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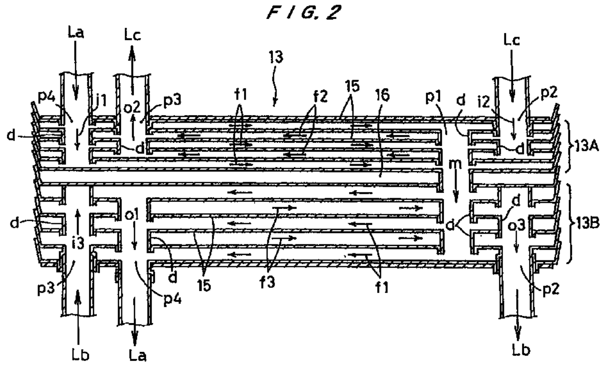
(54) PLATE TYPE HEAT EXCHANGER FOR THREE FLUIDS AND METHOD OF MANUFACTURING THE HEAT EXCHANGER

(57) The present invention relates to a plate heat exchanger for three fluids, which allows a first fluid to exchange heat with a second fluid, and then with a third fluid. A preceding-stage heat exchange section (13A) having interplate first fluid paths (f1) for passing the first fluid (La) between the plates and interplate second fluid paths (f2) for passing the second fluid (Lc) between the plates is formed at one side of the plate laminate in a plate laminating direction, and the interplate first fluid paths (f1) and the interplate second fluid paths (f2) are positioned alternately in the plate laminating direction. A succeeding-stage heat exchange section (13B) having interplate first fluid paths (f1) for passing the first fluid (La) between the plates and interplate third fluid paths (f3) for passing the third fluid (Lb) between the plates is formed at the other side of the plate laminate in a plate laminating direction, and the interplate first fluid paths (f1) and the interplate third fluid paths (f3) are positioned alternately in the plate laminating direction. A first fluid crossover path (m) is provided for allowing the first fluid which has passed through the interplate first fluid paths in the preceding-stage heat exchange section to flow into the interplate first fluid paths in the succeeding-stage heat exchange section.

FIG. 2



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Description

Technical Field

[0001] The present invention relates to a plate beat exchanger for three fluids, and more particularly to a plate heat exchanger for three fluids, which allows a first fluid to exchange heat with a second fluid, and then with a third fluid, and also to a method for producing the heat exchanger.

Background Art

[0002] Conventionally, with this type of heat exchanger, as shown in FIG. 6, a preceding-stage heat exchange section 13A having interplate first fluid paths f1 for passing a first fluid La between the plates 15 and interplate second fluid paths f2 for passing a second fluid Lc between the plates 15 is formed at one side in a plate longitudinal direction of a plate laminate composed of many plates 15 laminated one on another. The interplate first fluid paths f1 and the interplate second fluid paths f2 are positioned alternately in a plate laminating direction. A succeeding-stage heat exchange section 13B having interplate first fluid paths f1 continued from the interplate first fluid paths f1 in the preceding-stage heat exchange section 13A and adapted to pass the first fluid La between the plates 15 and interplate third fluid paths f3 for passing a third fluid Lb between the plates 15 is formed at the other side in the plate longitudinal direction of the plate laminate. The interplate first fluid paths f1 and the interplate third fluid paths f3 are positioned alternately in the plate laminating direction (see Japanese laid-open Patent Publication No. 9-60996).

[0003] Specifically, the heat exchanger has a structure in which the preceding-stage heat exchange section 13A for exchanging heat between the first fluid La and the second fluid Lc, and the succeeding-stage heat exchange section 13B for exchanging heat between the first fluid La and the third fluid Lb are located parallel in the longitudinal direction of the plates 15 and integrated together.

[0004] Such a conventional structure can make the entire heat exchanger considerably compact in comparison with the preceding-stage heat exchange section 13A and the succeeding-stage heat exchange section 13B being composed of separate plate heat exchangers. However, the conventional heat exchanger still has room for improvement in view of the fact that further downsizing of the equipments and further energy saving have been demanded in recent years.

Disclosure of Invention

[0005] The present invention has been made in view of the above drawbacks. It is therefore an object of the present invention mainly to ensure further compactness and achieve a further decrease in a heat loss, by adopting a rational structure in integrating the preceding-stage heat exchange section and the succeeding-stage heat exchange section.

(1) According to the present invention defined in claim 1, there is provided a plate heat exchanger for three fluids, which allows a first fluid to exchange heat with a second fluid, and then with a third fluid, characterized in that:

in a plate laminate comprising many plates laminated one on another,
a preceding-stage heat exchange section having interplate first fluid paths for passing the first fluid between the plates and interplate second fluid paths for passing the second fluid between the plates is formed at one side of the plate laminate in a plate laminating direction, the interplate first fluid paths and the interplate second fluid paths being positioned alternately in the plate laminating direction;
a succeeding-stage heat exchange section having interplate first fluid paths for passing the first fluid between the plates and interplate third fluid paths for passing the third fluid between the plates is formed at the other side of the plate laminate in a plate laminating direction, the interplate first fluid paths and the interplate third fluid paths being positioned alternately in the plate laminating direction; and
a first fluid crossover path is provided for allowing the first fluid which has passed as parallel streams through a plurality of the interplate first fluid paths in the preceding-stage heat exchange section to flow as parallel streams into a plurality of the interplate first fluid paths in the succeeding-stage heat exchange section.

With the above arrangement, the preceding-stage heat exchange section for exchanging heat between the first fluid and the second fluid, and the succeeding-stage heat exchange section for subsequently exchanging heat between the first fluid and the third fluid are arranged parallel in the plate laminating direction and integrated together. Thus, compared with the above-mentioned conventional structure having the preceding-stage heat exchange section and the succeeding-stage heat exchange section arranged parallel in the plate longitudinal direction and integrated together, this arrangement of the present invention offers the following advantages: The plate laminate of the heat exchanger can be integrated more three-dimensionally in such a state that the length (and also the occupied area) of the laminated plates can be halved. As a result, the entire heat exchanger can be made more compact, and easier to be installed and handled. Further, it is easy to deal with thermal shrinkage and thermal strain and to produce the heat exchanger itself by the halved length (and halved area) of the plates.

Furthermore, the three-dimensional integration can decrease the external surface area of the plate laminate, thus reducing a heat loss due to heat radiation from the external surface. Consequently, a heat exchanger with greater energy saving can be achieved.

(2) According to the present invention defined in claim 2, plates located at a boundary between the preceding-stage heat exchange section and the succeeding-stage heat exchange section among the laminated plates form a heat insulating layer in which no fluid flows.

With the above arrangement, the heat insulating layer can prevent heat from transferring between the preceding-stage heat exchange section and the succeeding-stage heat exchange section having different temperature levels from each other, thus suppressing heat loss due to heat transfer between the two heat exchange sections (in short, a heat loss due to heat exchange between the second fluid and the third fluid that is not expected). Hence, heat exchange with the first fluid in a heat exchanger becomes better, and more advantageous heat exchanger in energy saving can be achieved.

Furthermore, the heat insulating layer is formed at the boundary between the preceding-stage heat exchange section and the succeeding-stage heat exchange section in such a state that the plate laminated structure in which many plates are laminated together is employed. Hence, it is easy to form the heat insulating layer itself and to produce the heat exchanger efficiently.

(3) According to the present invention defined in claim 3, each of the portions between three or more of the adjacent plates located at the boundary between the preceding-stage heat exchange section and the succeeding-stage heat exchange section among the laminated plates forms the heat insulating layer in which no fluid flows.

With the above arrangement, in the present invention defined in claim 2, each of the portions between three or more of the adjacent plates forms the heat insulating layer. Thus, the heat insulating effect can be increased, and a heat loss due to heat transfer between the preceding-stage heat exchange section and the succeeding-stage heat exchange section can be suppressed more effectively in such a state that its entire thickness of the multi-layered heat insulating layer is large.

Further, with the above arrangement, even when the plates with a corrugated cross-section are laminated together in such a state that the ridges of the corrugations of the plates are contacted with those of the facing plates (namely, when heat transfer is expected via bonding portions between the ridges of the corrugations), the multi-layered heat insulating layer produces an increased heat insulating effect, and a heat loss due to heat transfer between the preceding-stage heat exchange section and the succeeding-stage heat exchange section can be suppressed more effectively.

(4) According to the present invention defined in claim 4, the plates located at the boundary between the preceding-stage heat exchange section and the succeeding-stage heat exchange section among the laminated plates form an airtight space under vacuum, and the heat insulating layer serves as a vacuum heat insulating layer.

With the above arrangement, in the present invention defined in claim 2 or 3, the heat insulating layer formed between the plates serves as a vacuum heat insulating layer. Thus, a high heat insulating effect based on a vacuum space can more effectively suppress a heat loss due to heat transfer between the preceding-stage heat exchange section and the succeeding-stage heat exchange section.

Further, with the above arrangement, since the heat exchanger needs no heat insulating material and the heat insulating layer is formed by utilizing the plate laminated structure, it is easier to form the heat insulating layer.

(5) According to the present invention defined in claim 5, the first fluid crossover path extends to a plurality of the interplate first fluid paths in the preceding-stage heat exchange section and a plurality of the interplate first fluid paths in the succeeding-stage heat exchange section in such a state that the first fluid crossover path pierces through the plates in the plate laminating direction inside the plate laminate.

Compared with a structure in which the first fluid crossover path for transferring the first fluid from the interplate first fluid paths of the preceding-stage heat exchange section to the interplate first fluid paths of the succeeding-stage heat exchange section is formed outside the plate laminate and connected to an external pipe, the above arrangement of the present invention enables the structure around the plate laminate to be simplified and hence the entire heat exchanger can be made more compact.

In addition to the above arrangement, each of inlet paths and outlet paths for the fluids (i.e., a first fluid inlet path for allowing the first fluid to flow as parallel streams into a plurality of the interplate first fluid paths in the preceding-stage heat exchange section, a second fluid inlet path for allowing the second fluid to flow as parallel streams into a plurality of the interplate second fluid paths in the preceding-stage heat exchange section, a second fluid outlet path for gathering and discharging the second fluid having passed through a plurality of the interplate second fluid paths in the preceding-stage heat exchange section, a third fluid inlet path for allowing the third fluid to flow as parallel streams into a plurality of the interplate third fluid paths in the succeeding-stage heat exchange section, a third fluid outlet path for gathering and discharging the third fluid having passed through a plurality of the interplate third fluid paths in the succeeding-stage heat exchange section, and a first fluid outlet path for gathering and discharging the first fluid having passed through a plurality of the interplate first fluid paths in the succeeding-stage heat exchange section) may extend to the corresponding interplate fluid paths while piercing through the plates in the plate laminating direction inside the plate laminate. This arrangement enables the structure around the plate laminate to be further simplified and hence the entire heat exchanger can be made more compact.

(6) According to the present invention defined in claim 6, there is provided a method for producing the plate heat exchanger for three fluids according to claim 4, wherein:

the respective interplate fluid paths are formed under vacuum, and simultaneously the plates located at the boundary between the preceding-stage heat exchange section and the succeeding-stage heat exchange section form the airtight space under vacuum as the vacuum heat insulating layer, by brazing the adjacent plates of many laminated plates.

With the above method, the adjacent plates are bonded, and the vacuum heat insulating layer is simultaneously formed, by so-called vacuum brazing. Thus, compared with an alternative method, for example, by which an airtight space is formed by other bonding method between the plates located at the boundary between the preceding-stage heat exchange section and the succeeding-stage heat exchange section, and then air is bled from the airtight space to form a vacuum heat insulating layer, it is very easy to form the heat insulating layer itself and to produce heat exchanger efficiently by the above method.

Brief Description of Drawings

[0006]

FIG. 1 is a schematic diagram showing a structure of an absorption refrigerating machine;

FIG. 2 is a vertical cross-sectional view showing a heat exchanger;

FIG. 3 is a sectional side elevation showing a part of the heat exchanger;

FIG. 4 is a perspective view schematically showing the heat exchanger;

FIG. 5 is a vertical cross-sectional view showing a heat exchanger of another embodiment; and

FIG. 6 is a schematic view showing a structure of a conventional heat exchanger.

Best Mode for Carrying Out the Invention

[0007] FIG. 1 shows a schematic structure of an absorption refrigerating machine, in which the reference numeral 1 denotes a high temperature regenerator, 2 a low temperature regenerator, 3 a condenser, 4 an evaporator, and 5 an absorber. In the high temperature regenerator 1, a low concentration absorption solution La (e.g., an aqueous solution of lithium bromide) which has absorbed a refrigerant R (e.g., water) is heated by a high temperature heater 6 to evaporate and separate the refrigerant R from the low concentration absorption solution La.

[0008] An intermediate concentration absorption solution Lb from which the refrigerant R has been separated in the high temperature regenerator 1 is sent to the low temperature regenerator 2 via a passage r1. A refrigerant vapor R' generated in the high temperature regenerator 1 is sent as a heat source to a low temperature heater 7 in the low temperature regenerator 2 via a passage r2. Thus, in the low temperature regenerator 2, the intermediate concentration absorption solution Lb is heated by the refrigerant vapor R' as a heat source which has been generated in the high temperature regenerator 1, for thereby further evaporating and separating the refrigerant R from the intermediate concentration absorption solution Lb.

[0009] The refrigerant vapor R' generated in the low temperature regenerator 2 and the refrigerant vapor R' which has been used as a heat source in the low temperature heater 7 are cooled by a cooler 8 in the condenser 3 to be condensed. The condensed refrigerant R (i.e., a liquid refrigerant) is sent to the evaporator 4 via a passage r3.

[0010] In the evaporator 4, the condensed refrigerant R sent from the condenser 3 is sprayed onto an interior heat exchanger 11 by a sprayer 10, while the refrigerant R is being circulated by a refrigerant pump 9A, for thereby cooling a fluid C to be cooled (e.g., water or brine) flowing in the interior heat exchanger 11 by evaporating the refrigerant R and utilizing the heat of vaporization thereof.

[0011] On the other hand, a high concentration absorption solution Lc from which the refrigerant R has been separated in the low temperature regenerator 2 is sent to the absorber 5 via a passage r4. In the absorber 5, the high concentration absorption solution Lc sent from the low temperature regenerator 2 is sprayed by a sprayer 12, and hence absorbs the refrigerant vapor R' generated in the evaporator 4, forming a low pressure atmosphere for evaporating the sprayed refrigerant R at a low temperature in the evaporator 4.

[0012] The low concentration absorption solution La which has absorbed the refrigerant vapor R' in the absorber 5 is returned to the high temperature regenerator 1 via a passage r5 by a solution pump 9B, and the step of separating the refrigerant R from the low concentration absorption solution La is conducted again.

[0013] The reference numeral 13 denotes a heat recovery type heat exchanger for allowing the low concentration absorption solution La having a low temperature which is to be returned to the high temperature regenerator 1 to exchange heat with the high concentration absorption solution Lc having an intermediate temperature which is to be sent from the low temperature regenerator 2 to the absorber 5, and then to exchange heat with the intermediate concentration absorption solution Lb having a high temperature which is to be sent from the high temperature regenerator 1 to the low temperature regenerator 2, for thereby recovering the heat that the high concentration absorption solution Lc and the intermediate concentration absorption solution Lb hold. In FIG. 1, the heat recovery type heat exchanger 13 is shown only schematically to describe the order of heat exchange of the low concentration absorption solution La with the high concentration absorption solution Lc and the intermediate concentration absorption solution Lb, and does not correspond with its concrete structure to be described later on.

[0014] The reference numeral 14 denotes a cooler for removing the heat of absorption generated at the time when the sprayed absorption solution Lc in the absorber 5 absorbs the refrigerant. A cooling fluid W (e.g., cooling water circulated into a cooling tower) is supplied to the cooler 14 in the absorber 5 and the cooler 8 in the condenser 3.

[0015] The heat recovery type heat exchanger 13 for exchanging heat among three fluids, i.e., the low concentration absorption solution La, the high concentration absorption solution Lc, and the intermediate concentration absorption solution Lb (hereinafter respectively referred to as a first fluid, a second fluid, and a third fluid), is constructed in the following manner: As shown in FIGS. 2 through 4, a plate 15 has a corrugated cross-sectional shape, except its portions near both ends thereof, and has holes p1 to p4 for inlet and outlet path at corners thereof. As shown in FIG. 3, a plurality of the plates 15 are laminated in such a state that the ridges of the corrugations of the plates 15 are contacted with those of the facing plates. As shown in FIG. 4, a preceding-stage heat exchange section 13A for exchanging heat between the first fluid La and the second fluid Lc is formed at one side of the plate laminate in a plate laminating direction. A succeeding-stage heat exchange section 13B for exchanging heat between the first fluid La which has exchanged heat with the second fluid Lc in the preceding-stage heat exchange section 13A and the third fluid Lb is formed at the other side of the plate laminate in the plate laminating direction.

[0016] In the preceding-stage heat exchange section 13A, with the above-mentioned plate laminate structure, interplate first fluid paths f1 for passing the first fluid La between the adjacent plates 15 and interplate second fluid paths f2 for passing the second fluid Lc between the adjacent plates 15 are positioned alternately in the plate laminating direction. While these fluids are passing through these interplate fluid paths f1 and f2, heat is exchanged between the first fluid La and the second fluid Lc via the plates 15 serving as heat transfer walls.

[0017] Similarly, in the succeeding-stage heat exchange section 13B, with the plate laminated structure, interplate first fluid paths f1 for passing the first fluid La between the adjacent plates 15 and interplate third fluid paths f3 for passing the third fluid Lb between the adjacent plates 15 are positioned alternately in the plate laminating direction. While these fluids are passing through these interplate fluid paths f1 and f3, heat is exchanged between the first fluid La and the third fluid Lb via the plates 15 serving as heat transfer walls.

[0018] Since, as shown in FIG. 3, the ridges of the corrugations of the plates are contacted with those of the facing plates in the plate laminated structure, the interplate fluid paths f1 to f3 are finely divided into many segments in the plate width direction perpendicular to the fluid flowing direction. Thus, a larger area of heat transfer can be ensured, and high strength can be obtained.

[0019] Since portions of each plate 15 near both ends thereof are in the form of a flat plate without corrugations, headers for the passages finely divided in the plate width direction are formed at both end portions of the interplate fluid paths f1 to f3. On the other hand, the holes p1 among the holes p1 to p4 for inlet and outlet path formed at the four corners of the respective plates 15 constitute a first fluid crossover path m which extends between the headers beside one end of the interplate first fluid paths f1 in the preceding-stage heat exchange section 13A and the headers beside one end of the interplate first fluid paths f1 in the succeeding-stage heat exchange section 13B inside the plate laminate. In a portion of the first fluid crossover path m which pierces through the interplate second fluid paths f2 and the interplate third fluid paths f3, the neck d of the hole p1 of the plate 15 extends to the corresponding hole p1 of the next plate 15 in the lamination of the plates 15, and hence each of communications is blocked between the first fluid crossover path m and the interplate second fluid paths f2, and between the first fluid crossover path m and the interplate third fluid paths f3.

[0020] In order to show the first fluid crossover path m, and inlet and outlet paths i1, o1, i2, o2, i3 and o3 to be described later on, FIG. 2 represents a vertical cross-sectional view of the heat exchanger 13 with overlaps of these flow paths being developed.

[0021] Among the four holes p1 to p4 for inlet and outlet path, the hole p4 located at a diagonal position to the hole p1 forming the first fluid crossover path m constitutes a first fluid inlet path i1 which extends between the headers beside the other end of the interplate first fluid paths f1 in the preceding-stage heat exchange section 13A inside the plate laminate. The hole p4 further constitutes a first fluid outlet path o1 which extends between the headers beside the other end of the interplate first fluid paths f1 in the succeeding-stage heat exchange section 13B inside the plate laminate. In a portion of the first fluid inlet path i1 which pierces through the interplate second fluid paths f2, and in a portion of the first fluid outlet path O1 which pierces through the interplate third fluid paths f3, the neck d of the hole p4 extends to the corresponding hole p4 of the next plate 15 in the lamination of the plates 15, and hence each of communications is blocked between the first fluid inlet path i1 and the interplate second fluid paths f2, and between the first fluid outlet path o1 and the interplate third fluid paths f3.

[0022] Among the four holes p1 to p4 for inlet and outlet path, the hole p2 located adjacent, in the plate width direction, to the hole p1 forming the first fluid crossover path m constitutes a second fluid inlet path i2 which extends between the headers beside the one end of the interplate second fluid paths f2 in the preceding-stage heat exchange section 13A inside the plate laminate. The hole p2 further constitutes a third fluid outlet path o3 which extends between headers beside the one end of the interplate third fluid paths f3 in the succeeding-stage heat exchange section 13B inside the plate laminate. In a portion of the second fluid inlet path i2 which pierces through the interplate first fluid paths f1, and in a portion of the third fluid outlet path o3 which pierces through the interplate first fluid paths f1, the neck d of the hole p2 extends to the corresponding hole p2 of the next plate 15 in the lamination of the plates 15, and hence each of communications is blocked between the second fluid inlet path i2 and the interplate first fluid paths f1, and between the third fluid outlet path o3 and the interplate first fluid paths f1.

[0023] Among the four holes p1 to p4 for inlet and outlet path, the remaining hole p3 constitutes a second fluid outlet path o2 which extends between the headers beside the other end of the interplate second fluid paths f2 in the preceding-stage heat exchange section 13A inside the plate laminate, and constitutes a third fluid inlet path i3 which extends between the headers beside the other end of the interplate third fluid paths f3 in the succeeding-stage heat exchange section 13B inside the plate laminate. In a portion of the second fluid outlet path o2 which pierces through the interplate first fluid paths f1, and in a portion of the third fluid inlet path i3 which pierces through the interplate first fluid paths f1, the neck d of the hole p3 of the plate 15 extends to the corresponding hole p3 of the next plate 15 in the lamination of the plates 15, as in the case of the other inlet and outlet paths, and hence each of communications is blocked between the second fluid outlet path o2 and the interplate first fluid paths f1, and between the third fluid inlet path i3 and the interplate first fluid paths f1.

[0024] Specifically, with the above structure, the first fluid La flows as parallel streams from the first fluid inlet path i1 into a plurality of the interplate first fluid paths f1 in the preceding-stage heat exchange section 13A. Subsequently, the first fluid La having passed as parallel streams through a plurality of the interplate first fluid paths f1 in the preceding-stage heat exchange section 13A is gathered at the first fluid crossover path m, and then flows as parallel streams into a plurality of the interplate first fluid paths f1 in the succeeding-stage heat exchange section 13B. Then, the first fluid La having passed as parallel streams through a plurality of the interplate first fluid paths f1 in the succeeding-stage heat exchange section 13B is discharged in a gathered state from the first fluid outlet path o1.

[0025] In contrast with this flow of the first fluid La, the second fluid Lc flows from the second fluid inlet path i2 into a plurality of the interplate second fluid paths f2 as parallel streams in the preceding-stage heat exchange section 13A. The second fluid Lc having passed through a plurality of the interplate second fluid paths f2 as parallel streams is discharged in a gathered state from the second fluid outlet path o2, and hence the first fluid La (low concentration absorption solution) exchanges heat with the second fluid Lc (high concentration absorption solution) as countercurrent flows at a plurality of the paths in the preceding-stage heat exchange section 13A.

[0026] In the succeeding-stage heat exchange section 13B, the third fluid Lb flows from the third fluid inlet path i3 into a plurality of the interplate third fluid paths f3 as parallel streams. The third fluid Lb having passed through a plurality of the interplate third fluid paths f3 as parallel streams is discharged in a gathered state from the third fluid outlet path o3, and hence the first fluid La (low concentration absorption solution) which has exchanged heat with the second fluid Lc (high concentration absorption solution) in the preceding-stage heat exchange section 13A exchanges heat with the third fluid Lb (intermediate concentration absorption solution) as countercurrent flows at a plurality of the paths in the succeeding-stage heat exchange section 13B.

[0027] The holes p1 constituting the first fluid crossover path m are blocked by the plates 15 located at both ends in the plate laminating direction of the plate laminate.

[0028] The plate laminate described above has a structure in which the preceding-stage heat exchange section 13A and the succeeding-stage heat exchange section 13B are arranged parallel in the plate laminating direction, and integrated. On the other hand, the two adjacent plates 15 located at the boundary between the preceding-stage heat exchange section 13A and the succeeding-stage heat exchange section 13B block the holes p2 to p4 except the holes p1 constituting the first fluid crossover path m. The neck d of one of the holes p1 constituting the first fluid crossover path m in these two adjacent plates 15 extends to the other corresponding hole p1. The two adjacent plates 15 located at the boundary form an airtight space under vacuum state. Thus, this interplate airtight space under vacuum serves as a vacuum heat insulating layer 16, for thereby preventing a heat loss due to heat transfer between the preceding-stage heat exchange section 13A and the succeeding-stage heat exchange section 13B.

[0029] To produce the heat exchanger 13 of the above structure, the plates 15 are laminated in such a state that a brazing material is put between bonding-required portions, such as the portions between folded-back peripheral edges of the adjacent plates 15, the portions between the neck d of each of the holes p1 to p4 and each of the corresponding holes p1 to p4 to which the neck d extends, and the like. These laminated plates are set into a vacuum furnace and heated under vacuum in the vacuum furnace, and hence the bonding-required portions are brazed. Further, this brazing under vacuum results in the bonding of the plates 15 and the formation of the above-mentioned airtight space under vacuum as the vacuum heat insulating layer 16 between the adjacent plates 15 located at the boundary between the preceding-stage heat exchange section 13A and the succeeding-stage heat exchange section 13B, at the same time.

[Another Embodiment]

[0030] Another embodiment will be described below.

[0031] The above embodiment shows an example in which the portion between the two adjacent plates 15 located at the boundary between the preceding-stage heat exchange section 13A and the succeeding-stage heat exchange section 13B serves as the vacuum heat insulating layer 16. However, as shown in FIG. 5, each of the portions between three or more of the adjacent plates 15 located at the boundary between the preceding-stage heat exchange section 13A and the succeeding-stage heat exchange section 13B may form the vacuum heat insulating layer 16.

[0032] In the above-mentioned embodiment, vacuum brazing was used for bonding the plates 15 and forming the vacuum heat insulating layer 16 at the same time. However, with respect to the present invention according to claim 4, as the case may be, an airtight space may be formed between the plates 15 located at the boundary between the two heat exchange sections 13A and 13B by bonding the plates 15, and then a vacuum heat insulating layer 16 may be formed by bleeding air from this airtight space.

[0033] The higher effect of insulating heat can be obtained, as the degree of vacuum in the vacuum heat insulating layer 16 is higher. However, the proper degree of vacuum in the vacuum heat insulating layer 16 may be concretely determined depending on various conditions. A high degree of vacuum is not always necessary for the vacuum heat insulating layer 16.

[0034] Further, with respect to the present invention according to claim 2, a heat insulating material or a gas (e.g., a non-corrosive gas) may be filled between the plates 15 located at the boundary between the preceding-stage heat exchange section 13A and the succeeding-stage heat exchange section 13B to form a heat insulating layer between the plates 15, instead of providing the vacuum heat insulating layer 16.

[0035] The number of the interplate fluid paths f1, f2 arranged parallel in the preceding-stage heat exchange section 13A, and the number of the interplate fluid paths f1, f3 arranged parallel in the succeeding-stage heat exchange section 13B may be determined by the required amount of heat exchange, respectively, and is not restricted to the number of them that was shown in the above embodiment.

[0036] In order to implement the present invention according to claim 6, various method can be applied as concrete methods for brazing the plates 15 in a vacuum atmosphere. The degree of vacuum and a rarefied gas during brazing may also be determined depending on various conditions.

[0037] The plate heat exchanger for three fluids according to the present invention can be applied not only to exchange heat between absorption solutions in an absorption refrigerating machine, but also to exchange heat between various fluids.

Industrial Applicability

[0038] The present invention relates to a plate heat exchanger for three fluids, which flows two fluids alternately between plates in a laminate of plates, whereby a first fluid exchanges heat with a second fluid, and then the first fluid further exchanges heat with a third fluid. The present invention can be used for a refrigerator such as an absorption refrigerating machine.

Claims

1. A plate heat exchanger for three fluids, which allows a first fluid to exchange heat with a second fluid, and then with a third fluid, characterized in that:

in a plate laminate comprising many plates laminated one on another,

a preceding-stage heat exchange section having interplate first fluid paths for passing the first fluid between the plates and interplate second fluid paths for passing the second fluid between the plates is formed at one side of the plate laminate in a plate laminating direction, said interplate first fluid paths and said interplate second fluid paths being positioned alternately in the plate laminating direction;

a succeeding-stage heat exchange section having interplate first fluid paths for passing the first fluid between the plates and interplate third fluid paths for passing the third fluid between the plates is formed at the other side of the plate laminate in a plate laminating direction, said interplate first fluid paths and said interplate third fluid paths being positioned alternately in the plate laminating direction; and

a first fluid crossover path is provided for allowing the first fluid which has passed as parallel streams through a plurality of said interplate first fluid paths in said preceding-stage heat exchange section to flow as parallel streams into a plurality of said interplate first fluid paths in said succeeding-stage heat exchange section.

2. A plate heat exchanger for three fluids according to claim 1, wherein:

plates located at a boundary between said preceding-stage heat exchange section and said succeeding-stage heat exchange section among the laminated plates form a heat insulating layer in which no fluid flows.

3. A plate heat exchanger for three fluids according to claim 2, wherein:

each of the portions between three or more of the adjacent plates located at the boundary between said preceding-stage heat exchange section and said succeeding-stage heat exchange section among the laminated plates forms the heat insulating layer in which no fluid flows.

4. A plate heat exchanger for three fluids according to claim 2 or 3, wherein:

the plates located at the boundary between said preceding-stage heat exchange section and said succeeding-stage heat exchange section among the laminated plates form an airtight space under vacuum, and said heat insulating layer serves as a vacuum heat insulating layer.

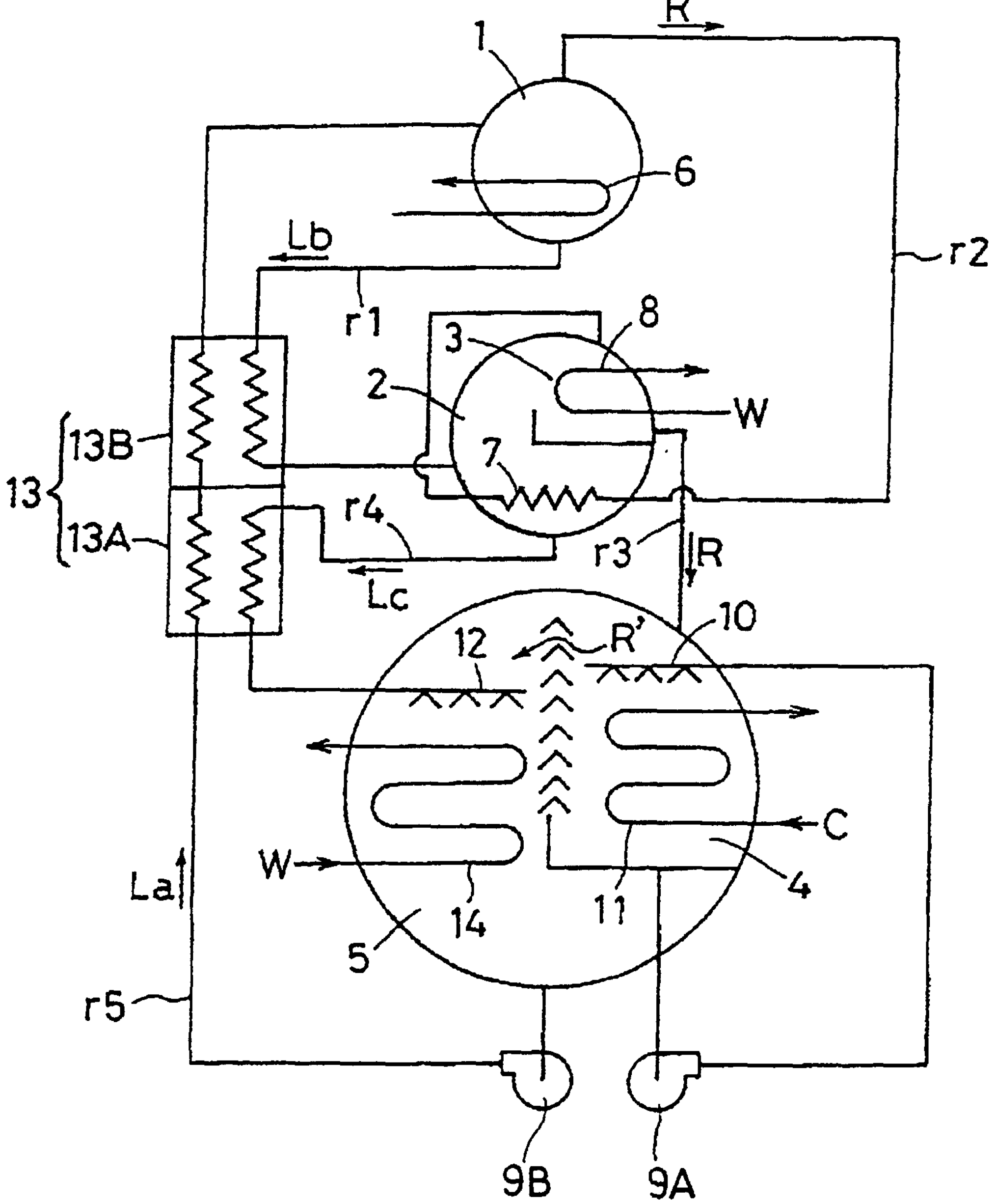
5. A plate heat exchanger for three fluids according to any one of claims 1 through 4, wherein:

said first fluid crossover path extends to a plurality of said interplate first fluid paths in said preceding-stage heat exchange section and a plurality of said interplate first fluid paths in said succeeding-stage heat exchange section in such a state that said first fluid crossover path pierces through the plates in the plate laminating direction inside said plate laminate.

6. A method for producing the plate heat exchanger for three fluids according to claim 4, wherein:

said respective interplate fluid paths are formed under vacuum, and simultaneously the plates located at the boundary between said preceding-stage heat exchange section and said succeeding-stage heat exchange section form the airtight space under vacuum as said vacuum heat insulating layer, by brazing the adjacent plates of many laminated plates.

F I G. 1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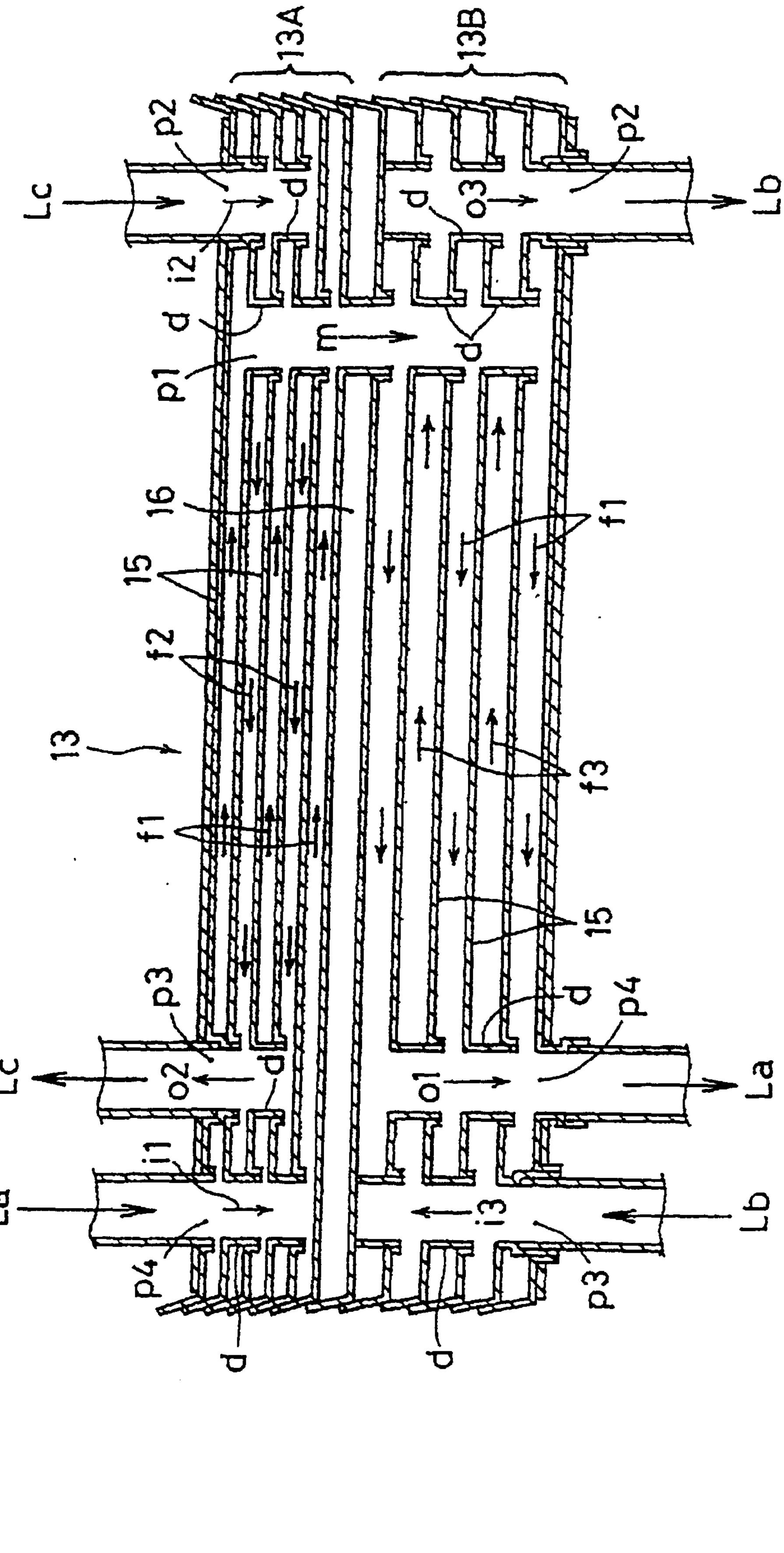
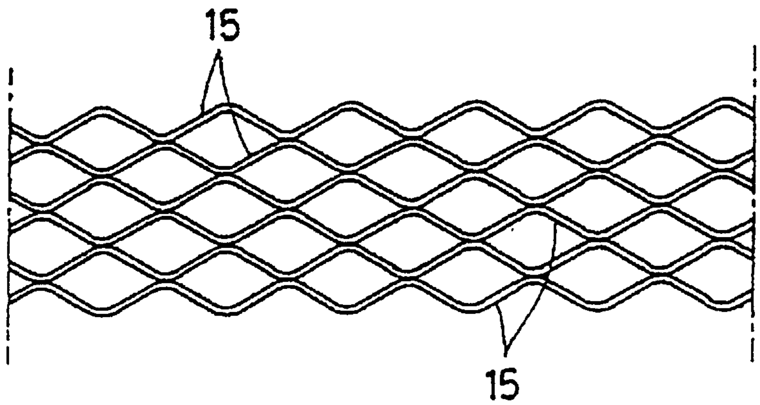
6
Lb
r2
r1
8
3
2
W
13B
7
13
r4
13A
r3
R
Lc
10
12
R'
C
W
La
14
11
4
5
r5
9B
9A

F I G. 2



F I G. 3



F I G. 4

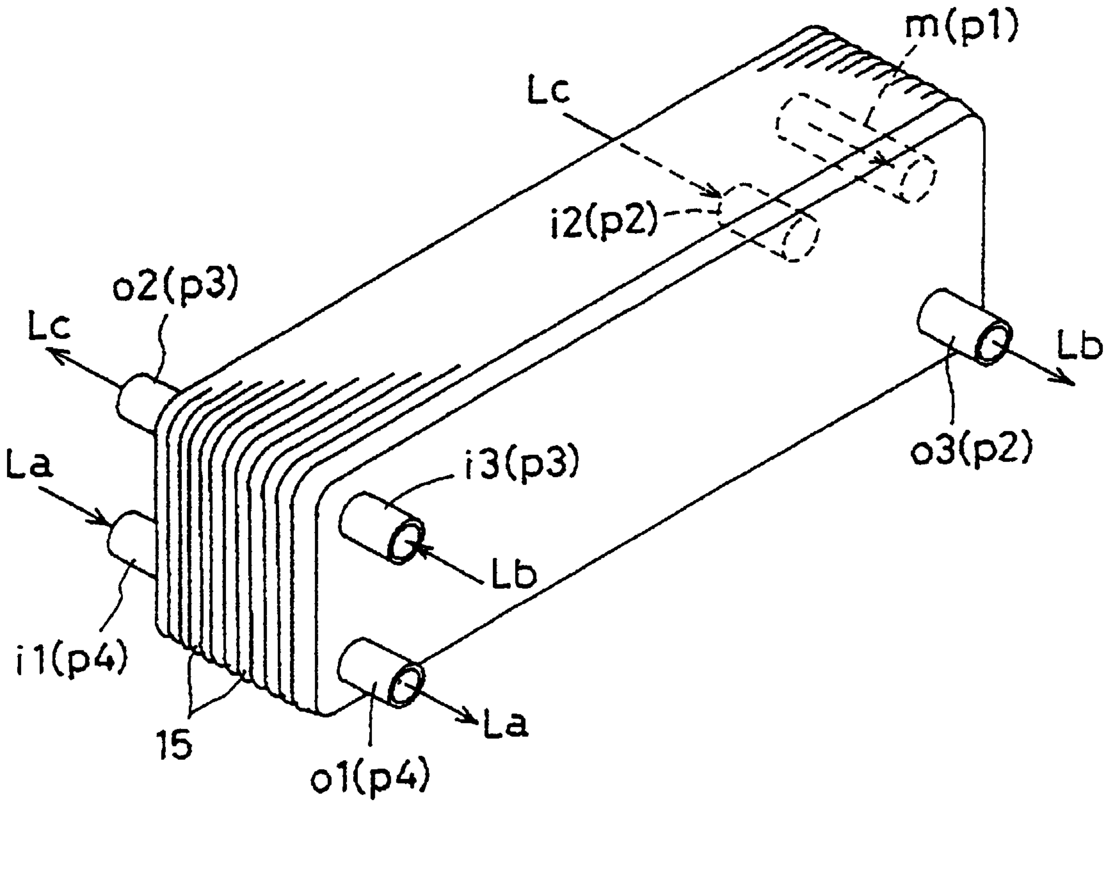
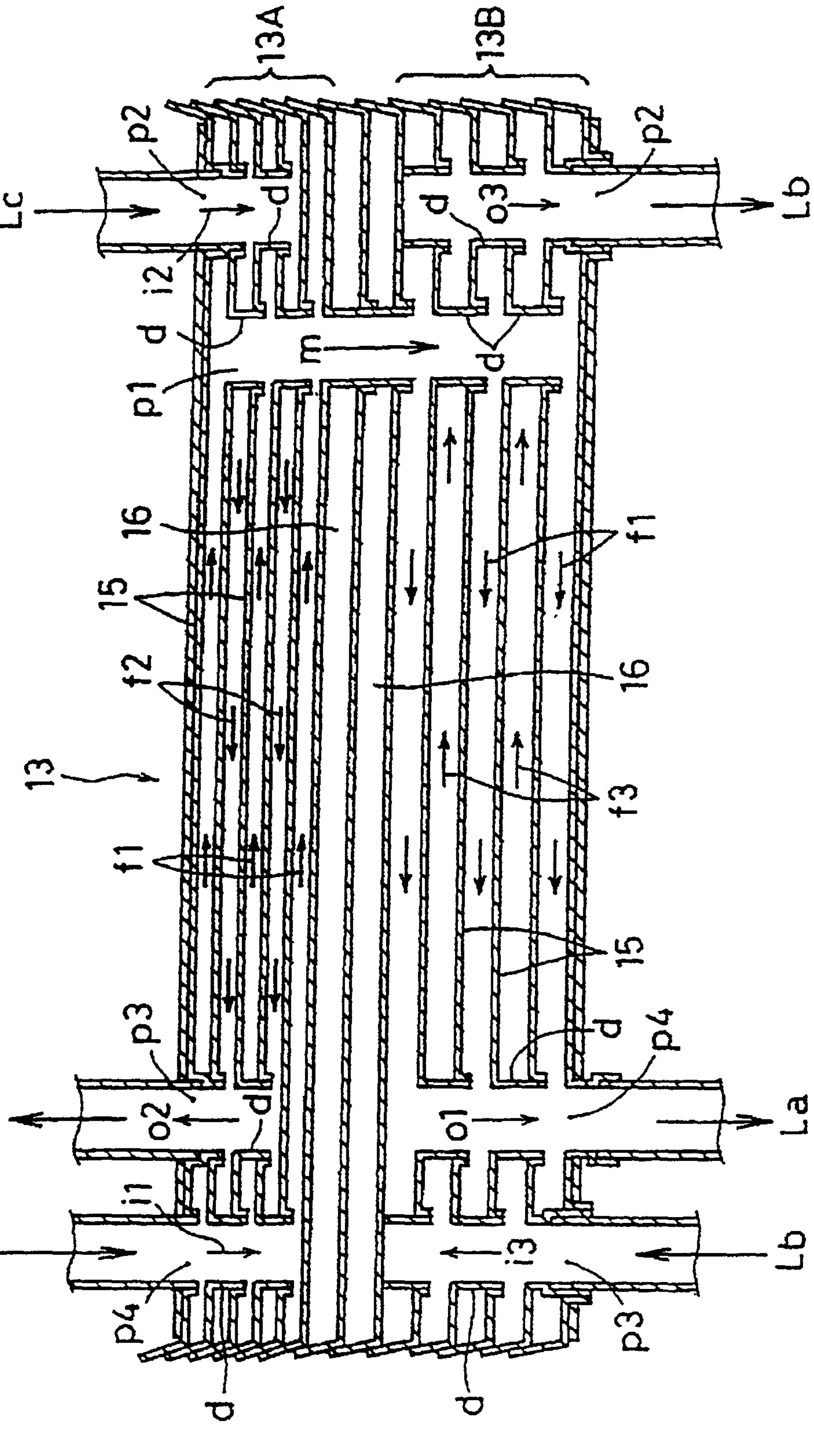


FIG. 5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13B
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d
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Lb
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p1
16
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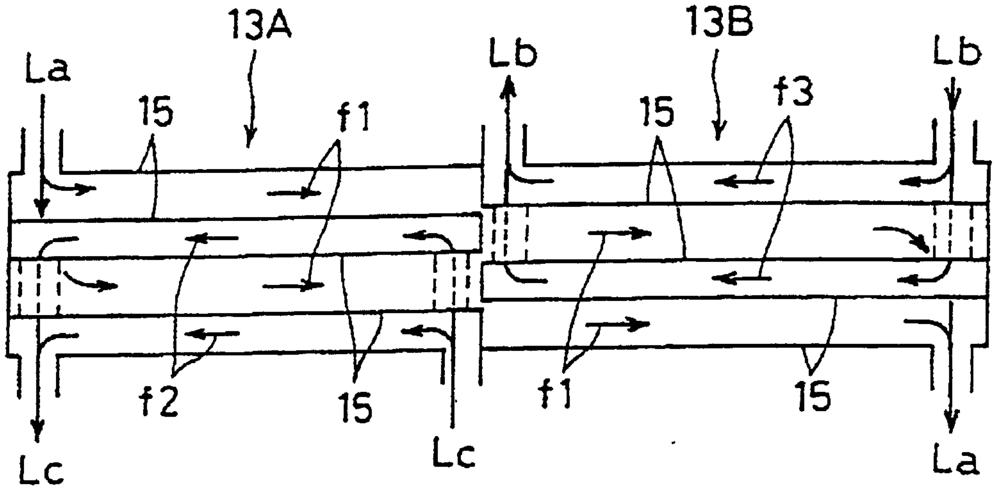
o2
o1
p4
La
i1
i3
Lc
La
Lb

F I G. 6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP99/06864

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl^7 F28D9/00, F28F3/08

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, F28F3/08

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, 10-19482, A (Toshiba Engineering K.K.), 23 January, 1998 (23.01.98), Full text (Family: none)	1-6
A	JP, 1-244290, A (Hisaka Works, Ltd.), 28 September, 1989 (28.09.89) (Family: none)	1-6
A	JP, 2-254290, A (Hisaka Works, Ltd.), 15 October, 1990 (15.10.90), Full text (Family: none)	1-6
A	JP, 4-10265, U (Kabushiki Kaisha Tsuchiya Seisakusho), 29 January, 1992 (29.01.92), Full text	1-6

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

* Special categories of cited documents:
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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
07 March, 2000 (07.03.00)	21 March, 2000 (21.03.00)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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