



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.03.2011 Bulletin 2011/11

(51) Int Cl.:
F28D 7/02 (2006.01)
F28D 7/16 (2006.01)
F28F 9/013 (2006.01)

(21) Application number: **10173013.3**

(22) Date of filing: **17.08.2010**

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

(72) Inventors:
• **Ando, Yoshio**
Nagoya-shi Aichi 467-8585 (JP)
• **Sano, Yasuhiro**
Nagoya-shi Aichi 467-8585 (JP)

(30) Priority: **20.08.2009 JP 2009191138**

(74) Representative: **Strobel, Wolfgang et al**
Kroher-Strobel
Rechts- und Patentanwälte
Bavariaring 20
80336 München (DE)

(71) Applicant: **Paloma Industries, Ltd.**
Nagoya-shi,
Aichi 467-8585 (JP)

(54) **Spiral pipe heat exchanger with tilted pipe sections**

(57) A spiral heat-transfer pipe (2a-2h) for heat exchange provided in a heat exchanger (1) includes: an upstream heat-transfer pipe section (22) disposed on an upstream side of a flow path of an external fluid flowing outside the spiral heat-transfer pipe (2); and a downstream heat-transfer pipe section (24) disposed on a downstream side of the flow path. Each of the heat-trans-

fer pipe sections (22, 24) is disposed so as to extend in a direction crossing the flow path of the external fluid, Each of an axis (12) of the upstream heat-transfer pipe section (22) and an axis (14) of the downstream heat-transfer pipe section (24) is tilted with respect to a horizontal plane. Also, the axis (12) of the upstream heat-transfer pipe section (22) crosses the axis (14) of the downstream heat-transfer pipe section (24).

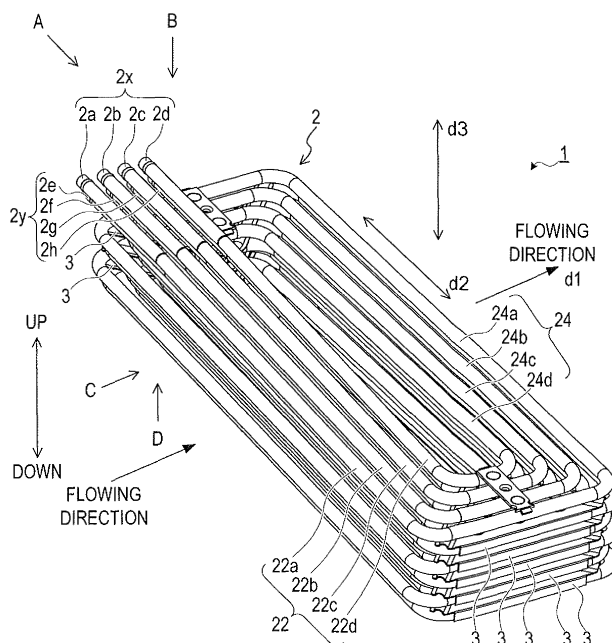


FIG.1

Description

BACKGROUND

[0001] The present invention relates to a heat exchanger that exchanges heat between external fluid introduced from outside and a heat-transfer member for heat exchange.

[0002] For example, in a heat exchanger disclosed in Japanese Unexamined Patent Application Publication No. 2008-025976 or Japanese Unexamined Patent Application Publication No. 2008-032252, heat-transfer pipes are disposed so as to cross a flow path of an external fluid on an upstream side and a downstream side, respectively, of the flow path.

SUMMARY

[0003] In a conventional heat exchanger, heat-transfer pipes are arranged so as to horizontally cross an upstream side and a downstream side, respectively, of the flow path of an external fluid. Accordingly, drain attached to the heat-transfer pipes as a result of heat exchange is likely to remain, which may hinder heat exchange and thus disable maintenance of efficiency of heat exchange.

[0004] In one aspect of the present invention, it is desirable that efficiency of heat exchange in a heat exchanger can be improved.

[0005] A heat exchanger according to the present invention includes a heat-transfer pipe for heat exchange and is configured such that heat exchange is performed between an external fluid flowing outside the heat-transfer pipe and the heat-transfer pipe. The heat exchanger may include a housing space for housing the heat-transfer pipe. The heat exchanger may be configured such that the external fluid introduced from outside is discharged after flowing through the housing space in which the heat-transfer pipe for heat exchange is housed, to thereby perform heat exchange between the external fluid and an internal fluid flowing inside the heat-transfer pipe.

[0006] The heat exchanger may include a spiral heat-transfer pipe having a spiral shape as the heat-transfer pipe. This spiral shape can also be described as helical shape. In this case, the spiral heat-transfer pipe may include an upstream heat-transfer pipe section disposed on an upstream side of a flow path of the external fluid in a direction crossing the flow path; and a downstream heat-transfer pipe section disposed on a downstream side of the flow path in a direction crossing the flow path. Further, each of an axis of the upstream heat-transfer pipe section and an axis of the downstream heat-transfer pipe section in the spiral heat-transfer pipe may be tilted with respect to a horizontal plane, and one of the axes may be relatively tilted with respect to the other of the axes, so that the axis of the upstream heat-transfer pipe section crosses the axis of the downstream heat-transfer pipe section.

[0007] The term "cross" here may be interpreted to mean that, when the spiral heat-transfer pipe is projected from the upstream side toward the downstream side of the flow path of the external fluid, the axis of the upstream heat-transfer pipe section and the axis of the downstream heat-transfer pipe section cross each other in a projected plan view.

[0008] According to the heat exchanger configured to have the tilted spiral heat-transfer pipe as above, since each of the upstream heat-transfer pipe section and the downstream heat-transfer pipe section, each crossing the flow path of the external fluid, is tilted with respect to the horizontal plane, drain, even if attached to the heat-transfer pipe as a result of heat exchange, can be made to flow along the tilt toward side areas of the flow path, and thus is unlikely to remain. Accordingly, heat exchange is unlikely to be hindered by remaining drain attached to each of the upstream heat-transfer pipe section and the downstream heat-transfer pipe section. Thus, an improved efficiency of heat exchange can be achieved.

[0009] Also, according to the tilted configuration as above, the upstream heat-transfer pipe section and the downstream heat-transfer pipe section are disposed in a positional relationship such that the axis of the upstream heat-transfer pipe section and the axis of the downstream heat-transfer pipe section cross each other in the projected plan view when the spiral heat-transfer pipe is projected from the upstream side toward the downstream side of the flow path. This configuration can reduce areas through which the external fluid simply passes, as compared with a non-tilted configuration (for example, a configuration in which the axis of the upstream heat-transfer pipe section and the axis of the downstream heat-transfer pipe section are parallel and overlapped in the projected plan view). Thus, the external fluid flowing through the housing space more easily contacts the heat-transfer pipe, and thereby a more improved efficiency of heat exchange can be achieved.

[0010] Further, a plurality of the spiral heat-transfer pipes may be housed in the housing space so as to form multiple spirals. The plurality of the spiral heat-transfer pipes may be stacked in a direction crossing a flowing direction of the external fluid (specifically, a direction crossing a surface defined by a longitudinal direction of the spiral heat-transfer pipes and the flowing direction, for example a vertical direction) to form multiple spirals.

[0011] In this case, each of the plurality of the spiral heat-transfer pipes may be relatively shifted with respect to the other spiral heat-transfer pipes in a predetermined direction. The predetermined direction may be a direction crossing a neighboring direction of the spiral heat-transfer pipes or the flowing direction of the external fluid.

[0012] More specifically, at least two most neighboring spiral heat-transfer pipes (having a smallest distance therebetween) may be configured as follows: one of the two spiral heat-transfer pipes is located upstream from the other in the flowing direction of the external fluid, and thereby the two spiral heat-transfer pipes are shifted with

respect to each other. In this case, the two spiral heat-transfer pipes may be stacked in the vertical direction (in other words, the two spiral heat-transfer pipes may be relatively shifted with respect to each other in the vertical direction).

[0013] According to the configuration including the plurality of the spiral heat-transfer pipes, there may be more chance of the external fluid contacting the spiral heat-transfer pipes.

[0014] Also, according to the above described configuration with the shifted spiral heat-transfer pipes, flow of the external fluid is more likely to be disturbed, as compared with the case where the plurality of the spiral heat-transfer pipes are not shifted with respect to one another. Accordingly, the external fluid may be caused to contact the spiral heat-transfer pipes at a higher possibility, and thereby a further improved efficiency of heat exchange can be achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The present invention will be described herein after by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a perspective view of an appearance of a heat exchanger according to an embodiment;

FIG. 2 is a schematic diagram of spiral heat-transfer pipes seen from a flowing direction of an external fluid;

FIG. 3A is a front view of one longitudinal end side of the heat exchanger seen from a direction indicated by an arrow A in FIG. 1, the front view being rotated 90° counterclockwise;

FIG. 3B is a top view of the one longitudinal end side of the heat exchanger seen from a direction indicated by an arrow B in FIG. 1;

FIG. 3C is a side view of the one longitudinal end side of the heat exchanger seen from a direction indicated by an arrow C in FIG. 1;

FIG. 3D is a bottom view of the one longitudinal end side of the heat exchanger seen from a direction indicated by an arrow D in FIG. 1;

FIG. 4A is a schematic diagram of spiral heat-transfer pipes according to another embodiment seen from a flowing direction of an external fluid;

FIG. 4B is a schematic diagram of the spiral heat-transfer pipes according to the another embodiment seen from a lateral direction to the flowing direction; and

FIG. 5 is a view showing an example of a form of use of a heat exchanger 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

(1) Overall Configuration

[0016] As shown in FIG. 5, a heat exchanger 1 houses a heat-transfer pipe group 2 in a housing space (a space inside a housing 10) 11. The heat exchanger 1 is configured such that an external fluid introduced from outside flows through the housing space 11 and is discharged from the housing space 11, to thereby perform heat exchange between the external fluid and an internal fluid flowing inside pipes 2a-2h.

[0017] In the present embodiment, the heat-transfer pipe group 2 includes a first pipe set 2x and a second pipe set 2y, as shown in FIG. 1. The first pipe set 2x includes pipes 2a, 2b, 2c, and 2d, while the second pipe set 2y includes pipes 2e, 2f, 2g and 2h.

[0018] Each of the pipes 2a-2h is formed to have a spiral shape. This spiral shape can also be described as helical shape. Each of the pipes 2a-2h has each different outside diameter of the spiral shape. In other words, sizes of areas spirally surrounded by the respective pipes 2a-2h are different.

[0019] The first pipe set 2x and the second pipe set 2y are stacked along a stacking direction d3, while relatively shifted slightly with respect to each other in a flowing direction d1 of the external fluid (see FIGS. 3A-3D). The stacking direction d3 is interpreted as a direction perpendicular to an alignment direction of the pipes 2a-2d, or an alignment direction 2e-2h (the same as the flowing direction d1 of the external fluid) (see FIG. 1).

[0020] Taking an example of the relationship between the two pipes 2a and 2e, the pipe 2a is located upstream from the pipe 2e in the flowing direction d1 of the external fluid, and thereby the pipe 2a and the pipe 2e are relatively shifted with respect to each other in the flowing direction d1 of the external fluid (see FIGS. 3A-3D). The pipe 2a and the pipe 2e are also relatively shifted with respect to each other in the stacking direction d3 (the vertical direction). That is, the pipe 2a and the pipe 2e are stacked in the stacking direction d3 (the vertical direction) and also are relatively shifted with respect to each other in the flowing direction d1.

[0021] Also, in the present embodiment, spacers 3 are disposed in the heat-transfer pipe group 2 at both longitudinal end sides of the heat-transfer pipe group 2. Specifically, the spacers 3 are disposed between the first pipe set 2x and the second pipe set 2y at the both longitudinal end sides of the heat-transfer group 2.

[0022] The pipes 2a-2h includes sections disposed in a direction crossing a flow path of the external fluid on each of an upstream side and a downstream side of the flow path. A specific explanation is provided here regarding the first pipe set 2x. The second pipe set 2y (i.e., the pipes 2e-2h), of which a detailed explanation is omitted, has the same structure as the first pipe set 2x. The pipe 2a has a section on the upstream side (hereinafter re-

ferred to as the "upstream pipe") 22a and a section on the downstream side (hereinafter referred to as the "downstream pipe") 24a. The pipe 2b has an upstream pipe 22b and a downstream pipe 24b, the pipe 2c has an upstream pipe 22c and a downstream pipe 24c, and the pipe 2d has an upstream pipe 22d and a downstream pipe 24d. Hereinafter, the upstream pipes 22a-22d and upstream pipes (not specifically shown) of the pipes 2e-2h are also collectively referred to as the "upstream pipe 22". Also, the downstream pipes 24a-24d and downstream pipes (not specifically shown) of the pipes 2e-2h are also collectively referred to as the "downstream pipe 24". The external fluid flows crossing over the upstream pipe 22 of the pipes 2a-2h, and then flows crossing over the downstream pipe 24 of the pipes 2a-2h.

[0023] When the heat exchanger 1 is disposed in a state of use, each of the upstream pipe 22 and the downstream pipe 24 is tilted with respect to a horizontal plane, as shown in FIG. 2. The upstream pipe 22 and the downstream pipe 24 are arranged in a positional relationship such that an axis 12 of the upstream pipe 22 crosses an axis 14 of the downstream pipe 24 in a projected plan view when the housing space 11 is projected from the upstream side toward the downstream side of the flow path.

[0024] Specifically, one of the axis 12 of the upstream pipe 22 and the axis 14 of the downstream pipe 24 is relatively tilted with respect to the other, and thereby the axis 12 of the upstream pipe 22 crosses the axis 14 of the downstream pipe 24.

[0025] In the present embodiment, the upstream pipe 22 and the downstream pipe 24 are configured to have a same length and a same tilting angle. "Have the same tilting angle" here means that interior angles with respect to a horizontal plane are the same. More specifically, an interior angle α formed by the horizontal plane and the upstream pipe 22 and an interior angle β formed by the horizontal plane and the downstream pipe 24 are the same. As a result, the axis 12 of the upstream pipe 22 and the axis 14 of the downstream pipe 24 cross each other in a position γ in a longitudinal direction d2 of the pipes 2a-2h obtained by equally dividing a length of each of the pipes 2a-2h by the number of the stacked pipe sets. For example, when the first pipe set 2x and the second pipe set 2y are arranged as in the present embodiment (i.e., arranged in two layers), the axis 12 and the axis 14 cross each other in the position γ obtained by bisecting a length (L) of the upstream pipe 22 and a length (L') (L=L' in the present case) of the downstream pipe 24 in the longitudinal direction of the upstream pipe 22 and the downstream pipe 24, as shown in FIG. 2.

[0026] Although the upstream pipe 22 and the downstream pipe 24 may have the same tilting angle, the downstream pipe 24 may have a tilting angle larger than the upstream pipe 22. Specifically, the interior angle β formed by the horizontal plane and the downstream pipe 24 may be larger than the interior angle α formed by the horizontal plane and the upstream pipe 22.

[0027] In addition, as shown in FIGS. 3A-3D, the first pipe set 2x and the second pipe set 2y are relatively shifted with respect to each other in the flowing direction d1 of the external fluid.

(2) Operation and Effects

[0028] According to the heat exchanger 1 in the present embodiment, each of the upstream pipe 22 and the downstream pipe 24 is tilted with respect to the horizontal plane. Accordingly, drain, even if attached to the upstream pipe 22 and the downstream pipe 24 as a result of heat exchange, can be made to flow along tilts of the upstream pipe 22 and the downstream pipe 24, which are tilted with respect to the horizontal planes, toward side areas of the flow path. As a result, the drain is unlikely to remain. Thus, heat exchange is unlikely to be hindered by remaining drain attached to each of the upstream pipe 22 and the downstream pipe 24, and thereby an efficiency of heat exchange can be maintained.

[0029] According to the configuration as above, the upstream pipe 22 and the downstream pipe 24 are arranged in the positional relationship such that the axis 12 of the upstream pipe 22 and the axis 14 of the downstream pipe 24 cross each other in the projected plan view when the housing space 11 is projected from the upstream side toward the downstream side of the flow path of the external fluid. This configuration can reduce areas through which the external fluid simply passes (areas in which the upstream pipe 22 or the downstream pipe is not present in FIG. 2) in the flowing direction of the external fluid, as compared with the case where such a positional relationship that the axis 12 of the upstream pipe 22 and the axis 14 of the downstream pipe 24 cross each other in the projected plan view is not employed (for example, the axis 12 and the axis 14 are parallel and overlapped in the projected plan view). Thus, the external fluid flowing through the housing space 11 more easily contacts the upstream pipe 22 and the downstream pipe 24, and thereby a more improved efficiency of heat exchange can be achieved.

[0030] In the above embodiment, since the first pipe set 2x and the second pipe set 2y are relatively shifted with respect to each other in the flowing direction d1 of the external fluid, flow of the external fluid is more likely to be disturbed, as compared with the case where the pipe sets are not shifted with respect to each other. Thus, the external fluid is more likely to contact the first pipe set 2x and the second pipe set 2y, and thereby a further improved efficiency of heat exchange can be achieved.

[0031] In a case where the pipes 2a-2h are configured such that the tilting angle of the downstream pipe 24 is larger than the tilting angle of the upstream pipe 22, areas through which the external fluid simply passes can be reduced, as compared with the case where all the tilting angles of the upstream pipe 22 and the downstream pipe 24 are the same. Specifically, when the upstream pipe 22 and the downstream pipe 24 are projected from the

upstream side toward the downstream side of the flow path, areas among the pipes 2a-2h can be reduced. Thus, the external fluid flowing through the housing space 11 more easily contacts the upstream pipe 22 and the downstream pipe 24, and thereby a more improved efficiency of heat exchange can be achieved.

[0032] In the above embodiment, the pipes 2a-2h correspond to examples of a heat-transfer pipe and a spiral heat-transfer pipe, the upstream pipe 22 corresponds to the upstream heat-transfer pipe section, and the downstream pipe 24 corresponds to the downstream heat-transfer pipe section.

(3) Variations

[0033] Although a preferred embodiment of the present invention has been described above, it should be understood that the present invention is not at all limited to the above-described embodiment, but may be practiced in various forms within the technical scope of the present invention.

[0034] For example, while the first pipe set 2x and the second pipe set 2y are arranged to form double spirals in the above-described embodiment, three or more pipe sets may be arranged to form triple or more spirals. Also, the length (L) (see FIG. 2) of the upstream pipe 22 and the length (L') (see FIG. 2) of the downstream pipe 24 may be different.

[0035] Further, the tilting angle of the upstream pipe 22 and the tilting angle of the downstream pipe 24 may be different. That is, the interior angle α (see FIG. 2) formed by the horizontal plane and the upstream pipe 22, and the interior angle β (see FIG. 2) formed by the horizontal plane and the downstream pipe 24 may be different. In this case, such a configuration may be possible that the length of the upstream pipe 22 and the length of the downstream pipe 24 is different and also the tilting angle of the upstream pipe 22 and the tilting angle of the downstream pipe 24 are different.

[0036] Moreover, the heat exchanger 1 in the above embodiment may be constituted by only one of the first pipe set 2x and the second pipe set 2y. In this case, by tilting a connecting section 26 for connecting the upstream pipe 22 and the downstream pipe 24 in the single pipe set with respect to the flowing direction of the external fluid, the upstream pipe 22 and the downstream pipe 24 may be configured to cross each other, as shown in FIGS. 4A and 4B.

[0037] Also, a direction of shifting the first pipe set 2x with respect to the second pipe set 2y in the above-described embodiment is not limited to the direction of the flow path as long as the flow of the external fluid is likely to be disturbed by the shifting.

[0038] Further, the pipes 2a-2h may be configured such that when the pipes 2a-2h are projected from the upstream side toward the downstream side of the flow path of the external fluid, the axis 12 of the upstream pipe 22 and the axis 14 of the downstream pipe 24 cross each

other only in part in the projected plan view. More specifically, only a part of the upstream pipe 22 and only a part of the downstream pipe 24 may be relatively tilted with each other, and thereby the part of the upstream pipe 22 and the part of the downstream pipe 24 cross each other. In this case, the remaining part of the upstream pipe 22 and the remaining part of the downstream pipe 24 may be parallel.

Claims

1. A heat exchanger (1) comprising:

a heat-transfer pipe (2a-2h) for heat exchange, wherein the heat exchanger (1) is configured such that heat exchange is performed between an external fluid flowing outside the heat-transfer pipe (2a-2h) and the heat-transfer pipe (2a-2h), the heat-transfer pipe (2a-2h) being a spiral heat-transfer pipe (2a-2h) having a spiral shape, wherein the spiral heat-transfer pipe (2a-2h) includes:

an upstream heat-transfer pipe section (22) disposed on an upstream side of a flow path of the external fluid in a direction crossing the flow path; and

a downstream heat-transfer pipe section (24) disposed on a downstream side of the flow path in a direction crossing the flow path, and

wherein each of an axis (12) of the upstream heat-transfer pipe section (22) and an axis (14) of the downstream heat-transfer pipe section (24) in the spiral heat-transfer pipe (2a-2h) is tilted with respect to a horizontal plane, and also is relatively tilted with respect to the other of the axes (12, 14), so that the axis (12) of the upstream heat-transfer pipe section (22) crosses the axis (14) of the downstream heat-transfer pipe section (24).

2. The heat exchanger (1) according to claim 1, further comprising:

a housing space (11) for housing the spiral heat-transfer pipe (2a-2h),

wherein the heat exchanger (1) is configured such that the external fluid is discharged after flowing through the housing space (11), to thereby perform heat exchange between the external fluid and an internal fluid flowing inside the spiral heat-transfer pipe (2a-2h).

3. The heat exchanger (1) according to claim 2, wherein a plurality of the spiral heat-transfer pipes (2a-2h)

are housed in the housing space (11) so as to form multiple spirals.

4. The heat exchanger (1) according to claim 3, wherein each of the plurality of the spiral heat-transfer pipes (2a-2h) is relatively shifted in a predetermined direction with respect to the other spiral heat-transfer pipes (2a-2h). 5
5. The heat exchanger (1) according to claim 3 or 4, wherein the plurality of the spiral heat-transfer pipes (2a-2h) are stacked in a direction crossing a flowing direction (d1) of the external fluid so as to form multiple spirals. 10
6. The heat exchanger (1) according to claim 4, wherein each of the plurality of the spiral heat-transfer pipes (2a-2h) is relatively shifted in a direction crossing a neighboring direction of the spiral heat-transfer pipes (2a-2h) with respect to the other spiral heat-transfer pipes (2a-2h). 15 20
7. The heat exchanger (1) according to claim 4, wherein, at least in a relationship between two most neighboring spiral heat-transfer pipes ((2a,2e),(2b,2f),(2c,2g),(2d,2h)), one of the spiral heat-transfer pipes ((2a,2e),(2b,2f),(2c,2g),(2d,2h)) is located upstream from the other in the flow path of the external fluid, so that the two spiral heat-transfer pipes ((2a,2e),(2b,2f),(2c,2g),(2d,2h)) are relatively shifted with respect to each other. 25 30
8. The heat exchanger (1) according to claim 4, wherein the each of the plurality of the spiral heat-transfer pipes (2a-2h) is relatively shifted with respect to the other spiral heat-transfer pipes (2a-2h) in the flowing direction (d1) of the external fluid. 35
9. The heat exchanger (1) according to claims 1 to 8, wherein when the spiral heat-transfer pipe (2a-2h) is projected from the upstream side toward the downstream side of the flow path of the external fluid, the axis (12) of the upstream heat-transfer pipe section (22) and the axis (14) of the downstream heat-transfer pipe section (24) cross each other in a projected plan view. 40 45

50

55

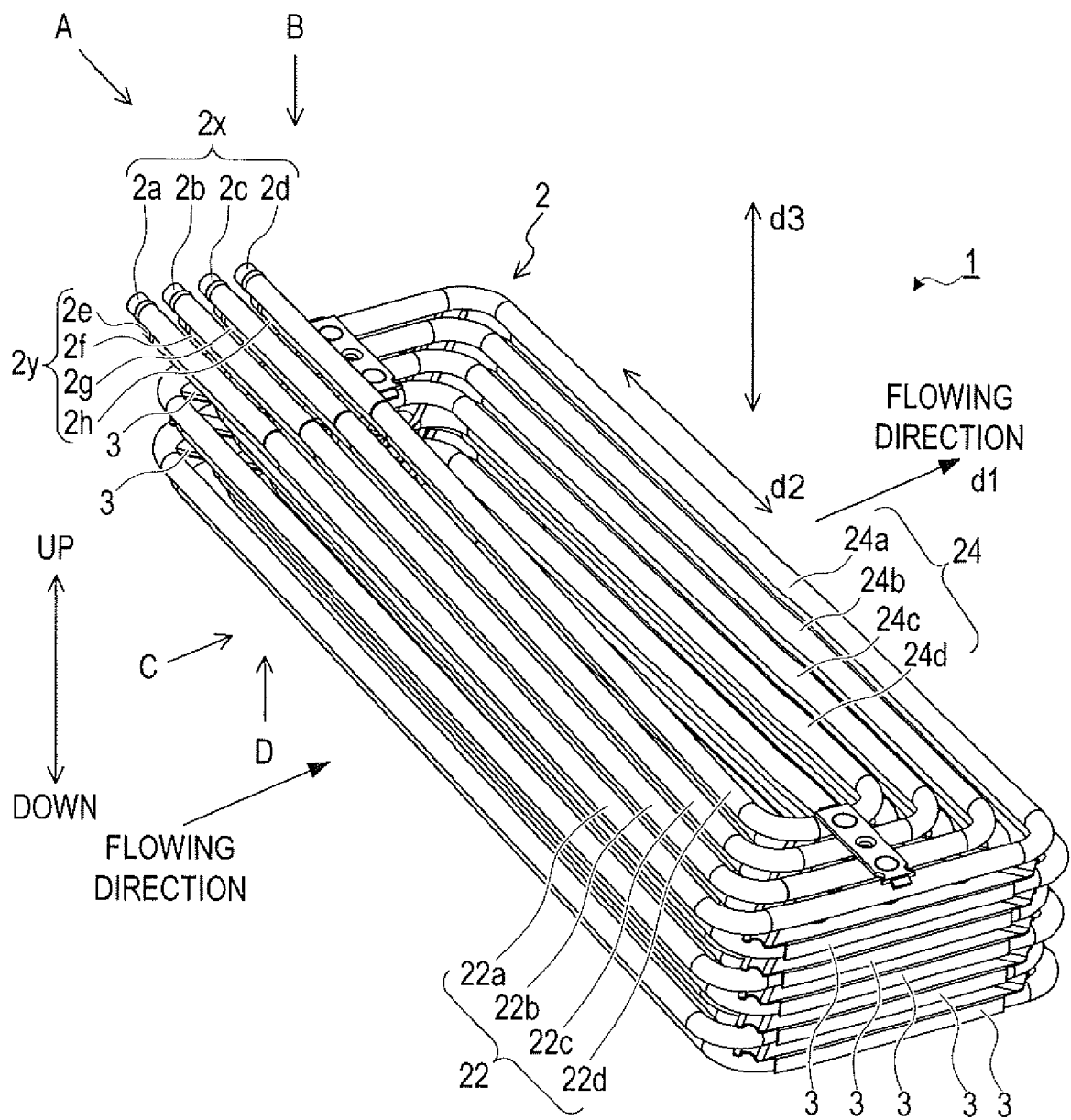


FIG.1

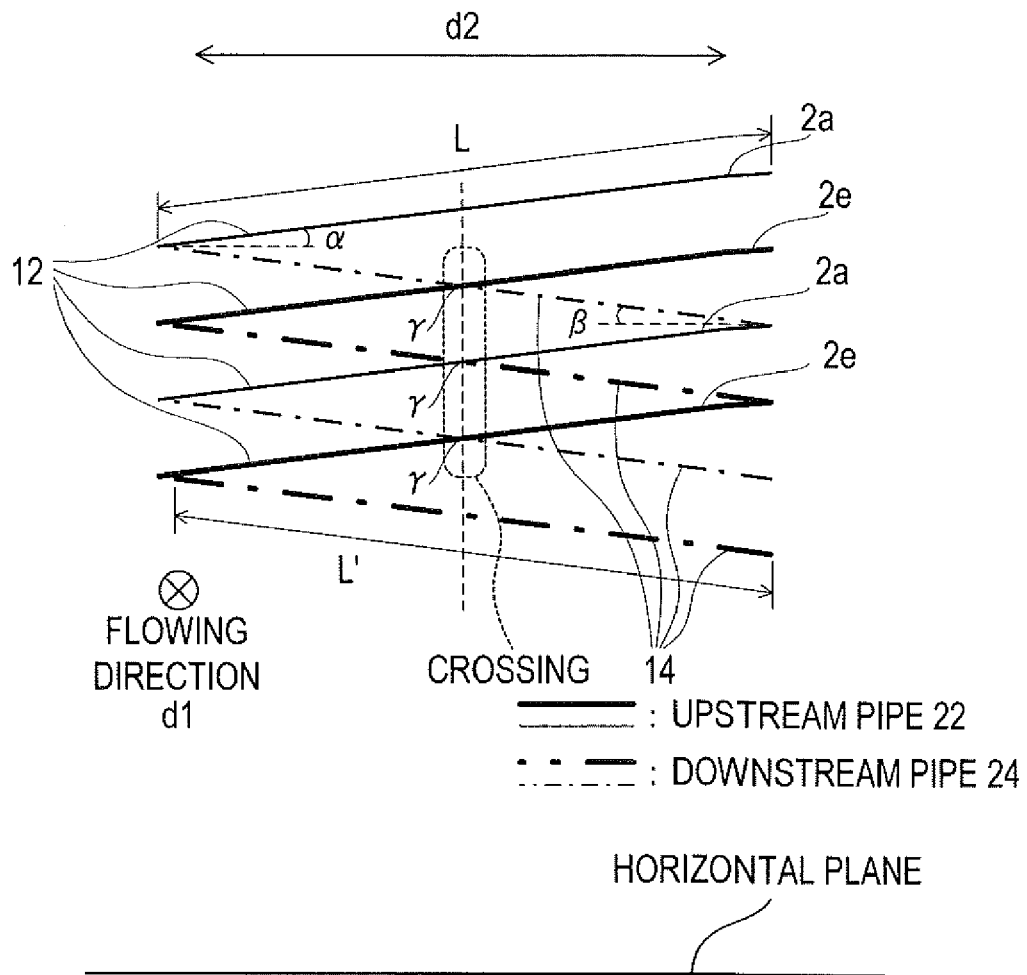


FIG.2

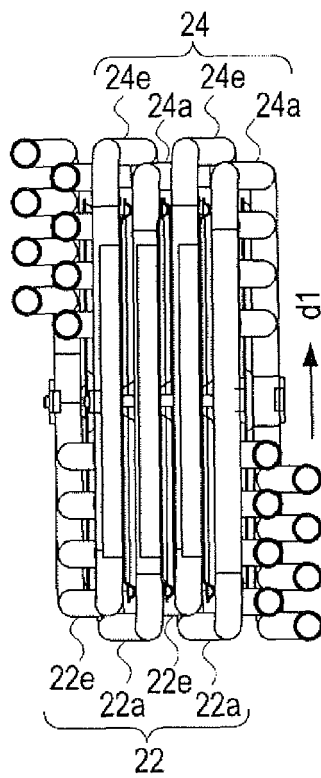


FIG. 3A

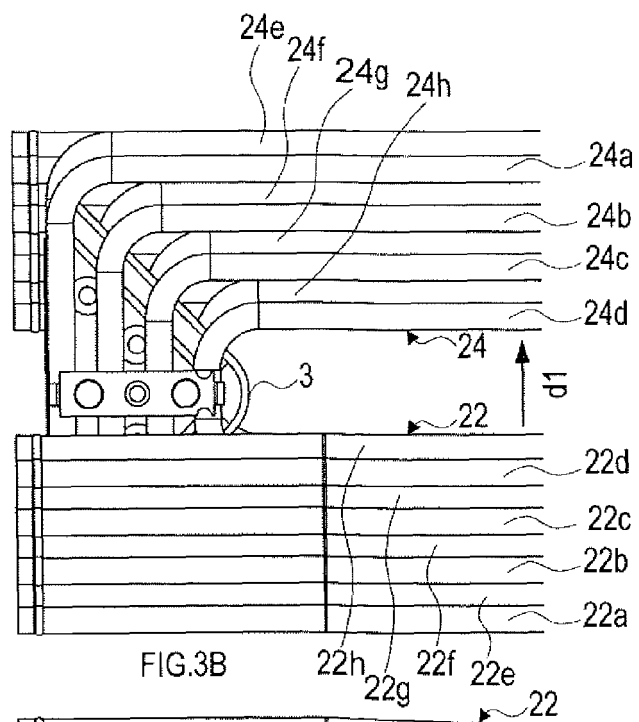


FIG. 3B

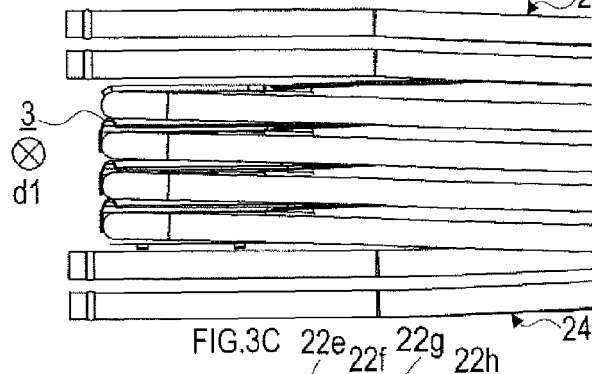


FIG. 3C

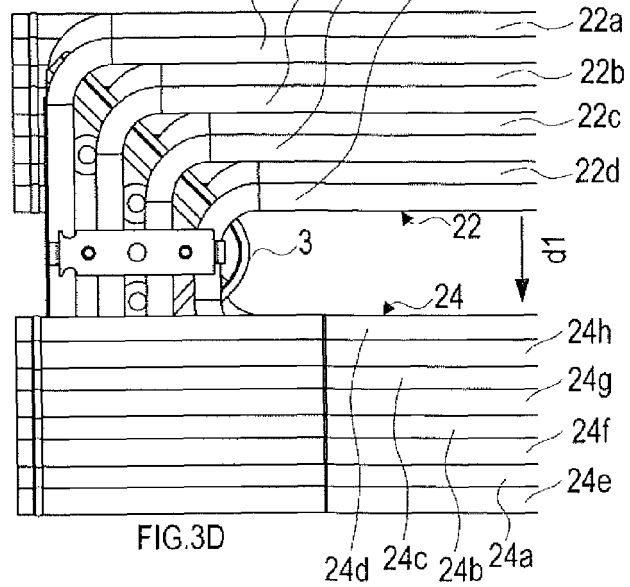
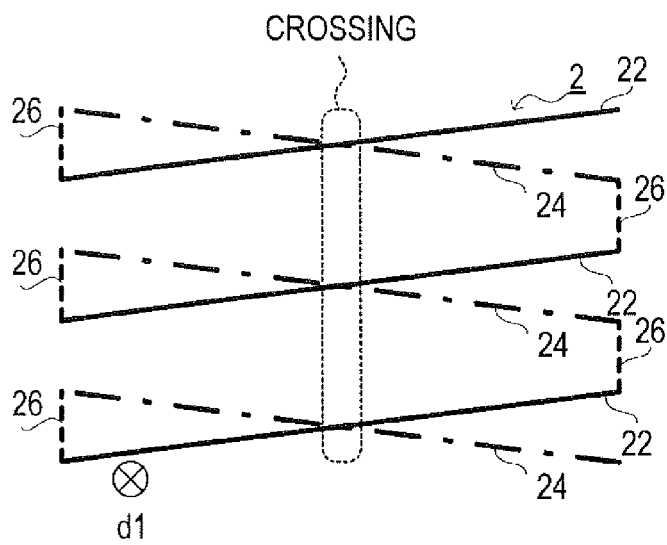
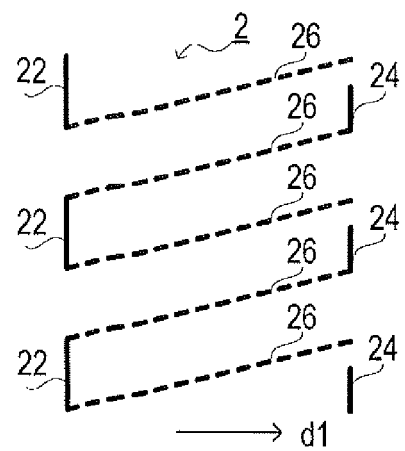


FIG. 3D



—— : UPSTREAM PIPE 22
 - - - : DOWNSTREAM PIPE 24
 : CONNECTING SECTION 26

FIG. 4A



—— : UPSTREAM PIPE 22
 - - - : DOWNSTREAM PIPE 24
 : CONNECTING SECTION 26

FIG. 4B

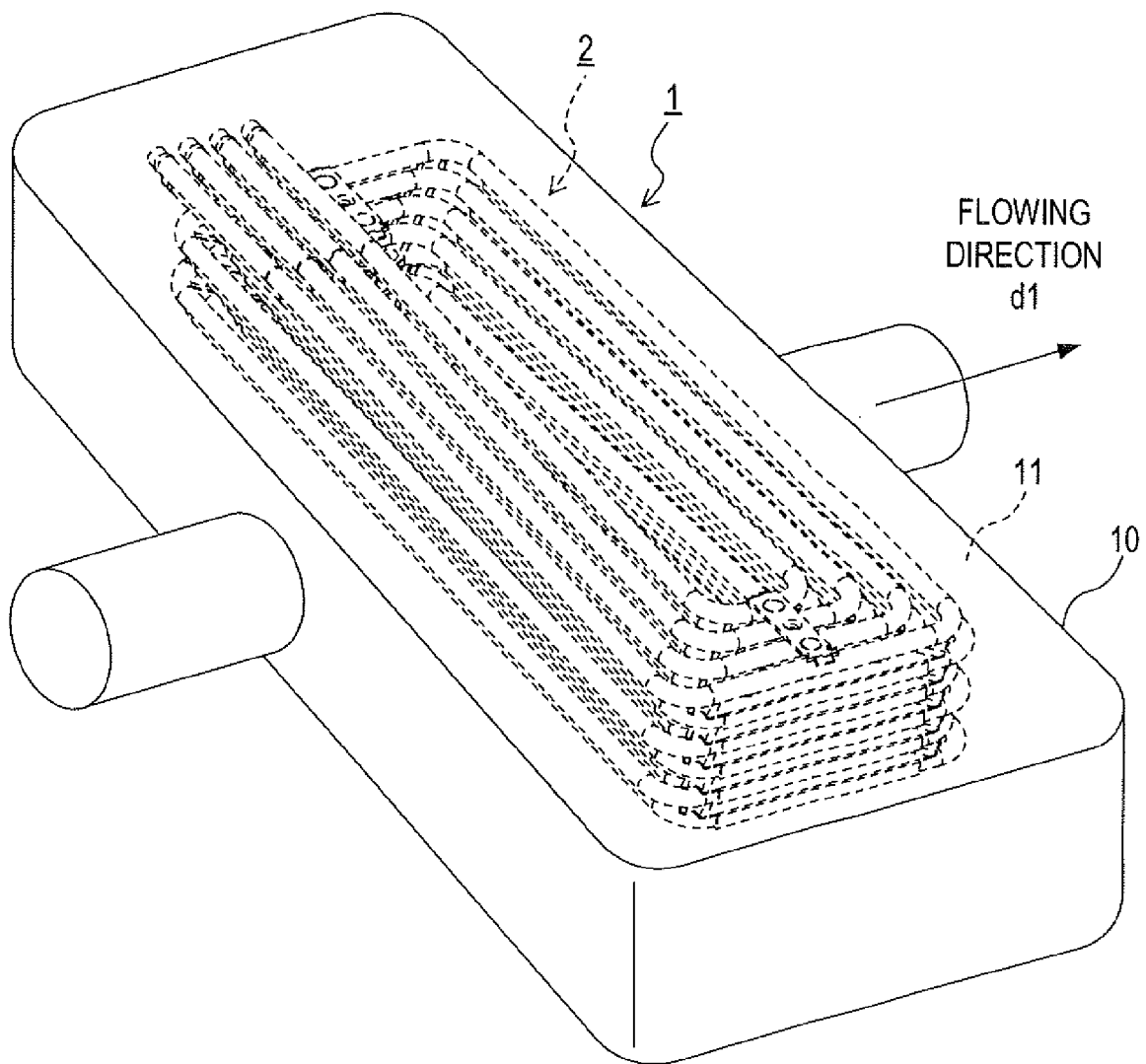


FIG.5

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2008025976 A [0002]
- JP 2008032252 A [0002]