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(71) Applicant: **EBARA CORPORATION**
Ohta-ku, Tokyo 144-8510 (JP)

(72) Inventors:
- **INOUE, Naoyuki**
  Tokyo 144-8510 (JP)
- **MATSUBARA, Toshio**
  Tokyo 144-8510 (JP)

(74) Representative:
Wagner, Karl H., Dipl.-Ing. et al
Wagner & Geyer,
Patentanwälte,
Gewürzmühlstrasse 5
80538 München (DE)

(54) PLATE TYPE HEAT EXCHANGER

(57) The present invention relates to a plate heat exchanger for exchanging heat between two fluids flowing alternately through adjacent fluid passages between piled plates. Two plates are piled as a set on each other at peripheries thereof to form a heat exchange element (2). Each of the two plates has a projection and a depression and is provided with opening portions (5) at both ends in a longitudinal direction thereof. A plurality of the heat exchange elements (2) are piled so that the opening portions (5) are aligned with each other. A space (11) between the two plates (3) forming the heat exchange element (2) defines a passage for a first fluid. A space (12) between the adjacent heat exchange elements (2) defines a passage for another fluid having heat exchange relationship with the first fluid. The plate (3) serves as a heat transfer surface for both of the fluids. The peripheral portions (4) of the heat exchange elements (2) are brought into contact with each other to form a sealed passage for the second fluid when the heat exchange elements (2) are piled on each other.

FIG. 1A

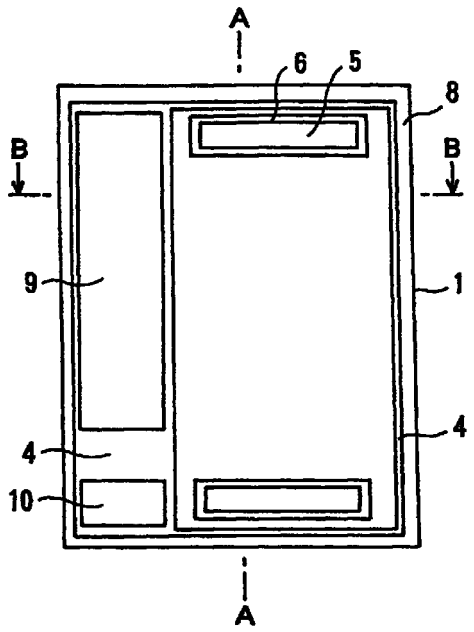

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FIG. 1B

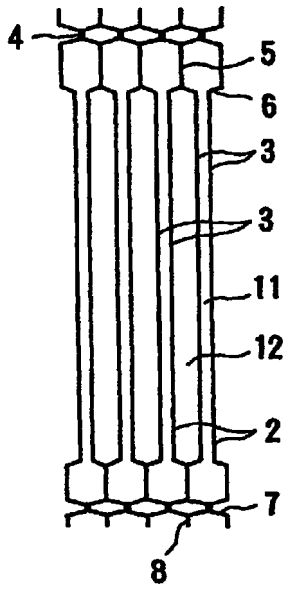
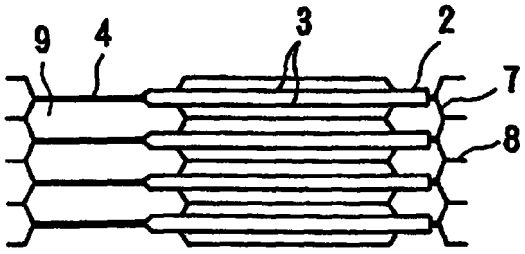


FIG. 1C



Description

Technical Field

[0001] The present invention relates to a plate heat exchanger, and more particularly to a plate heat exchanger for exchanging heat between two fluids flowing alternately through adjacent fluid passages between piled plates, which is suitable for such cases where at least one of the fluids is a low-pressure vapor, or is evaporated with phase change, or is condensed from a vapor, as an evaporator, a low-temperature generator, or a condenser in a refrigerating machine using a low-pressure refrigerant.

Background Art

[0002] A conventional plate heat exchanger is shown in FIGS. 10 and 11. FIGS. 10A and 10B are schematic views showing a conventional plate heat exchanger, FIG. 10A is a front view, and FIG. 10B is a side view. FIG. 11 is an exploded explanatory view of FIGS. 10A and 10B.

[0003] In the conventional plate heat exchanger, as shown in FIGS. 10A, 10B and 11, two plates 3 having opening portions 5 at both ends thereof are piled on each other to form a space therebetween, and the peripheral portions of the plates 3 are sealed to form a heat exchange element 2. The heat exchange elements 2 are piled on and combined with each other in such a state that the opening portions 5 of the plates 3 communicate with each other, thereby producing a heat exchange structure. This heat exchange structure is housed in a shell 20, and fluids flow through the interior and the exterior of the heat exchange elements 2 so as to exchange heat with each other.

[0004] Such a conventional plate heat exchanger requires not only heat exchange elements composed of plates, but also a shell. Thus, such a conventional plate heat exchanger has been problematic in that manufacturing procedure is complicated and various types of components are required.

[0005] FIG. 12 shows an example of an absorber and an evaporator utilizing conventional plate heat exchangers.

[0006] In the conventional example shown in FIG. 12, an evaporator 21 and an absorber 22 are disposed on the left side and the right side, respectively. Plate heat exchangers for the evaporator and the absorber have been manufactured separately, and the absorber and the evaporator are different from each other in shape. Many types of components are used for the absorber and the evaporator, and many man-hours are needed to manufacture the absorber and the evaporator.

[0007] With such a type of plate heat exchanger, a gap between plates needs to be considerably large, thereby posing a problem that it is difficult to make a plate heat exchanger compact.

Disclosure of Invention

[0008] The present invention has been made in view of the above drawbacks. It is therefore an object of the present invention to provide a plate heat exchanger which can easily be manufactured and assembled with a small number of components, can achieve a cost reduction and compactness, and has a high heat exchanging performance.

[0009] In order to achieve the above object, according to an aspect of the present invention, there is provided a plate heat exchanger characterized in that: two plates, each having a projection and a depression and provided with opening portions at both ends in a longitudinal direction thereof, are piled as a set on each other at peripheries thereof to form a heat exchange element; a plurality of the heat exchange elements are piled so that the opening portions are aligned with each other; a space between the two plates forming the heat exchange element defines a passage for a first fluid; a space between the heat exchange elements adjacent to each other defines a passage for another fluid (a second fluid) having heat exchange relationship with the first fluid; the plate serves as a heat transfer surface for both of the fluids; and the peripheral portions of the heat exchange elements are brought into contact with each other to form a sealed passage for the second fluid when the heat exchange elements are piled on each other.

[0010] In the above plate heat exchanger, an inlet and an outlet for the second fluid may be provided on a surface of the plate at positions other than the opening portions at the both ends constituting an inlet and an outlet for the first fluid. Two plate heat exchangers described above may be arranged in parallel in a direction of piling of the heat exchange elements, and the passages for the second fluid in the two plate heat exchangers communicate with each other so that a vapor is generated from one of the plate heat exchangers, and condensed or absorbed by the other of the plate heat exchangers.

[0011] According to the present invention, passages curved by projections and depressions are formed inside and outside of heat exchange elements composed of one or two types of components, and the external passages can be formed at a time without use of a shell. Thus, a complicated plate heat exchanger for exchanging heat between two fluids having different temperatures can be manufactured at low cost from a small number of components by a simple manufacturing process.

[0012] According to a second aspect of the present invention, there is provided a plate heat exchanger, characterized in that: a plurality of heat exchange elements are provided, each of the heat exchange elements being composed of two plates opposed to each

other as a set, sealed spaces being provided as two systems inside of the two plates, each of the heat exchange elements having two opening portions as an inlet and an outlet for each of the systems; and different fluids flow through internal spaces in the two systems and through passages outside of the internal spaces, respectively.

[0013] In the plate heat exchanger, the plurality of the heat exchange elements may be constructed such that the heat exchange elements adjacent to each other communicate with each other, and have peripheral portions which are brought into contact with each other and sealed therebetween. In this case, the internal spaces in the two systems may be arranged on a right side and a left side, and portions of communication between the plurality of the heat exchange elements are divided into a plurality of segments in a vertical direction.

[0014] According to another aspect of the present invention, there is provided a plate heat exchanger, characterized in that: a plurality of heat exchange elements are provided, each of the heat exchange elements being composed of two plates opposed to each other as a set, sealed spaces being provided as four systems inside of the two plates, each of the heat exchange elements having two opening portions as an inlet and an outlet for each of the systems; among the four systems, a set of a first system and a second system and a set of a third system and a fourth system are arranged on a right side and a left side, respectively; and different fluids flow through internal spaces in the four systems and through passages outside of the internal spaces, respectively.

[0015] In the plate heat exchanger, the plurality of the heat exchange elements may be constructed such that the heat exchange elements, adjacent to each other, outside of the set of the first system and the second system and the set of the third system and the fourth system arranged on a right side and a left side communicate with each other, and the peripheral portions of the heat exchange elements adjacent to each other may be brought into contact with each other and sealed therebetween.

[0016] According to the above construction, a single plate heat exchanger can perform two or four types of heat exchange. For example, a fluid flows as a liquid film on an outer surface of the first system, and is heated by the internal fluid, thereby generating a vapor from the liquid film. When the second system is utilized for an absorber, the vapor is cooled by the internal fluid, and can hence be condensed on the outer surface of the second system. Further, when the second system is utilized for a condenser, an absorption solution flows as a liquid film on the outer surface, whereby the vapor can be absorbed.

Brief Description of Drawings

[0017]

FIGS. 1A, 1B and 1C are schematic views showing an example of a plate heat exchanger according to a first embodiment of the present invention, and FIG. 1A is a front view, FIG. 1B is a cross-sectional view taken along a line A-A of FIG. 1A, and FIG. 1C is a cross-sectional view taken along a line B-B of FIG. 1A;

FIGS. 2A through 2D are schematic views showing another example of a plate heat exchanger according to the first embodiment of the present invention, and FIG. 2A is a side cross-sectional view, FIG. 2B is a cross-sectional view taken along a line A-A of FIG. 2A, FIG. 2C is a cross-sectional view taken along a line B-B of FIG. 2A, and FIG. 2D is a cross-sectional view taken along a line C-C of FIG. 2A;

FIGS. 3A, 3B and 3C are schematic views showing an example of a plate heat exchanger according to a second embodiment of the present invention, and FIG. 3A is a front view, FIG. 3B is a plan view, and FIG. 3C is a side view;

FIGS. 4A, 4B and 4C are schematic views showing another example of a plate heat exchanger according to the second embodiment of the present invention, and FIG. 4A is a front view, FIG. 4B is a plan view, and FIG. 4C is a side view;

FIG. 5 is a schematic view showing an example of a construction of a plate heat exchanger, according to the second embodiment of the present invention, which is housed in a shell;

FIGS. 6A, 6B and 6C are schematic views showing another example of a plate heat exchanger according to the second embodiment of the present invention, and FIG. 6A is a front view, FIG. 6B is a cross-sectional view taken along a line A-A of FIG. 6A, and FIG. 6C is a cross-sectional view taken along a line B-B of FIG. 6A;

FIGS. 7A, 7B and 7C are schematic views showing another example of a plate heat exchanger according to the second embodiment of the present invention, and FIG. 7A is a front view, FIG. 7B is a cross-sectional view taken along a line A-A of FIG. 7A, and FIG. 7C is a cross-sectional view taken along a line B-B of FIG. 7A;

FIGS. 8A, 8B and 8C are schematic views showing another example of a plate heat exchanger according to the second embodiment of the present invention, and FIG. 8A is a front view, FIG. 8B is a cross-sectional view taken along a line A-A of FIG. 8A, and FIG. 8C is a cross-sectional view taken along a line B-B of FIG. 8A;

FIGS. 9A, 9B and 9C are schematic views showing another example of a plate heat exchanger according to the second embodiment of the present invention, and FIG. 9A is a front view, FIG. 9B is a plan

view, and FIG. 9C is a side view;

FIGS. 10A and 10B are schematic views showing a conventional plate heat exchanger, and FIG. 10A is a front view, and FIG. 10B is a side view;

FIG. 11 is an exploded explanatory view of the conventional plate heat exchanger; and

FIG. 12 is a schematic view showing a construction of the conventional plate heat exchanger applied to an absorber and an evaporator.

Best Mode for Carrying Out the Invention

[0018] A plate heat exchanger according to a first embodiment of the present invention will be described below in detail.

[0019] As a plate used in the present invention, a plate having a shape suitable for meeting the following conditions can be used: Two plates having projections and depressions are piled on each other to form a space therebetween. When the peripheral portions of the two plates are simply piled, the plates are brought into light contact (i.e., line contact) with each other along the whole peripheries. When a force in a direction of piling is increased, the contacting portions are changed in shape to be brought into surface contact with each other. When the force is increased until the projections and depressions of the respective plates are brought into contact with each other, the area of the contact surface is increased, and hence the peripheries of the plates can be sealed by brazing.

[0020] In the case of brazing, plates are brazed while a force is being applied in order to bring the plates into close contact with each other. Accordingly, the aforementioned plates are preferable because, upon application of this force, the peripheral portions of the plates become parallel, and further the projections and depressions of the plates are brought into contact with each other.

[0021] When the two plates described above are piled on each other while a brazing filler material is laid (applied) at portions to be brought into contact with each other, a heat exchange element which has a fluid passage between the opening portions formed at both ends of the plates and the aforementioned space is formed.

[0022] The present invention can be applied to not only a case of brazing, but also a case where a gasket is interposed between the plates and a force is applied from the outside, and a case where the plates are sealed by welding.

[0023] The projections and depressions of the plate according to the present invention can be formed as a corrugated pattern extending in a predetermined direction, and hence a complicated passage curved two-dimensionally can be formed with a relatively simple arrangement.

[0024] A plate heat exchanger is constructed from the above heat exchange elements as follows: A required number of the heat exchange elements are piled in such a manner that the opening portions at both ends and the element peripheral sealing portions which are to form a passage for a second fluid by sealing adjacent heat exchange elements are aligned with each other. The brazing filler material is laid on surfaces on which the opening portions of the heat exchange elements and the element peripheral sealing portions are piled. The heat exchange elements are brazed under heat in such a state that a force is being applied in a direction of piling. Consequently, the heat exchange elements are sealed at their peripheral portions, so that a plate heat exchanger having a sealed portion serving as a shell can be manufactured at a time.

[0025] One of the opening portions at both ends of the plate is provided with a rising portion, so that positioning of the plates upon piling can be facilitated by the fitting of the opening portions. Thus, the two-dimensional positioning of the heat exchange elements can naturally be performed by simply piling the heat exchange elements on each other. Consequently, the manufacturing process can be simplified.

[0026] A plate heat exchanger according to a first embodiment of the present invention will be described below in detail with reference to FIGS. 1 and 2.

[0027] FIGS. 1A, 1B and 1C are schematic views showing an example of a plate heat exchanger, and FIG. 1A is a front view, FIG. 1B is a cross-sectional view taken along a line A-A of FIG. 1A, and FIG. 1C is a cross-sectional view taken along a line B-B of FIG. 1A.

[0028] In FIGS. 1A, 1B and 1C, the plate heat exchanger 1 is constructed by combination of four heat exchange elements 2. The heat exchange element 2 is constructed in such a state that two plates 3 are piled, and contacting portions having projections and depressions and peripheral portions 4 are fixed to each other by welding or brazing. Peripheral rising portions 6 of opening portions 5 at both ends of the heat exchange elements 2 are piled on each other, and contacting portions 8 of peripheral protuberances 7 are piled on each other. These portions 6, 8 are welded or brazed to combine the four heat exchange elements 2, for thereby constructing a plate heat exchanger. As a result, a passage is formed within each of the heat exchange elements 2, and passages are formed between the adjacent heat exchange elements 2.

[0029] A first fluid flows from the opening portions 5 through internal spaces 11 of the heat exchange elements 2. A vapor, as a second fluid, for example, is introduced from vapor passages 9 into spaces 12 formed between the adjacent heat exchange elements 2, and then condensed in the spaces 12 and discharged as a liquid from liquid passages 10. Separated passages for a second fluid may be provided outside of the heat exchange elements 2 to absorb a vapor introduced from the vapor passages 9, and the second fluid may then be discharged front the liquid passages 10.

[0030] As described above, the protuberances are

provided at the peripheries of the heat exchange elements 2, and brought into contact with each other to seal the heat exchange elements 2. Hence, external passages as passages for a second fluid can be formed at a time without use of a shell.

[0031] FIGS. 2A through 2D are schematic views showing another example of a plate heat exchanger, and FIG. 2A is a side cross-sectional view, FIG. 2B is a cross-sectional view taken along a line A-A of FIG. 2A, FIG. 2C is a cross-sectional view taken along a line B-B of FIG. 2A, and FIG. 2D is a cross-sectional view taken along a line C-C of FIG. 2A.

[0032] In a plate heat exchanger shown in FIGS. 2A through 2D, two plate heat exchangers shown in FIGS. 1A, 1B and 1C are piled in parallel as shown by the reference numerals 1a, 1b to form an integrated unit. Vapor passages 9 for a second fluid provide a communication between the heat exchangers 1a and 1b.

[0033] The heat exchangers shown in FIGS. 2A through 2D are applied to an absorber 1b and an evaporator 1a of an absorption refrigerating machine. The vapor passages 9 communicate with the absorber 1b and the evaporator 1a. Cold water 13a and cooling water 14a are blocked therebetween, and outlets for these liquids are also blocked therebetween, and hence these liquids flow in and flow out through end surfaces.

[0034] In the plate heat exchanger described above, cold water is introduced into internal spaces 11 of the heat exchange elements from opening portions 13a in the evaporator 1a, passed through the spaces 11, cooled thereby, and discharged from 13b. In external spaces 12 between the elements, a refrigerant liquid flows down, although this is not shown. The refrigerant removes heat from the cold water and is changed into a refrigerant vapor, and this refrigerant vapor is passed from the external spaces 12 through the vapor passages 9 and reaches the absorber 1b.

[0035] In the absorber 1b, cooling water is introduced into internal spaces 11 from opening portions 14a, passed through the spaces 11 to cool an absorption solution passing through external spaces 12, and discharged from 14b. The absorption solution flowing down through the external spaces 12 absorbs the refrigerant vapor flowing from the vapor passages 9, and is then discharged from discharge passages 18 provided below the vapor passages 9, although this not shown.

[0036] The refrigerant that has not evaporated is recovered in discharge passages 17 for being used as a circulating refrigerant liquid.

[0037] In FIGS. 2A through 2D, the same reference numerals as those shown in FIGS. 1A, 1B and 1C denote the same parts or components. The reference numeral 15 denotes a barrier plate, and the reference numeral 16 denotes shut-off plates.

[0038] The plate heat exchanger shown in FIGS. 2A through 2D can similarly be applied to a generator and a condenser of an absorption refrigerating machine.

[0039] As described above, according to the first embodiment of the present invention, passages curved by projections and depressions are formed inside and outside of heat exchange elements composed of one or two types of components, and the external passages can be formed at a time without use of a shell. Thus, a complicated plate heat exchanger with high efficiency of heat exchanging performance for exchanging heat between two fluids having different temperatures can be manufactured at low cost from a small number of components by a simple manufacturing process.

[0040] Next, a plate heat exchanger in a second embodiment of the present invention will be described below in detail.

[0041] As a plate used in the present invention, a plate having a shape suitable for meeting the following conditions can be used: When two plates having projections and depressions are piled on each other to form a space therebetween, two or four divided sealed spaces are formed inside of the two plates. Two opening portions are provided for each of the spaces. When the peripheral portions, the divided portions, and the opening portions of the plates are simply piled, they are brought into light contact (i.e., line contact) with each other along the whole peripheries. When a force in a direction of piling is increased, the contacting portions are changed in shape to be brought into surface contact with each other. When the force is increased until the projections and depressions of the respective plates are brought into contact with each other, the area of the contact surface is increased, and hence the peripheries and the divided portions of the plates can be sealed by brazing.

[0042] In the case of brazing, plates are brazed while a force is being applied in order to bring the plates into close contact with each other. Accordingly, the aforementioned plates are preferable because, upon application of this force, the peripheral portions and the divided portions of the plates become parallel, and further the projections and depressions of the plates are brought into contact with each other.

[0043] When two plates described above are piled on each other while a brazing filler material is laid (applied) at portions to be brought into contact with each other, a heat exchange element which has two opening portions in each of the plates and has two or four independent fluid passages in an internal space is formed.

[0044] The present invention can be applied to not only a case of brazing, but also a case where a gasket is interposed between the plates and a force is applied from the outside, and a case where the plates are sealed by welding.

[0045] The projections and depressions of the plate according to the present invention can be formed as a corrugated pattern extending in a predetermined direction, and hence a complicated passage curved two-dimensionally can be formed with a relatively simple arrangement.

[0046] One of the opening portions at both ends of the plate is provided with a rising portion, so that positioning of the plates upon piling can be facilitated by the fitting of the opening portions. Thus, the two-dimensional positioning of the plates can naturally be performed by simply piling the plates on each other. Consequently, the manufacturing process can be simplified.

[0047] The two opening portions provided for the two or four systems in the internal space of the heat exchange element are connected to those of the adjacent heat exchange elements to form fluid passages. Fluids flow separately through the outside of the heat exchange element corresponding to these systems in the internal space. Consequently, a plate heat exchanger capable of simultaneously exchanging heat between the two or four fluids can be constructed.

[0048] For example, the plate heat exchanger can be applied to a plate type absorber and a plate type evaporator of an absorption refrigerating machine, by using cooling water as an internal fluid in the first system, an absorption solution as an external fluid in the first system, cold water as an internal fluid in the second system, and a refrigerant liquid as an external fluid in the second system. Further, the plate heat exchanger can be applied to a plate type generator and a plate type condenser of an absorption refrigerating machine, by using a heat source fluid (e.g., hot water, vapor) as an internal fluid in the first system, an absorption solution as an external fluid in the first system, cooling water as an internal fluid in the second system, and a refrigerant condensate as an external fluid in the second system. Furthermore, when a four-system plate heat exchanger in which the plate type absorber and evaporator and the plate type generator and condenser are integrated is used, the absorber, the evaporator, the generator, and the condenser of an absorption refrigerating machine can be constructed by a single plate heat exchanger.

[0049] A plate heat exchanger according to the second embodiment of the present invention will be described below in detail with reference to FIGS. 3 through 9.

[0050] FIGS. 3A, 3B and 3C are schematic views showing an example of a plate heat exchanger according to the present invention, and FIG. 3A is a front view, FIG. 3B is a plan view, and FIG. 3C is a side view.

[0051] In FIGS. 3A, 3B and 3C, the reference numeral 3 denotes a plate, and the reference numeral 2 denotes a heat exchange element. The plate heat exchanger comprises three heat exchange elements. The heat exchange element 2 has internal spaces 23 formed into two systems 23a and 23b, and opening portions 24 (24a, 24b) at an upper side and a lower side of each of the two systems. Internal spaces of the two systems are sealed by sealing portions 26. The adjacent heat exchange elements 2 are connected to each other by open rising portions 25 of the opening portions 24. External passages 27 are formed between the adjacent elements and provided so as to communicate with the exteriors of the elements.

[0052] In the plate heat exchanger of FIGS. 3A, 3B and 3C, fluids flow through the two systems in the internal spaces of the heat exchange elements, and also fluids flow through the two systems in the outside of the heat exchange elements. Thus, vapor movement occurs between the internal two systems and the external two systems. Accordingly, two types of heat exchangers, such as an evaporator and an absorber, or a generator and a condenser, can be constructed, thereby achieving compactness.

[0053] FIGS. 4A, 4B and 4C are schematic views showing another example of a plate heat exchanger, and FIG. 4A is a front view, FIG. 4B is a plan view, and FIG. 4C is a side view. As shown in these drawings, projections and depressions 31, 32 can be provided on the surface of the plate constituting the heat exchange element. The projections and depressions 32 provided on the sealing portions 26 between the two systems serve as straightening vanes for allowing vapor to speedily pass through external passages 27 outside of the heat exchange elements, and as eliminators for separating gas and liquid.

[0054] FIG. 5 is a schematic view showing an example of a construction of the plate heat exchanger, according to the present invention, which is housed in a shell. As shown in FIG. 5, spreader pipes 29 for fluids are respectively mounted on the exteriors of the heat exchange elements 2 corresponding to the internal spaces 23a, 23b of the heat exchange elements 2 housed in a shell 20.

[0055] FIGS. 6A, 6B and 6C show heat exchange elements 2 sealed at the peripheries thereof, as indicated by the reference numeral 28, instead of using the shell of FIG. 5. FIG. 6A is a front view, FIG. 6B is a cross-sectional view taken along a line A-A of FIG. 6A, and FIG. 6C is a cross-sectional view taken along a line B-B of FIG. 6A. In FIGS. 6A, 6B and 6C, an inlet 33 for introducing a solution or a refrigerant, for example, is provided in an upper portion. A solution or a refrigerant is supplied to respective units by the pipes 29 (see FIG. 5) through the inlet 33, and outlets 34, 35 for a solution or a refrigerant are separately provided at a lower portion. When the heat exchanger is used as a condenser, it is not necessary to supply a refrigerant liquid.

[0056] FIGS. 7A, 7B and 7C are schematic views showing another plate heat exchanger according to the present invention, and FIG. 7A is a front view, FIG. 7B is a cross-sectional view taken along a line A-A of FIG. 7A, and FIG. 7C is a cross-sectional view taken along a line B-B of FIG. 7A.

[0057] FIGS. 8A, 8B and 8C are schematic views showing still another plate heat exchanger according to the present invention, and FIG. 8A is a front view, FIG. 8B is a cross-sectional view taken along a line A-A of FIG. 8A, and FIG. 8C is a cross-sectional view taken along a line B-B of FIG. 8A.

[0058] In the plate heat exchangers shown in FIGS. 3 through 6, the outsides of the passages for the internal fluids in the two systems of the right and left units communicate with each other in the right and left direction to thus form one system. On the other hand, in the plate heat exchangers shown in FIGS. 7 through 8, the internal fluids in the right and left units are flowed in the form of two systems, and the outsides of the passages for the internal fluids are divided in a vertical direction, and the divided portions communicate with each other in the right and left direction. By division of the exteriors through which a vapor flows, a pressure distribution can be developed in the vertical direction. If the heat exchanger thus constructed is applied to an evaporator and an absorber of an absorption refrigerating machine, for example, then a multi-stage evaporator and a multi-stage absorber can be constructed. FIGS. 7 through 8 show heat exchangers having a four-stage structure.

[0059] In the example shown in FIGS. 7A, 7B and 7C, the divisions into the upper stages and the lower stages are performed by molded portions 36 of the plates. In the example shown in FIGS. 8A, 8B and 8C, the divisions into the upper stages and the lower stages are performed by insertion of plates 37. In FIGS. 8A, 8B and 8C, the inserted plates 37 serve as not only partition plates, but also eliminators, and distributors of a liquid flowing downwardly outside of the plates 3.

[0060] The multi-stage configuration is effective for a generator and a condenser, also.

[0061] FIGS. 9A, 9B and 9C are schematic views showing still another example of a plate heat exchanger according to the present invention, which is an improved form of the plate heat exchanger shown in FIGS. 6A, 6B and 6C. In FIGS. 9A, 9B and 9C, four systems, i.e., two right systems and two left systems, of internal fluids are formed inside of the plates. Outside of the plates, vapor passages are provided so as to communicate with the right systems and the left systems. FIG. 9A is a front view, FIG. 9B is a plan view, and FIG. 9C is a side view.

[0062] The plate heat exchanger shown in FIGS. 9A, 9B and 9C is used as a generator, a condenser, an evaporator, and an absorber of an absorption refrigerating machine, for example. A generator 23b and a condenser 23a are arranged on the left side and the right side of an upper portion, respectively, while an evaporator 23c and an absorber 23d are arranged on the right side and the left side of a lower portion, respectively. However, an evaporator, an absorber, a condenser, and a generator may be arranged side by side at the same height.

[0063] As described above, in the case where a plate heat exchanger is constructed so as to have four systems, main components constituting an absorption refrigerating machine can be constructed by one type of plate.

[0064] As described above, according to the second embodiment of the present invention, passages in two or four systems are formed inside and outside of heat exchange elements composed of one type of plate. Thus, a complicated plate heat exchanger with high efficiency of heat exchanging performance for exchanging heat between two or four fluids having different temperatures can be manufactured at low cost from a small number of components by a simple manufacturing process.

Industrial Applicability

[0065] The present invention relates to a plate heat exchanger for exchanging heat between two fluids flowing alternately through adjacent fluid passages between piled plates, which is suitable for an evaporator, a low-temperature generator, a condenser, and the like of a refrigerating machine using a low-pressure refrigerant.

Claims

1. A plate heat exchanger characterized in that:

two plates, each having a projection and a depression and provided with opening portions at both ends in a longitudinal direction thereof, are piled as a set on each other at peripheries thereof to form a heat exchange element;
a plurality of said heat exchange elements are piled so that said opening portions are aligned with each other;
a space between said two plates forming said heat exchange element defines a passage for a first fluid;
a space between said heat exchange elements adjacent to each other defines a passage for another fluid (a second fluid) having heat exchange relationship with said first fluid;
said plate serves as a heat transfer surface for both of said fluids; and
the peripheral portions of said heat exchange elements are brought into contact with each other to form a sealed passage for said second fluid when said heat exchange elements are piled on each other.

2. A plate heat exchanger according to claim 1, wherein an inlet and an outlet for said second fluid are provided on a surface of said plate at positions other than said opening portions at said both ends constituting an inlet and an outlet for said first fluid.

3. A plate heat exchanger, wherein two plate heat exchangers according to claim 2 are arranged in parallel in a direction of piling of said heat exchange elements; and

said passages for said second fluid in said two plate heat exchangers communicate with each other so that a vapor is generated from one of

said plate heat exchangers, and condensed or absorbed by the other of said plate heat exchangers.

4. A plate heat exchanger, characterized in that:

a plurality of heat exchange elements are provided, each of said heat exchange elements being composed of two plates opposed to each other as a set, sealed spaces being provided as two systems inside of said two plates, each of said heat exchange elements having two opening portions as an inlet and an outlet for each of said systems; and
different fluids flow through internal spaces in said two systems and through passages outside of said internal spaces, respectively.

5. A plate heat exchanger according to claim 4, wherein said plurality of said heat exchange elements are constructed such that said heat exchange elements adjacent to each other communicate with each other, and have peripheral portions which are brought into contact with each other and sealed therebetween.

6. A plate heat exchanger according to claim 5, wherein said plurality of said heat exchange elements are constructed such that said internal spaces in said two systems are arranged on a right side and a left side, and portions of communication between said plurality of said heat exchange elements are divided into a plurality of segments in a vertical direction.

7. A plate heat exchanger, characterized in that:

a plurality of heat exchange elements are provided, each of said heat exchange elements being composed of two plates opposed to each other as a set, sealed spaces being provided as four systems inside of said two plates, each of said heat exchange elements having two opening portions as an inlet and an outlet for each of said systems;
among said four systems, a set of a first system and a second system and a set of a third system and a fourth system are arranged on a right side and a left side, respectively; and
different fluids flow through internal spaces in said four systems and through passages outside of said internal spaces, respectively.

8. The plate heat exchanger according to claim 7, wherein said plurality of said heat exchange elements are constructed such that said heat exchange elements, adjacent to each other, outside of said set of said first system and said second system and said set of said third system and said fourth system arranged on a right side and a left side communicate with each other, and the peripheral portions of said heat exchange elements adjacent to each other are brought into contact with each other and sealed therebetween.

FIG. 1A

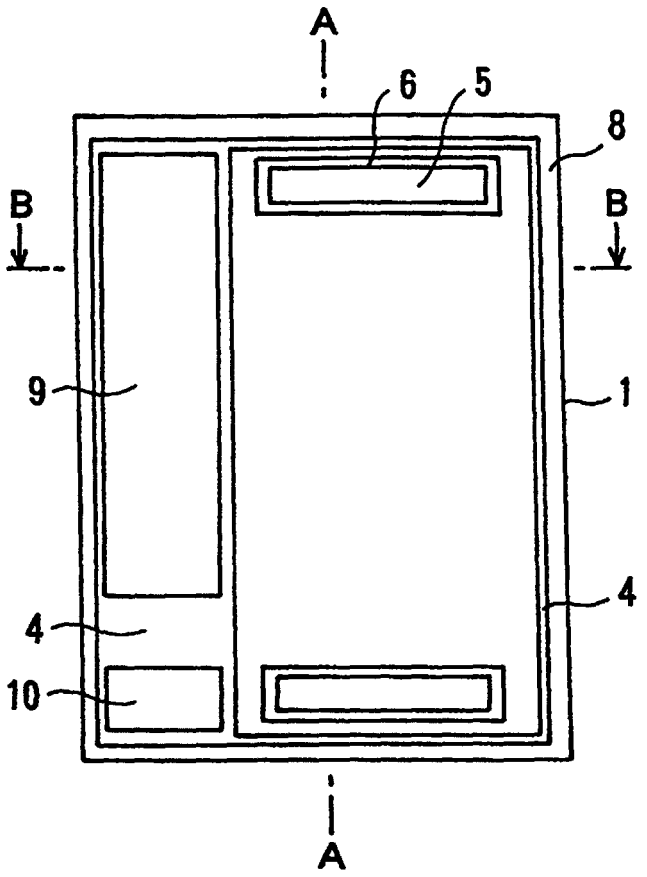


FIG. 1B

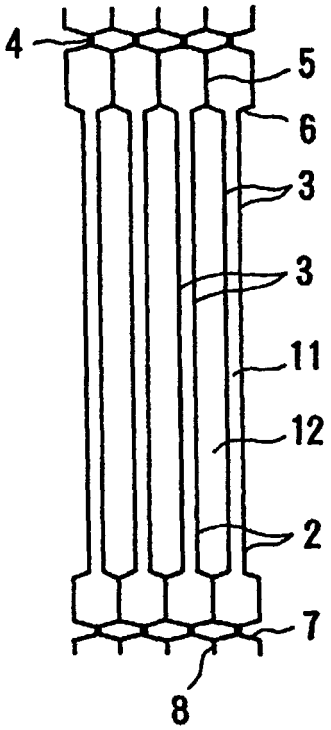


FIG. 1C

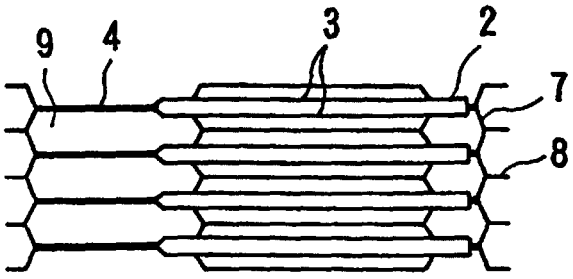


FIG. 2A

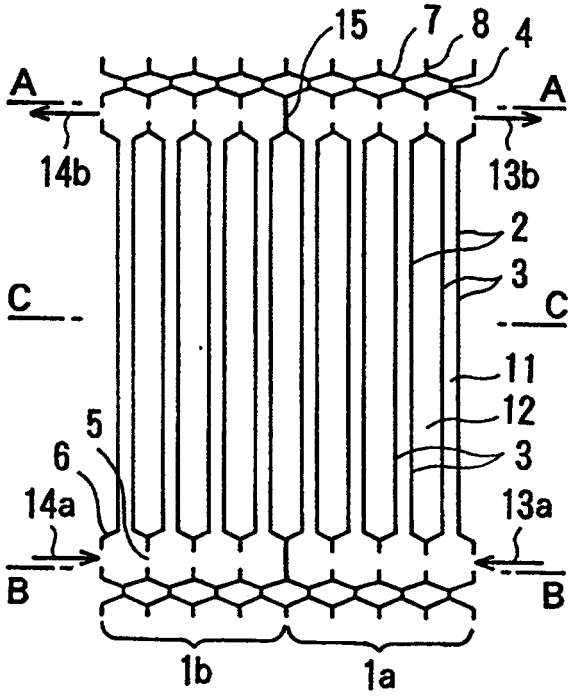


FIG. 2B

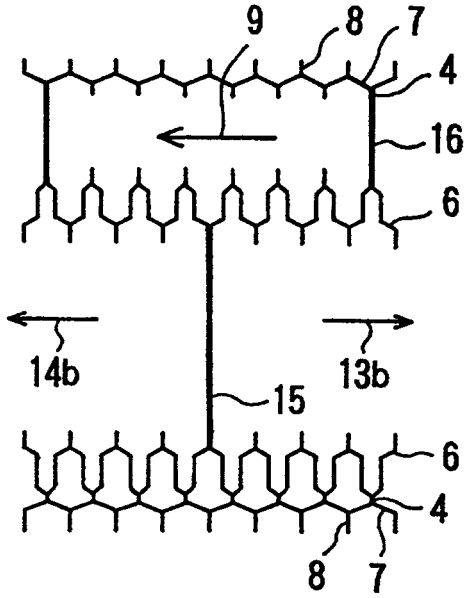


FIG. 2C

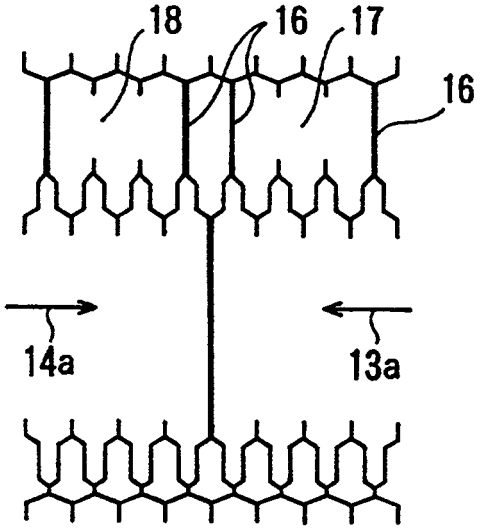


FIG. 2D

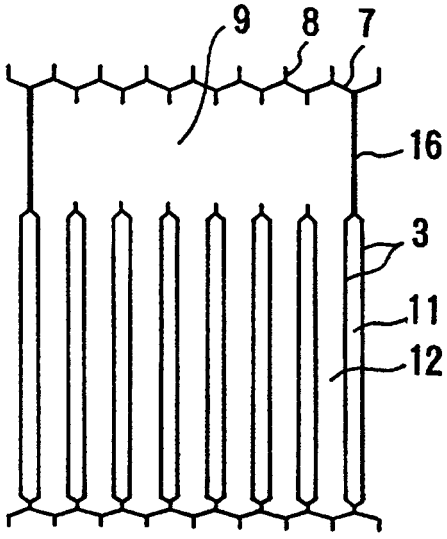


FIG. 3A

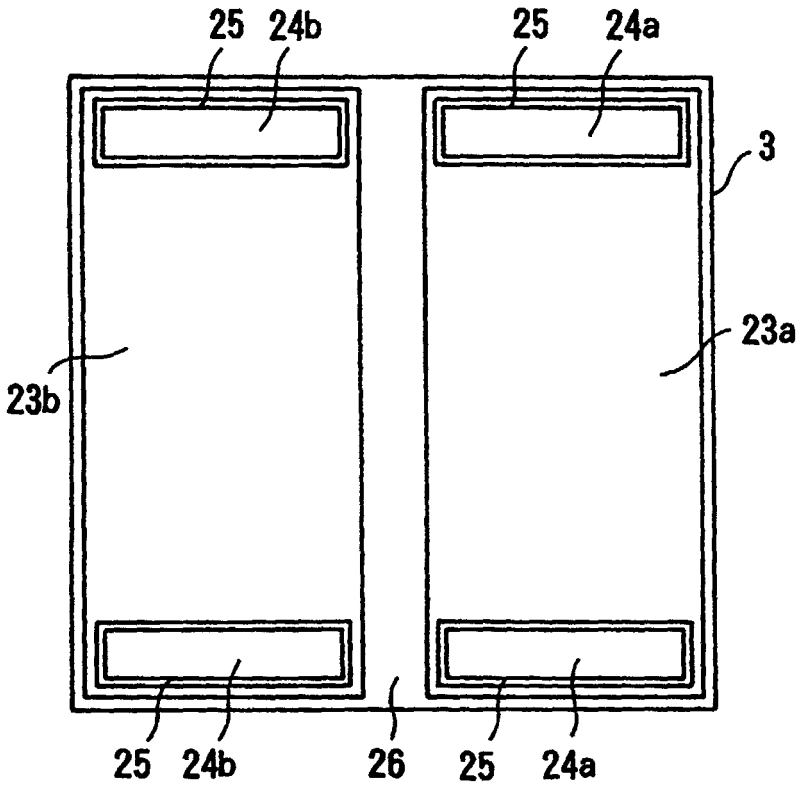


FIG. 3C

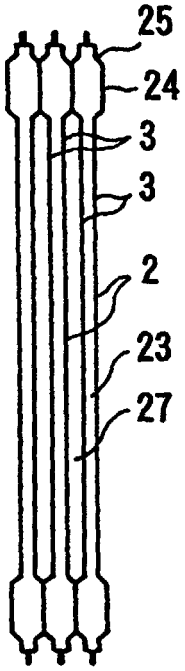


FIG. 3B

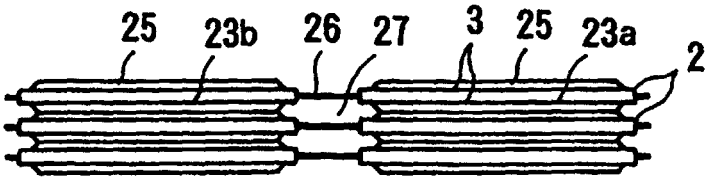


FIG. 4A

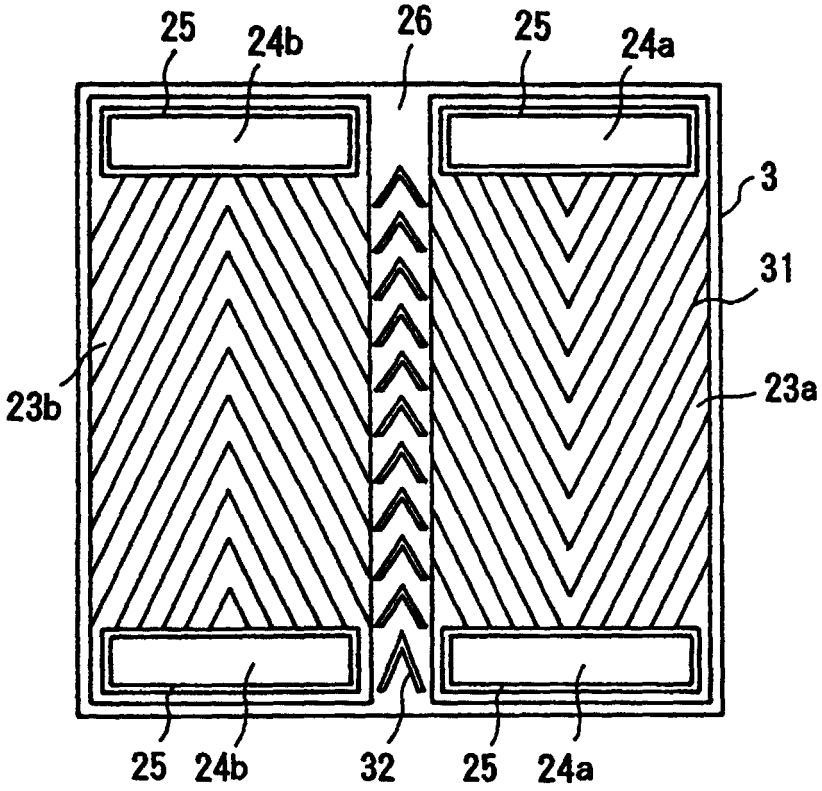


FIG. 4C

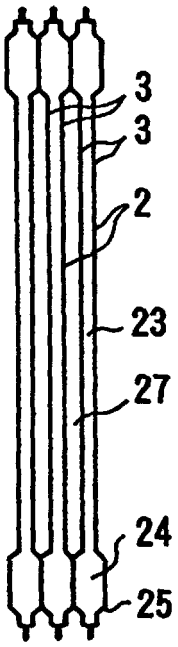


FIG. 4B

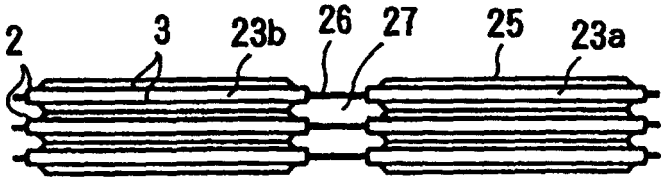


FIG. 5

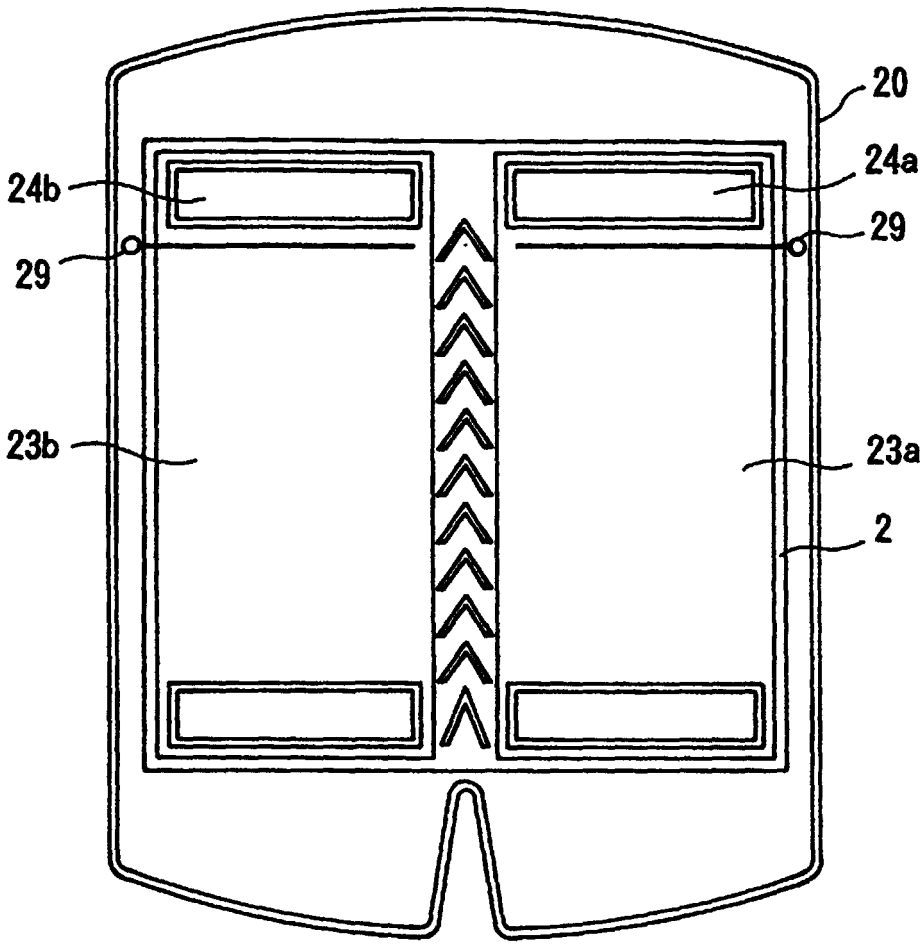


FIG. 6A

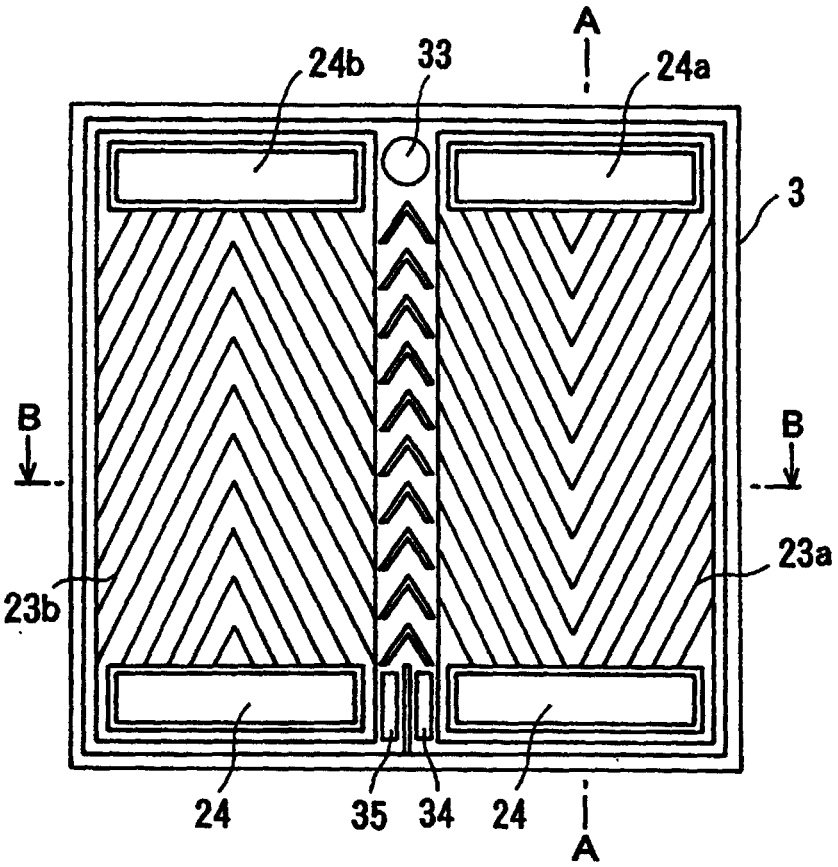


FIG. 6B

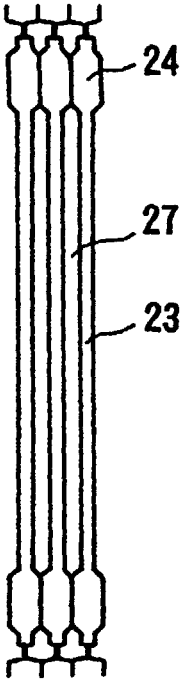


FIG. 6C

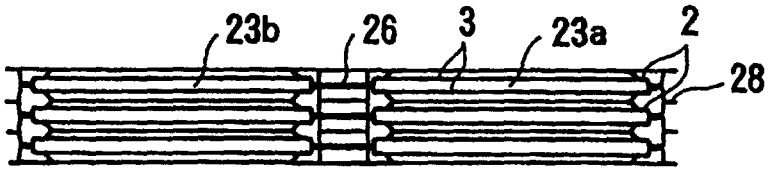


FIG. 7A

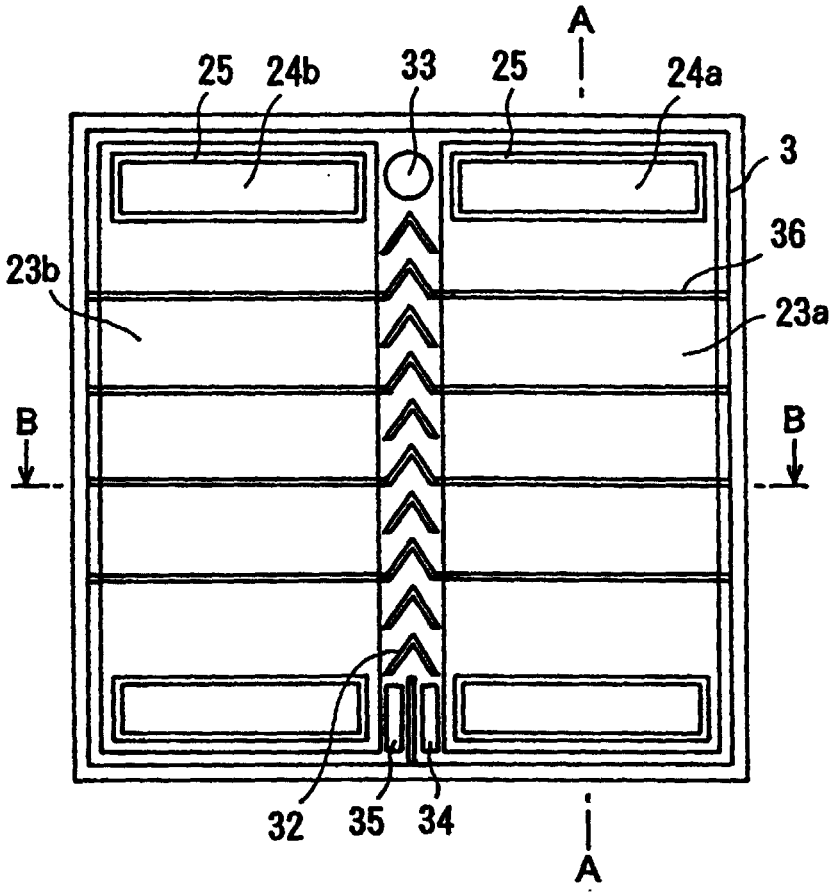


FIG. 7B

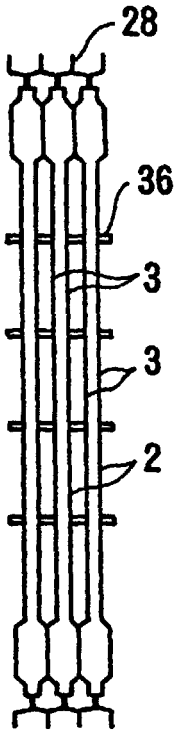


FIG. 7C

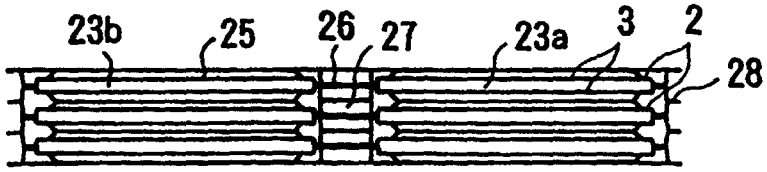


FIG. 8A

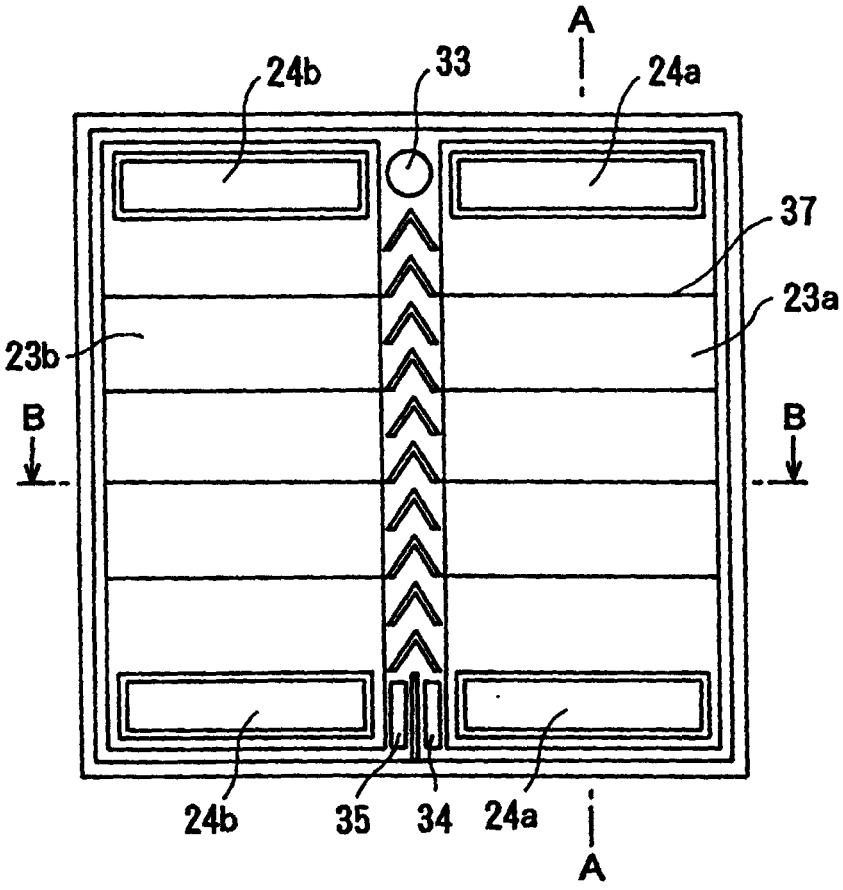


FIG. 8B

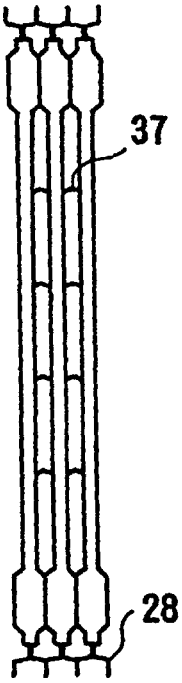


FIG. 8C

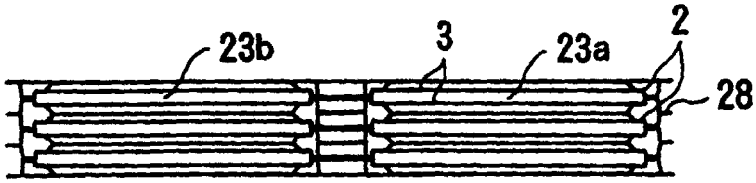


FIG. 9A

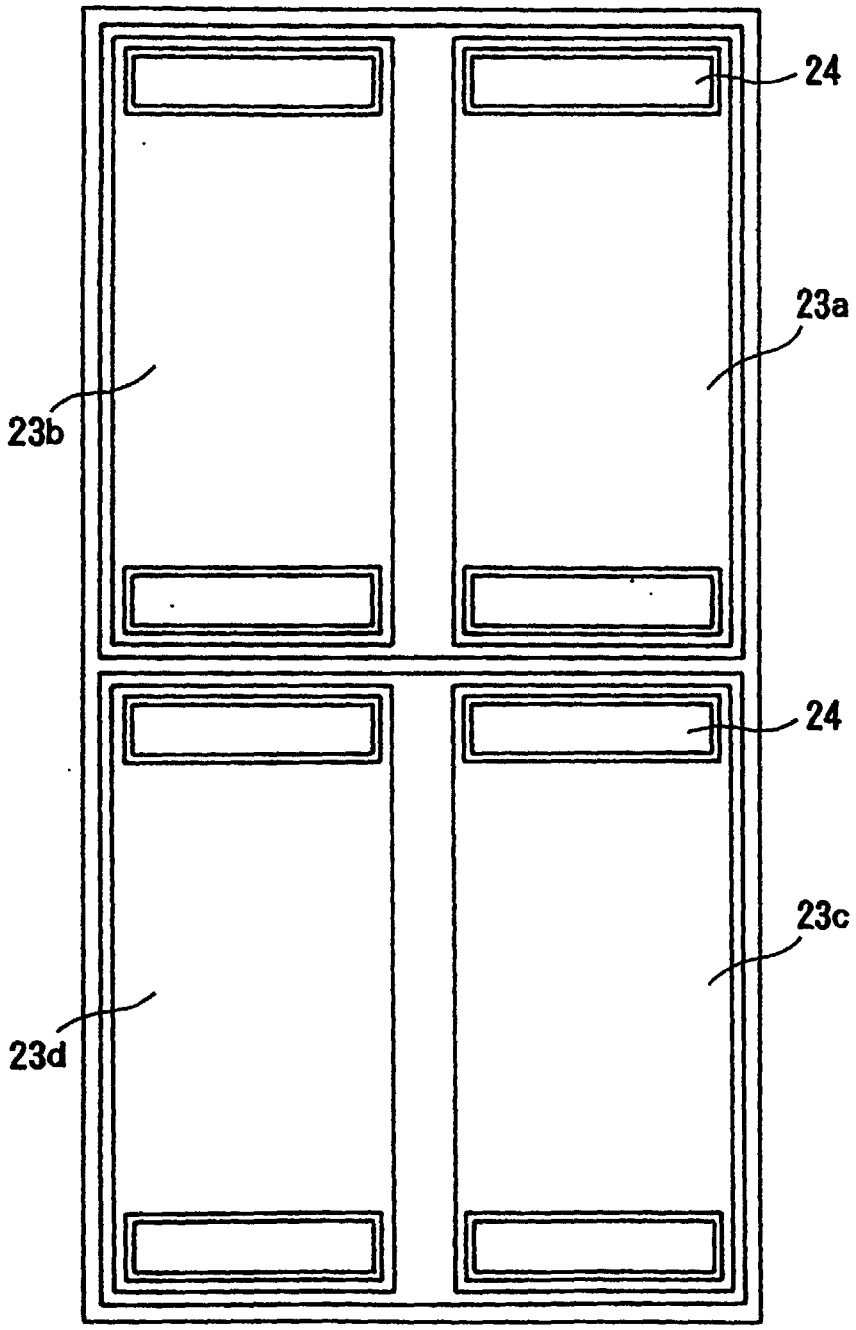


FIG. 9C

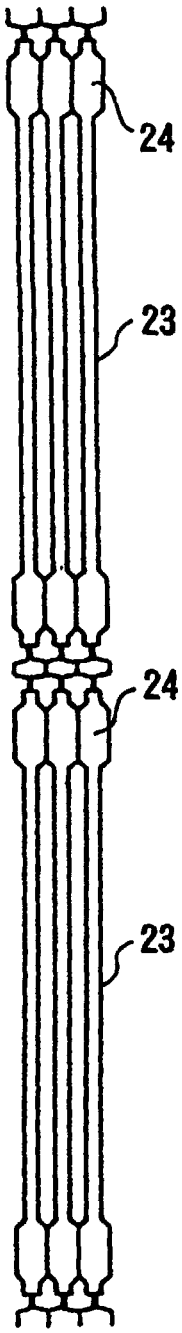


FIG. 9B

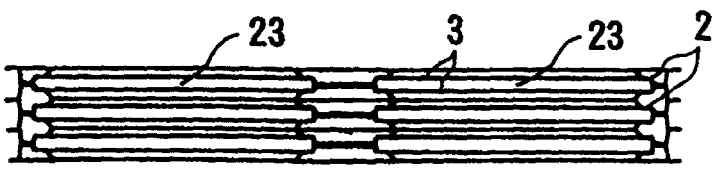


FIG. 10A

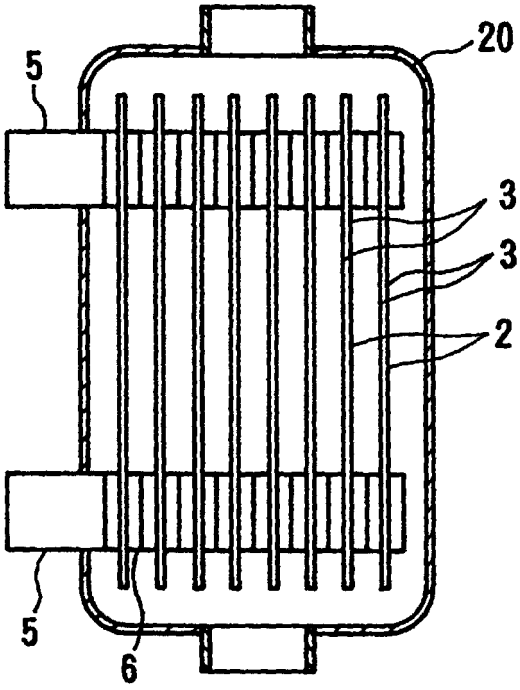


FIG. 10B

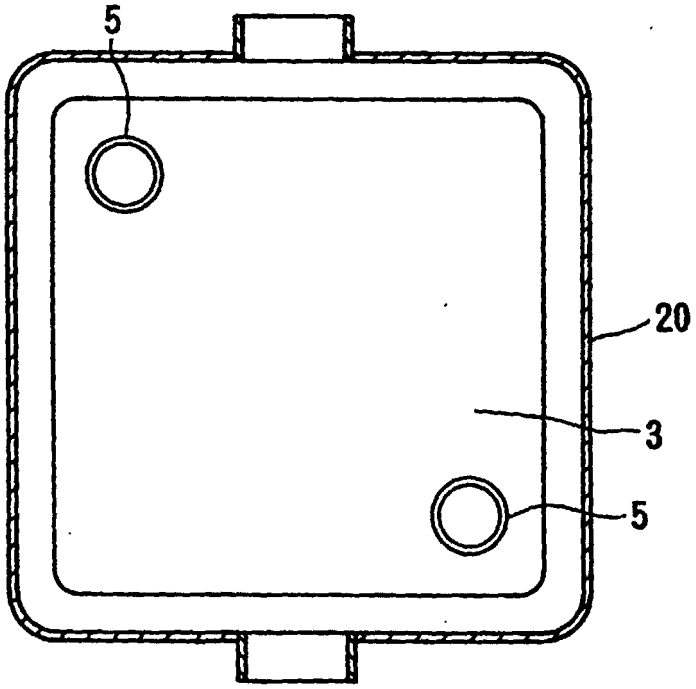


FIG. 11

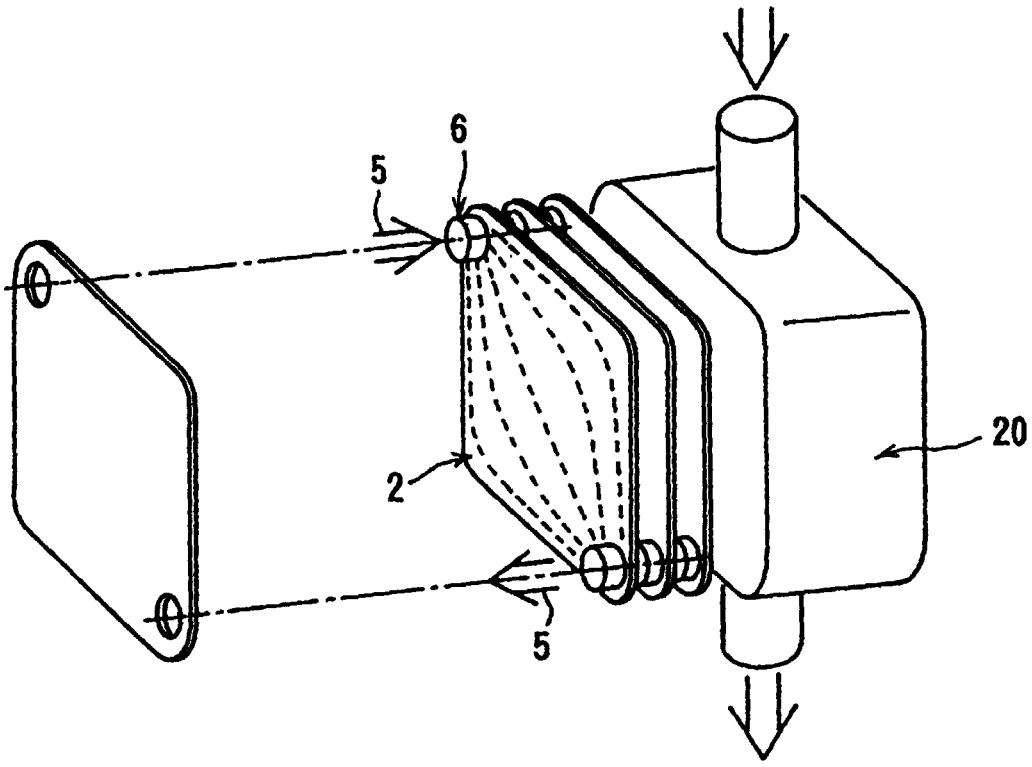
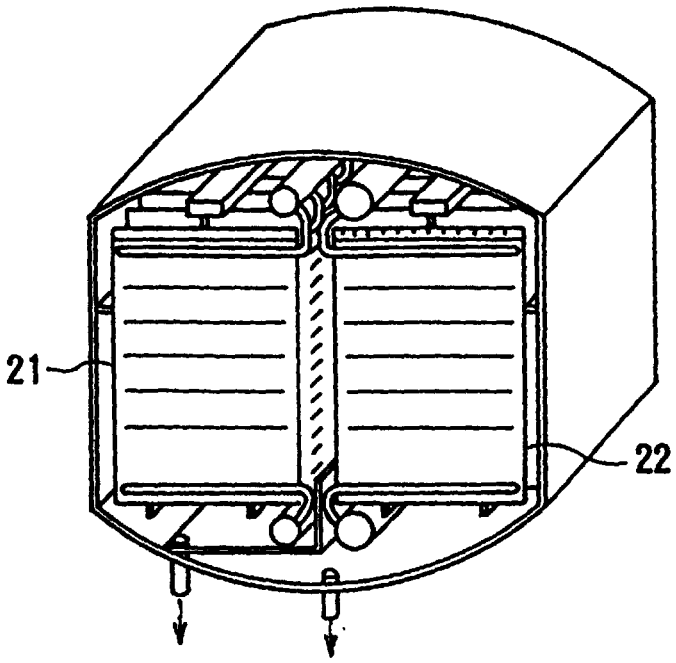


FIG. 12



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/01762

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F28D9/00, 3/00

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)
Int.Cl[7] F28D9/00, 9/02, 3/00, 3/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2000
Kokai Jitsuyo Shinan Koho 1971-2000 Jitsuyo Shinan Toroku Koho 1996-2000

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 61-186794, A (Hisaka Works, Ltd.), 20 August, 1986 (20.08.86), Full text (Family: none)	1-8
A	JP, 64-8063, U (Toyo Radiator K.K.), 17 January, 1989 (17.01.89), Full text	1-8
A	JP, 62-180269, U (Hitachi Zosen Corporation), 16 November, 1987 (16.11.87), Full text	1-8
A	JP, 8-94280, A (ZEXEL CORPORATION), 12 April, 1996 (12.04.96), Full text (Family: none)	1-8
A	JP, 7-280466, A (Nippon Denso Co., Ltd.), 27 October, 1995 (27.10.95), Full text (Family: none)	1-8
A	JP, 9-89484, A (Hisaka Works, Ltd.), 04 April, 1997 (04.04.97),	1-8

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 May, 2000 (12.05.00)	23 May, 2000 (23.05.00)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/01762

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Full text (Family: none)	

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