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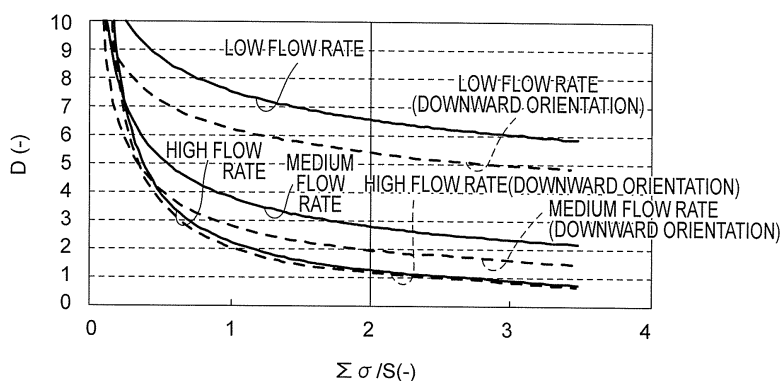
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(54) **HEAT EXCHANGER**

(57) Provided is a heat exchanger capable of distributing a fluid evenly into a plurality of channels under various conditions of the flow rate of the fluid. The heat exchanger includes: a channel forming section (51) having a plurality of arrayed fluid channels; a distribution path forming section (53) having a distribution path (57) to which inlets (55) of the plurality of arrayed fluid channels communicate; and a cylindrical partition wall (59) provided in the distribution path forming section, for defining an introduction path (63) on an inner side of the cylindrical partition wall, the distribution path being positioned on

an outer side of an outer periphery of the cylindrical partition wall. The cylindrical partition wall has a plurality of distribution holes (65). The following expression is satisfied: $L/d' \times \Pi(d/2)^2 > \sum \sigma \geq 2S$, where S represents a channel sectional area of the introduction path, d represents a channel diameter of the introduction path, $\sum \sigma$ represents a sum of areas (σ) of the plurality of distribution holes, L represents a length of array of the plurality of distribution holes, and d' represents a diameter of each of the plurality of distribution holes.

FIG. 9



Description

Technical Field

[0001] The present invention relates to a heat exchanger.

Background Art

[0002] Plate heat exchangers include a plurality of stacked heat transfer plates each having corrugated projections and depressions formed in a plurality of arrays. First channels and second channels are alternately formed between pairs of the heat transfer plates, respectively. Further, heat is exchanged between a first fluid flowing through a first channel and a second fluid flowing through a second channel.

[0003] Further, a plate heat exchanger disclosed in Patent Literature 1 is intended to distribute a refrigerant evenly through a distribution tube having a large number of distribution holes, which is provided in a lower space communicating to an inlet side of each of a plurality of refrigerant channels.

Citation List

Patent Literature

[0004] [PTL 1] JP 08-504027 A

Summary of Invention

Technical Problems

[0005] Simple provision of the distribution tube having the distribution holes in the lower space communicating to the inlet side of each of the plurality of refrigerant channels may not achieve even distribution of the refrigerant under various conditions of the flow rate of the refrigerant. In particular, when the flow rate of the refrigerant is low, the even distribution of the refrigerant very probably may not be able to achieve. In a case where the heat exchanger functions as an evaporator, a refrigerant in a gas-liquid two phase state is caused to flow into the distribution tube. When the refrigerant is caused to flow at a relatively high flow rate, the refrigerant in the gas phase is caused to flow in the vicinity of a tube axis, whereas the refrigerant in the liquid phase is caused to flow in an annular pattern around the refrigerant in the gas phase. In this manner, the gas-liquid separation state occurs in a radial direction. When the refrigerant is caused to flow at a relatively low flow rate or low flow velocity, on the other hand, a large amount of refrigerant in the liquid phase tends to flow toward a deep side of the distribution tube due to an inertial force. Further, a large amount of refrigerant in the liquid phase exists on a lower side of the distribution tube, whereas a large amount of refrigerant in the gas phase exists on an upper side of the distribution tube. In this

manner, a gas-liquid separation state occurs in a vertical direction. Thus, when the refrigerant is caused to flow at a relatively low flow rate, there is such a tendency that the refrigerant is difficult to flow out evenly through the plurality of distribution holes over an extending direction of the distribution tube. As described above, the gas-liquid separation state is different between the flow at a high flow rate and the flow at a low flow rate. In particular, when the refrigerant is caused to flow at a low flow rate, the refrigerant is difficult to distribute evenly into the plurality of channels.

[0006] The present invention has been made in view of the above, and it is therefore an object thereof to provide a heat exchanger capable of distributing a heat exchange fluid evenly into a plurality of channels under various conditions of the flow rate of the heat exchange fluid, in particular, even in a case of a flow at a low flow rate.

Solution to Problems

[0007] In order to attain the above-mentioned object, according to one embodiment of the present invention, there is provided a heat exchanger, including: a channel forming section having a plurality of arrayed fluid channels; a distribution path forming section having a distribution path to which inlets of the plurality of arrayed fluid channels communicate; and a cylindrical partition wall provided in the distribution path forming section, the cylindrical partition wall defining an introduction path on an inner side of the cylindrical partition wall, the distribution path being positioned on an outer side of an outer periphery of the cylindrical partition wall, in which the cylindrical partition wall has a plurality of distribution holes each communicating the introduction path and the distribution path to each other, and in which the following expression is satisfied: $L/d' \times \Pi(d/2)^2 > \sum \sigma \geq 2S$, where S represents a channel sectional area of the introduction path, d represents a channel diameter of the introduction path, $\sum \sigma$ represents a sum of areas (σ) of the plurality of distribution holes, L represents a length of array of the plurality of distribution holes, and d' represents a diameter of each of the plurality of distribution holes.

Advantageous Effects of Invention

[0008] According to one embodiment of the present invention, it is possible to distribute the heat exchange fluid evenly into the plurality of channels under the various conditions of the flow rate of the heat exchange fluid, in particular, even in the case of the flow at the low flow rate.

Brief Description of Drawings

[0009]

FIG. 1 is a perspective view illustrating components of a plate heat exchanger according to an embodiment of the present invention.

FIG. 2 is a side view illustrating the plate heat exchanger.

FIG. 3A to 3D, each is a view illustrating plates, which are main components of the plate heat exchanger.

FIG. 4 is a view illustrating a region in the vicinity of a first fluid inlet of the plate heat exchanger.

FIG. 5 is a sectional view taken along the line V-V of FIG. 4.

FIG. 6 is a perspective view illustrating a cylindrical partition wall.

FIG. 7 is a sectional view taken along the line VII-VII of FIG. 6.

FIG. 8 is a graph showing a relationship between $\Sigma\sigma/S$ and a distribution ratio D.

FIG. 9 is a graph showing the relationship between $\Sigma\sigma/S$ and the distribution ratio D, and further showing differences caused by an orientation of distribution holes.

Description of Embodiments

[0010] Now, a heat exchanger according to embodiments of the present invention is described with reference to the accompanying drawings. Note that, in the drawings, the same reference symbols represent the same or corresponding parts.

[0011] FIG. 1 is a perspective view illustrating components of a plate heat exchanger according to this embodiment, and FIG. 2 is a side view illustrating the plate heat exchanger. Further,

[0012] FIG. 3A to 3D, each is a view illustrating plates, which are main components of the plate heat exchanger.

[0013] A plate heat exchanger 1 includes a front reinforcement side plate 3, a rear reinforcement side plate 5, and a plurality of front heat transfer plates 7 and a plurality of rear heat transfer plates 9, which are stacked between the reinforcement side plates.

[0014] At four corners of the front heat transfer plate 7, four openings, that is, a first fluid inlet 11, a first fluid outlet 13, a second fluid inlet 15, and a second fluid outlet 17 are formed. Further, at four corners of each of the front heat transfer plates 7 and the rear heat transfer plates 9, four through-holes, that is, a first fluid advancing hole 19, a first fluid returning hole 21, a second fluid advancing hole 23, and a second fluid returning hole 25 are formed.

[0015] This embodiment describes such an example that the plate heat exchanger 1 is used as an evaporator. It is assumed that the first fluid is a refrigerant and the second refrigerant is water. Specifically, as illustrated in FIG. 1, the refrigerant indicated by the arrow A is caused to flow into the plate heat exchanger 1 through the first fluid inlet 11, then caused to flow through a plurality of the first fluid advancing holes 19 and a plurality of the first fluid returning holes 21, and is caused to flow out of the plate heat exchanger 1 through the first fluid outlet 13. Further, the water indicated by the arrow B is caused to flow into the plate heat exchanger 1 through the second

fluid inlet 15, then caused to flow through a plurality of the second fluid advancing holes 23 and a plurality of the second fluid returning holes 25, and is caused to flow out of the plate heat exchanger 1 through the second fluid outlet 17.

[0016] Further, first channels and second channels are alternately formed between pairs of the front heat transfer plates 7 and the rear heat transfer plates 9, respectively. Therefore, the refrigerant serving as the first fluid is supplied to the plurality of first channels in a distributed manner while flowing in a lower space including the plurality of first fluid advancing holes 19 (in a strict sense, flowing out through a large number of distribution holes of a distribution tube as described later), and is caused to flow upward in a meandering manner as indicated by the arrow A1. Then, the refrigerant is collected in an upper space including the plurality of first fluid returning holes 21, and is caused to flow out through the first fluid outlet 13. Similarly, the water serving as the second fluid is supplied to the plurality of second channels in a distributed manner while flowing in a lower space including the plurality of second fluid advancing holes 23, and is caused to flow upward in a meandering manner as indicated by the arrow B1. Then, the water is collected in an upper space including the plurality of second fluid returning holes 25, and is caused to flow out through the second fluid outlet 17.

[0017] During a period in which the refrigerant serving as the first fluid and the water serving as the second fluid are caused to flow upward as indicated by the arrows A1 and B1, heat is exchanged between the refrigerant and the water through intermediation of the corresponding front heat transfer plate 7 or rear heat transfer plate 9, which separates the refrigerant and the water from each other. Each of the front heat transfer plate 7 and the rear heat transfer plate 9 has corrugated projections and depressions formed in a plurality of arrays, and the first channel and the second channel are formed by such projections and depressions 27.

[0018] The heat exchanger of the present invention includes a channel forming section, a distribution path forming section, and a cylindrical partition wall. Now, the channel forming section, the distribution path forming section, and the cylindrical partition wall are described. FIG. 4 is a view illustrating a region in the vicinity of the first fluid inlet of the above-mentioned plate heat exchanger, and FIG. 5 is a sectional view taken along the line V-V of FIG. 4. Note that, FIG. 5 schematically illustrates the structure for clarity of the description. Further, FIG. 6 is a perspective view illustrating the cylindrical partition wall, and FIG. 7 is a sectional view taken along the line VII-VII of FIG. 6.

[0019] A channel forming section 51 is a section having a plurality of arrayed fluid channels. Regions having an upward flow of the fluid in the front heat transfer plates 7 and the rear heat transfer plates 9 described above function as the channel forming section 51. That is, the plurality of first channels arrayed in a stacking direction

of the front heat transfer plates 7 and the rear heat transfer plates 9 and the plurality of second channels arrayed similarly in the stacking direction correspond to the plurality of arrayed fluid channels.

[0020] A distribution path forming section 53 is a section having a distribution path 57 to which inlets 55 of the plurality of fluid channels communicate. Regions having a lateral flow (flow passing through each of the first fluid advancing holes 19 and the second fluid advancing holes 23) of the fluid in the front heat transfer plates 7 and the rear heat transfer plates 9 function as the distribution path forming section 53.

[0021] A cylindrical partition wall 59 is provided in the distribution path forming section 53. In a specific example of this embodiment, the cylindrical partition wall 59 corresponds to a cylindrical distribution tube 61 inserted into the plurality of first fluid advancing holes 19 or the plurality of second fluid advancing holes 23. The distribution path 57 is formed into an annular shape on an outer side of an outer periphery of the distribution tube 61. Further, an introduction path 63 defined by an inner surface of the distribution tube 61 is formed on an inner side of the distribution tube 61.

[0022] A plurality of distribution holes 65 are formed in the distribution tube 61. The plurality of distribution holes 65 each communicate the introduction path 63 and the distribution path 57 to each other. The plurality of distribution holes 65 are arrayed along an extending direction of the distribution tube 61, that is, along the stacking direction of the front heat transfer plates 7 and the rear heat transfer plates 9.

[0023] In this embodiment, as illustrated in FIGS. 6 and 7, all of the plurality of distribution holes 65 are circular through-holes, which are formed at substantially the same size. Further, the plurality of distribution holes 65 are arranged at regular intervals. In addition, as illustrated in FIG. 5, dimensions h of the fluid channels in an array direction are set equal to each other.

[0024] As illustrated mainly in FIG. 5, the inlets 55 of the plurality of fluid channels communicate to the distribution path 57 at positions above the cylindrical partition wall 59. Further, as illustrated in FIG. 7, 60% or more of the plurality of distribution holes 65 are formed in a downward orientation in the cylindrical partition wall 59. That is, assuming that the upper side, on which the inlets 55 of the plurality of fluid channels exist, is 0° with respect to the distribution tube 61, the plurality of distribution holes 65 are formed at 180° -positions on the lower side opposite to the inlets 55.

[0025] A diameter d' of each of the plurality of distribution holes 65 is set to 40% to 100% of the dimension h of each of the fluid channels in the array direction. Further, the respective related portions are formed so that the following expression is satisfied:

$$L/d' \times \pi (d/2)^2 > \sum \sigma \geq 2S$$

where S represents a channel sectional area of the introduction path 63 (in a cross section taken in a direction perpendicular to the array direction of the fluid channels), d represents a channel diameter of the introduction path 63, $\sum \sigma$ represents a sum of areas σ of the plurality of distribution holes 65, L represents a length of array of the plurality of distribution holes 65 (length between an upstream edge portion of the distribution hole at the end of the upstream side and a downstream edge portion of the distribution hole at the end of the downstream side), and d' represents a diameter of each of the distribution holes 65.

[0026] With the structure described above, for example, the first fluid first is caused to flow into the distribution tube 61 serving as the cylindrical partition wall 59 through the first fluid inlet 11, then caused to flow through the introduction path 63, and is caused to flow out of the distribution tube 61 into the distribution path 57 through the plurality of distribution holes 65. Further, the first fluid in the distribution path 57 is caused to flow through the inlets 55 of the respective channels so as to be distributed into the respective fluid channels. Then, flows of the first fluid are caused to flow upward through the respective channels.

[0027] In the above-mentioned plate heat exchanger according to this embodiment, the relationship between the introduction path and the plurality of distribution holes is set to $\sum \sigma \geq 2S$, and thus even distribution of liquid or even distribution of gas and liquid into the respective fluid channels is promoted greatly. That is, a partition wall portion of the distribution tube, which separates the adjacent distribution holes from each other, serves as a resistor so that the pressure distribution of the fluid is equalized and a rectification effect is obtained. As a result, even distribution of the fluid into the respective fluid channels is promoted. Thus, heat is exchanged evenly in the respective channels irrespective of the single phase and the gas-liquid two phases. In particular, in the case of the gas-liquid two phases, the first fluid easily forms an annular flow in the distribution tube, or easily forms a homogeneous flow due to the above-mentioned partition wall portion. As a result, even distribution of gas and liquid can be achieved.

[0028] Now, description is given of even distribution property obtained by the plate heat exchanger according to this embodiment. FIG. 8 is a graph showing a relationship between $\sum \sigma/S$ and a distribution ratio D . In FIG. 8, the horizontal axis represents $\sum \sigma/S$, and the vertical axis represents the distribution ratio D . The distribution ratio D is calculated by Expression (1):

[Expression 1]

$$D = \sqrt{1/n \times \sum_{i=1}^n (Y_i - m)^2}$$

[0029] In this case, G represents a total flow rate of a fluid of interest, G_i represents a flow rate of the fluid in each channel, n represents the number of channels branched from the distribution path, and i represents a number of a channel branched from the distribution path, for indicating a specific position of the channel in an order of from the upstream side toward the downstream side. Further, $Y_i = (G_i/G) \times 100$. That is, Y_i represents a distribution ratio of each flow rate of the fluid with respect to the total flow rate. The symbol m represents a target distribution ratio for achieving even distribution, and $m = (1/G) \times (G/n) \times 100$.

[0030] As is apparent from FIG. 8, irrespective of whether the flow rate of the fluid is high, medium, or low, when $\Sigma\sigma/S$ is 2 or more, it is found that the change in distribution ratio D is stably suppressed at a low level relative to the change in $\Sigma\sigma/S$. That is, in a range in which $\Sigma\sigma/S$ is smaller than 2, the distribution ratio D significantly fluctuates along a curved line relative to the change in $\Sigma\sigma/S$, whereas when $\Sigma\sigma/S$ is 2 or more, the change in distribution ratio D is suppressed into a flat change relative to $\Sigma\sigma/S$. Further, from the viewpoint of the difference in flow rate, in particular, in the case of the flow at a low flow rate, in the range in which $\Sigma\sigma/S$ is smaller than 2, it is found that the distribution ratio D is significantly high. Further, from the viewpoint of manufacture, it is preferred that the distribution ratio D be set as small as possible. As described above, when $\Sigma\sigma/S$ is 2 or more, the fluid can be distributed evenly into the plurality of channels under various conditions of the flow rate of the fluid, in particular, even in the case of the flow at a low flow rate. Note that, in actual use, it is preferred that $\Sigma\sigma/S$ be set within a range of from 2 to 3, approximately.

[0031] Further, when $\Sigma\sigma \geq L/d' \times \Pi(d/2)^2$, the above-mentioned effect of the partition wall portion for forming the homogeneous flow cannot be obtained, and hence even distribution of gas and liquid becomes difficult. Further, the adjacent distribution holes may communicate to each other, and hence the difficulty in processing is increased, with the result that the processing cost is increased. In this embodiment, the above-mentioned inconvenience can be suppressed under the condition that $L/d' \times \Pi(d/2)^2 > \Sigma\sigma$.

[0032] Further, in this embodiment, 60% or more of the plurality of distribution holes are formed in the downward orientation as described above. FIG. 9 shows advantages of this structure. FIG. 9 is a graph showing the relationship between $\Sigma\sigma/S$ and the distribution ratio D similarly to FIG. 8, and further showing differences caused by the orientation of the distribution holes. The results shown in FIG. 9 reveal that, irrespective of whether the flow rate of the fluid is high, medium, or low, the distribution ratio becomes even lower in the structure in which the distribution holes are formed in the downward orientation (indicated by the dotted lines) than in the structure in which 60% or more of the distribution holes are not formed in the downward orientation (indicated by the solid lines). In particular, under the condition that the flow

rate is lower, it is found that the distribution ratio becomes lower more significantly. This is because even distribution of gas and liquid into the respective channels is promoted due to the facts that the liquid having high density and being liable to accumulate on the lower side of the introduction path sequentially is caused to flow out from the inflow side of the distribution tube in its longitudinal direction and therefore the amount of liquid flowing toward a deep side of the distribution tube in its longitudinal direction can be reduced, and that the amount of liquid is easily maintained in the distribution tube and therefore the pressure distribution can be equalized in the longitudinal direction. In particular, even under a state in which the annular flow cannot be maintained due to, for example, the case of a low flow rate or a low flow velocity, when the distribution holes are formed in the downward orientation, vapor is caused to flow out from the lower side, on which the liquid accumulates, and hence the liquid is also caused to flow out along with the flow of the vapor, with the result that the gas and liquid can be caused to flow out homogeneously while being mixed with each other. Further, even in the case of the single-phase flow, the temperature distribution in the longitudinal direction, which is caused by a drift, is equalized through the equalization of the pressure distribution, and thus even distribution can be achieved.

[0033] Further, in this embodiment, the diameter d' of each of the plurality of distribution holes is set to 40% to 100% of the dimension h of each of the fluid channels in the array direction. Thus, even distribution into the respective channels can be achieved. In addition, the resistance of the distribution holes is small, and accordingly there is an advantage in that the even distribution can be maintained even when the flow rate is reduced.

[0034] As described above, with the plate heat exchanger according to this embodiment, the fluid can be distributed evenly into the plurality of channels under various conditions of the flow rate of the fluid. Further, the present invention is also applicable to a refrigeration cycle system including the plate heat exchanger used as an evaporator and a condenser within a refrigeration cycle. Accordingly, it is possible to attain a refrigeration cycle system having excellent heat exchange performance and high reliability.

[0035] Although the details of the present invention are specifically described above with reference to the preferred embodiments, it is apparent that persons skilled in the art may adopt various modifications based on the basic technical concepts and teachings of the present invention.

[0036] The present invention is not limited to the application to the plate heat exchanger, but is widely applicable to a heat exchanger including a plurality of arrayed heat exchange fluid channels, and a distribution path to which inlets of the fluid channels communicate. For example, the present invention is applicable to a flat-tube heat exchanger.

Reference Signs List

[0037] 1 plate heat exchanger, 7 front heat transfer plate, 9 rear heat transfer plate, 51 channel forming section, 53 distribution path forming section, 55 inlet, 57 distribution path, 59 cylindrical partition wall, 61 distribution tube, 63 introduction path, 65 distribution hole

wherein the channel forming section is configured to exchange heat between a first fluid flowing through each of a plurality of the first channels and a second fluid flowing through each of a plurality of the second channels, and wherein the plurality of arrayed fluid channels comprise the plurality of the first channels.

Claims

1. A heat exchanger, comprising:

a channel forming section having a plurality of arrayed fluid channels;

a distribution path forming section having a distribution path to which inlets of the plurality of arrayed fluid channels communicate; and

a cylindrical partition wall provided in the distribution path forming section, for defining an introduction path on an inner side of the cylindrical partition wall, the distribution path being positioned on an outer side of an outer periphery of the cylindrical partition wall,

wherein the cylindrical partition wall has a plurality of distribution holes each communicating the introduction path and the distribution path to each other, and

wherein the following expression is satisfied:

$$L/d' \times \pi (d/2)^2 \geq \sum \sigma \geq 2S$$

where S represents a channel sectional area of the introduction path, d represents a channel diameter of the introduction path, $\sum \sigma$ represents a sum of areas (σ) of the plurality of distribution holes, L represents a length of array of the plurality of distribution holes, and d' represents a diameter of each of the plurality of distribution holes.

2. A heat exchanger according to claim 1, wherein the diameter (d') of the each of the plurality of distribution holes is set to 40% to 100% of a dimension (h) of each of the plurality of arrayed fluid channels in an array direction.

3. A heat exchanger according to claim 1 or 2, wherein the channel forming section comprises a plurality of stacked heat transfer plates each having projections and depressions formed in a plurality of arrays, wherein the channel forming section defines first channels and second channels, which are alternately formed between pairs of the plurality of stacked heat transfer plates,

4. A refrigeration cycle system, comprising the heat exchanger according to any one of claims 1 to 3.

FIG. 1

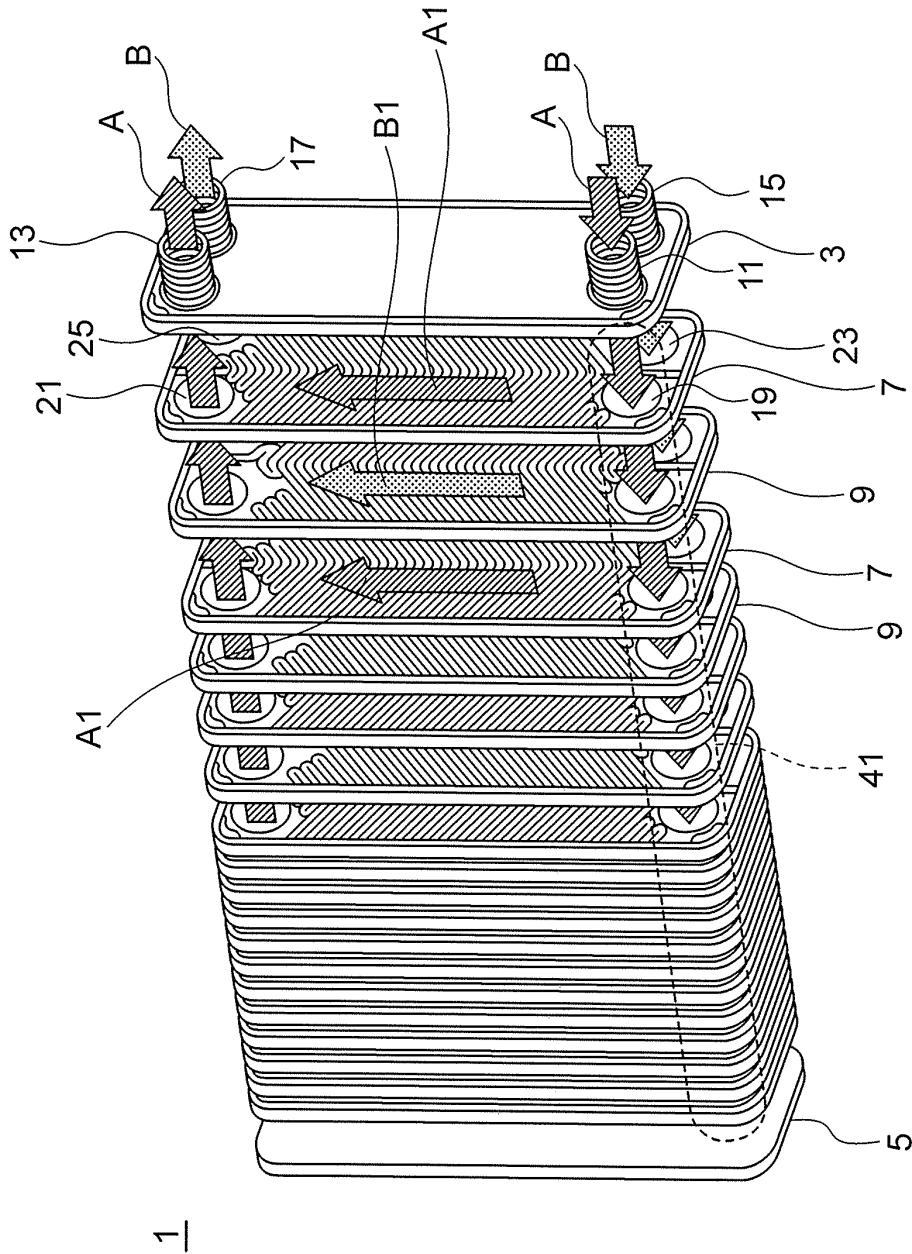


FIG. 2

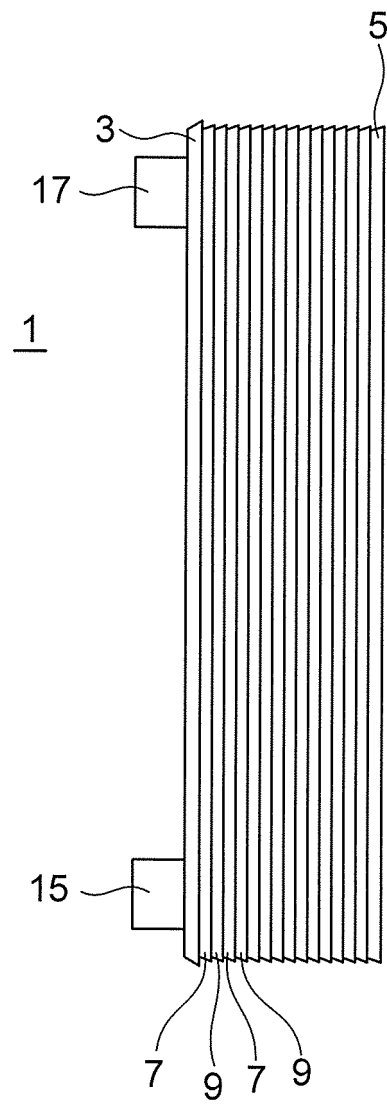


FIG. 3A

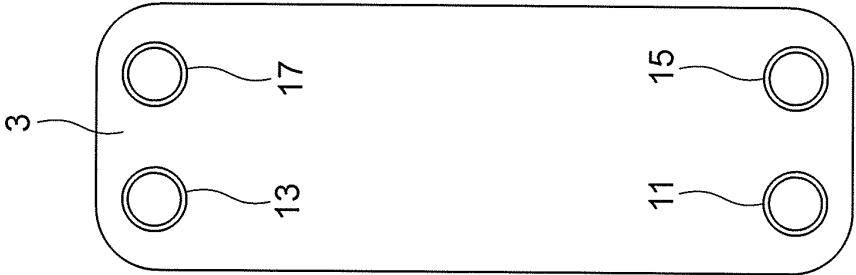


FIG. 3B

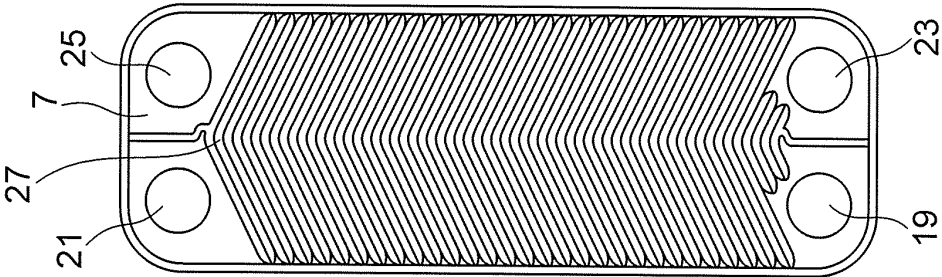


FIG. 3C

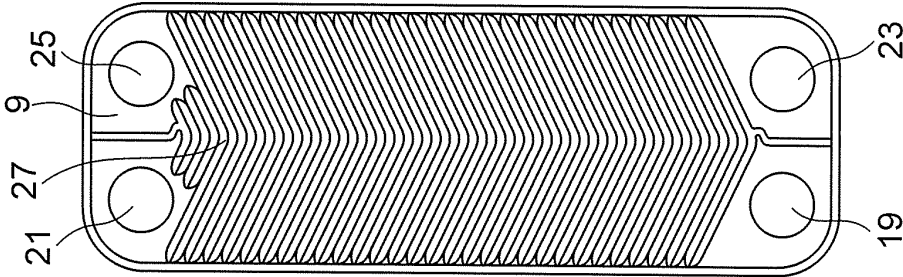


FIG. 3D

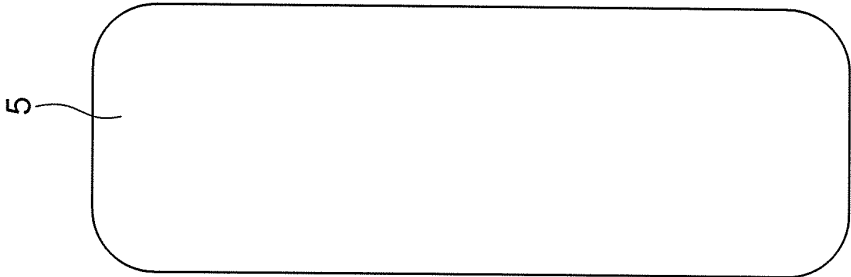


FIG. 4

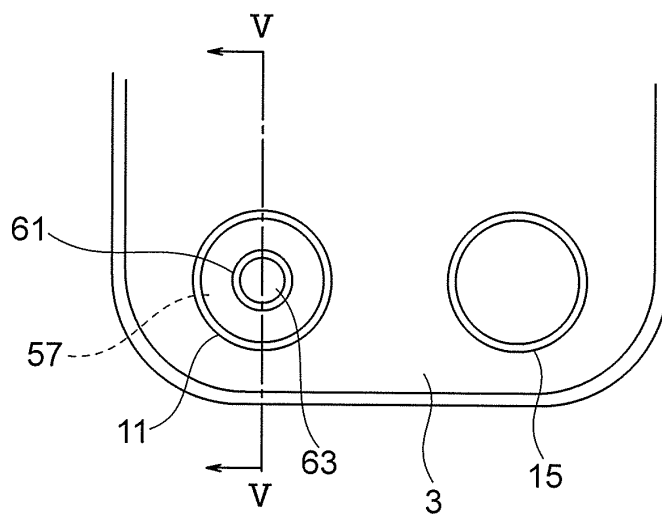


FIG. 5

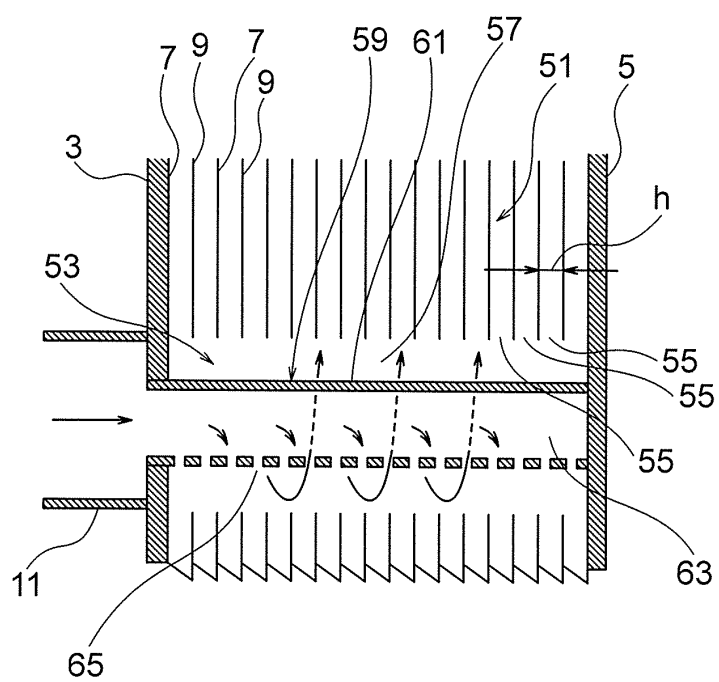


FIG. 6

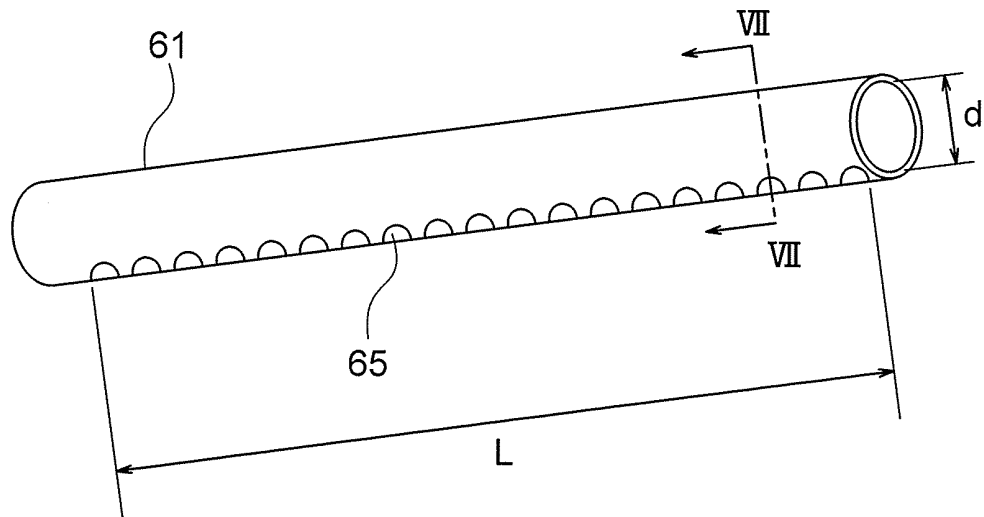


FIG. 7

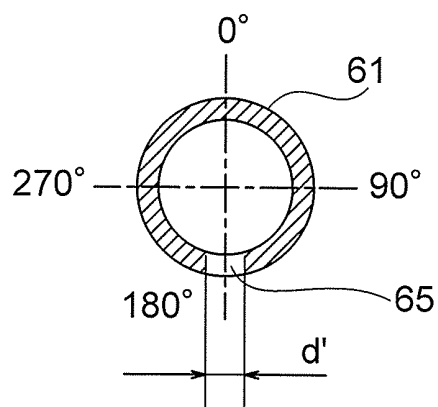


FIG. 8

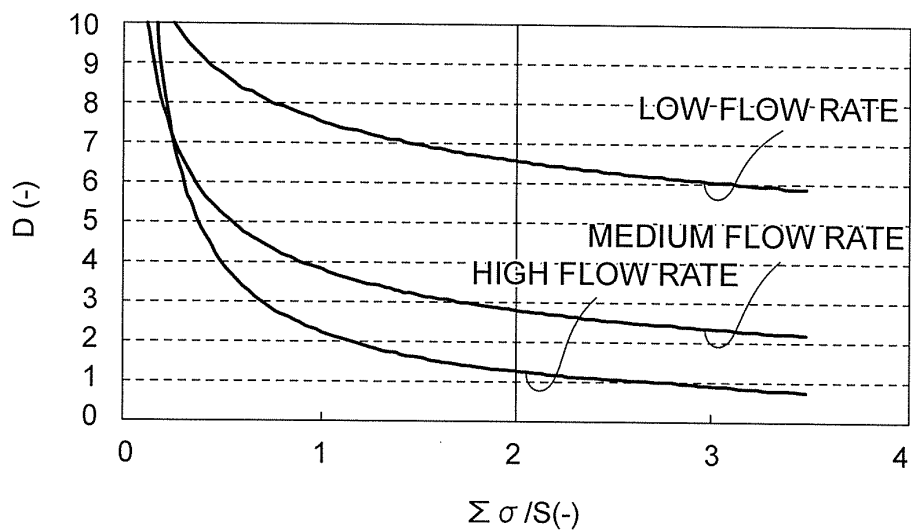
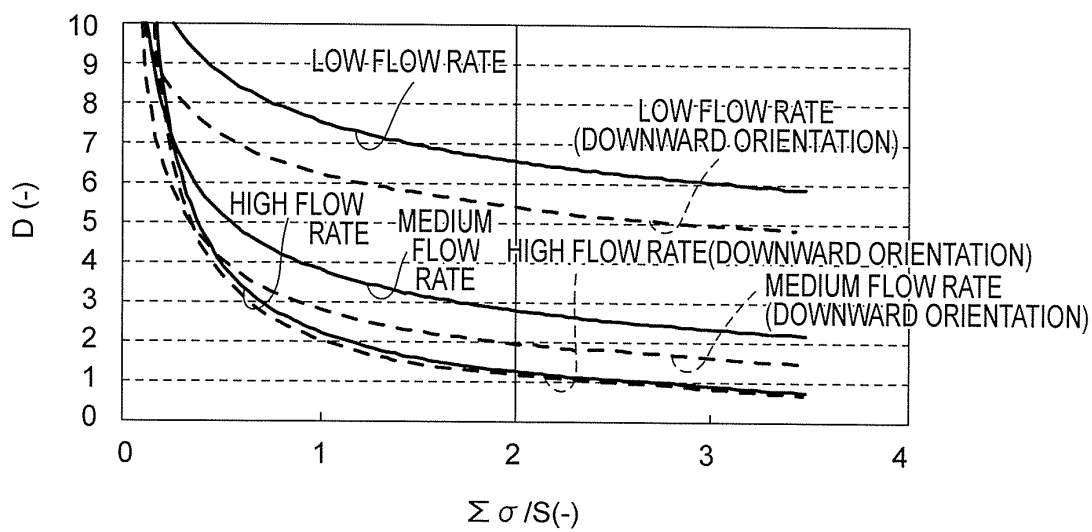


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/066215

A. CLASSIFICATION OF SUBJECT MATTER

F28F3/08(2006.01)i, F28D9/00(2006.01)i, F28F9/22(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)

F28F3/08, F28D9/00, F28F9/22

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013

Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

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.
X Y	JP 4-86492 A (Hisaka Works, Ltd.), 19 March 1992 (19.03.1992), page 3, upper right column, line 4 to lower right column, line 13; fig. 1 to 3 (Family: none)	1 2-4
Y	JP 2011-503509 A (Swep International AB.), 27 January 2011 (27.01.2011), paragraph [0017]; fig. 3 & US 2012/0061064 A1 & WO 2009/062738 A1 & CN 101868686 A	2-4
A	JP 2002-62082 A (Daikin Industries, Ltd.), 28 February 2002 (28.02.2002), paragraphs [0007], [0030] (Family: none)	1-4

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

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Date of the actual completion of the international search
09 September, 2013 (09.09.13)Date of mailing of the international search report
17 September, 2013 (17.09.13)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/066215

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 10-300384 A (Daikin Industries, Ltd.), 13 November 1998 (13.11.1998), paragraphs [0016] to [0031]; fig. 1 to 9 (Family: none)	1-4
A	JP 11-101588 A (Hisaka Works, Ltd.), 13 April 1999 (13.04.1999), paragraph [0007]; fig. 2, 3 (Family: none)	1-4

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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