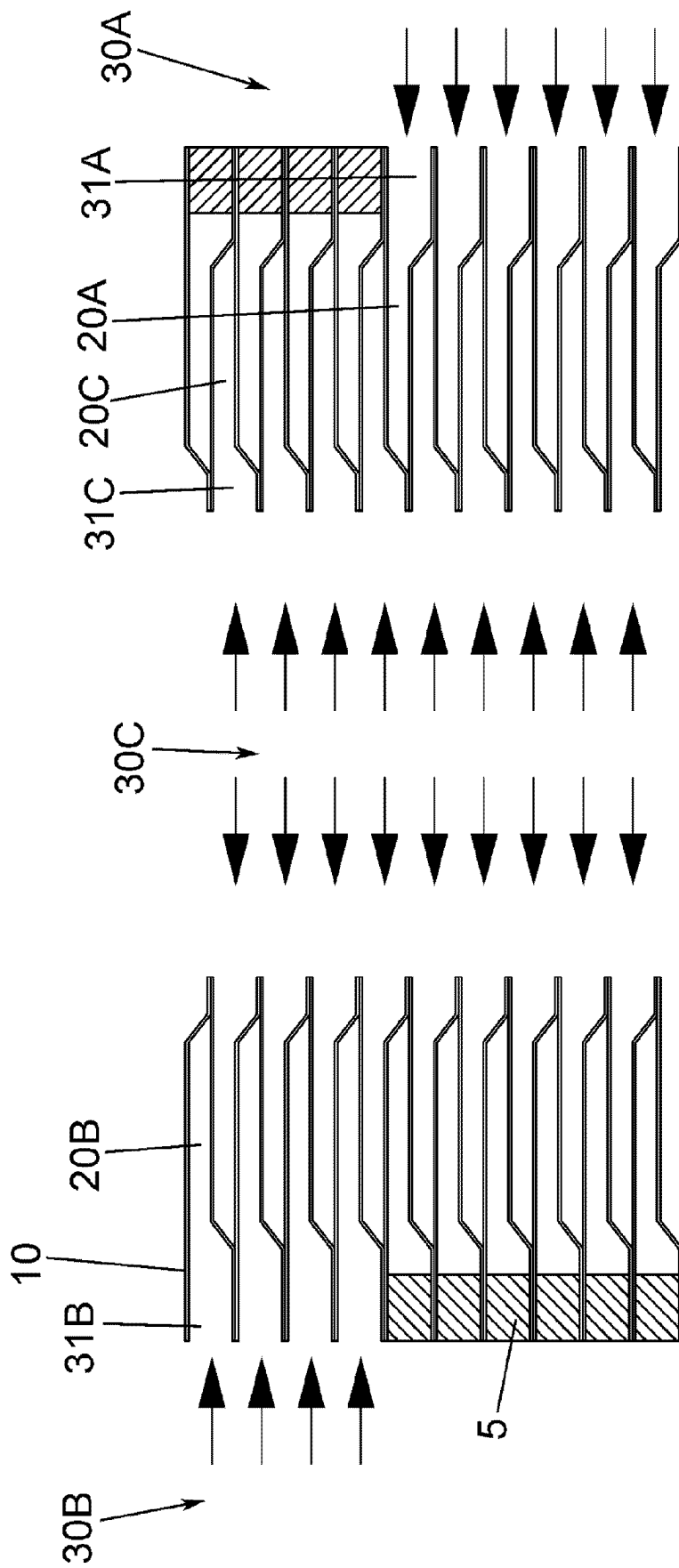


FIG. 8

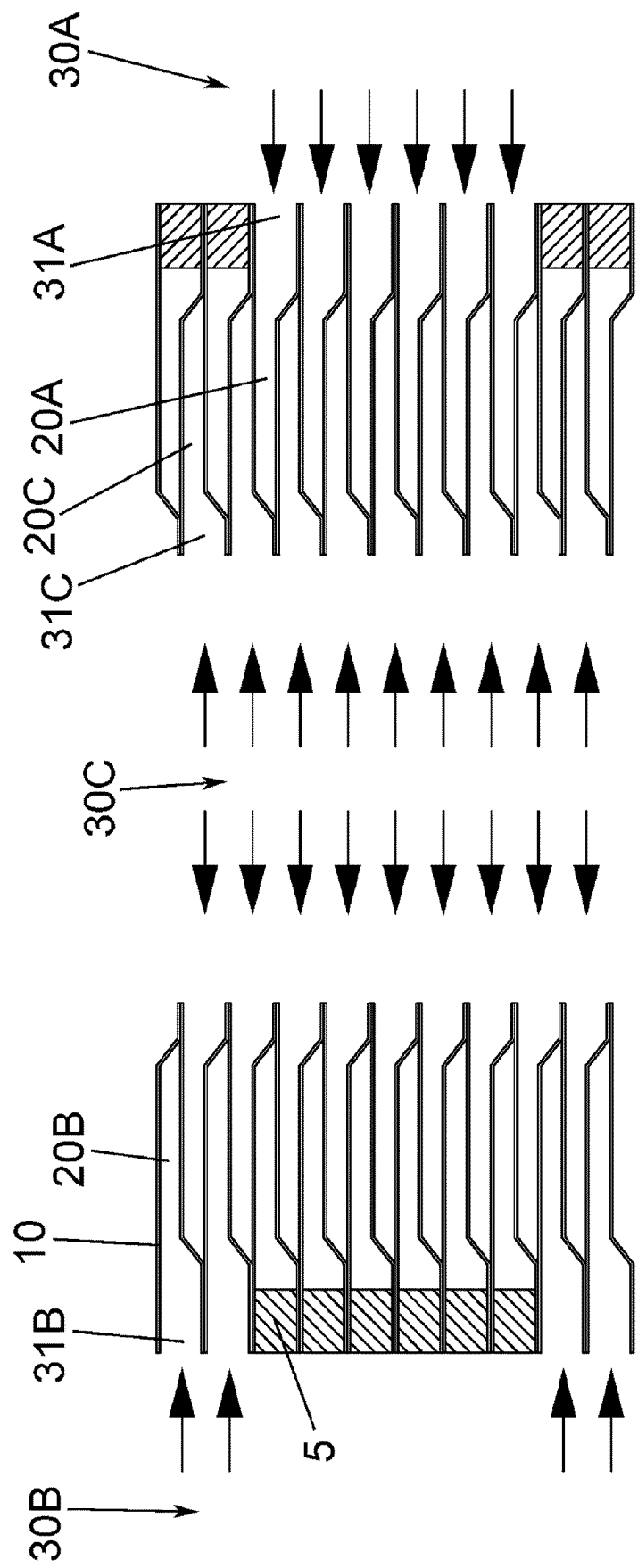


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/078407

A. CLASSIFICATION OF SUBJECT MATTER

F28D 9/04(2006.01);F28F 3/08(2006.01);i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F28D9, F28F3

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

CNTXT, ENTXTC, VEN, ENTXT, CNKI: 板式换热器, 三种, 第三, plate?, panel?, stack+, three, third

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	JP H1019482 A (TOSHIBA ENGINEERING CO. et al.) 23 January 1998 (1998-01-23) description, paragraphs 6-9 and 22-48, and figures 1-3 and 8	1-3, 6, 8-13
Y	JP H1019482 A (TOSHIBA ENGINEERING CO. et al.) 23 January 1998 (1998-01-23) description, paragraphs 6-9 and 22-48, and figures 1-3 and 8	4-5, 7
Y	JP H01244290 A (HISAKA WORKS LTD.) 28 September 1989 (1989-09-28) description, page 2, right upper column, line 3 to right bottom column, the third-to-last line, and figures 1-2	4-5, 7
A	CN 111316057 A (DANA CANADA CORP.) 19 June 2020 (2020-06-19) entire document	1-13
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☒ Further documents are listed in the continuation of Box C.
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Date of the actual completion of the international search

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