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(54) **SPACER, FIXING STRUCTURE AND HEAT EXCHANGER**

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(57) **ABSTRACT**

A spacer includes a plane portion and at least one positioning portion. The plane portion is interposed between two pipe arrays stacked one another. Each of the two pipe arrays is formed by arranging at least one pipe along a plane which crosses a stacking direction of the two pipe arrays. The at least one positioning portion positions the at least one pipe in at least one of the two pipe arrays on the plane portion.

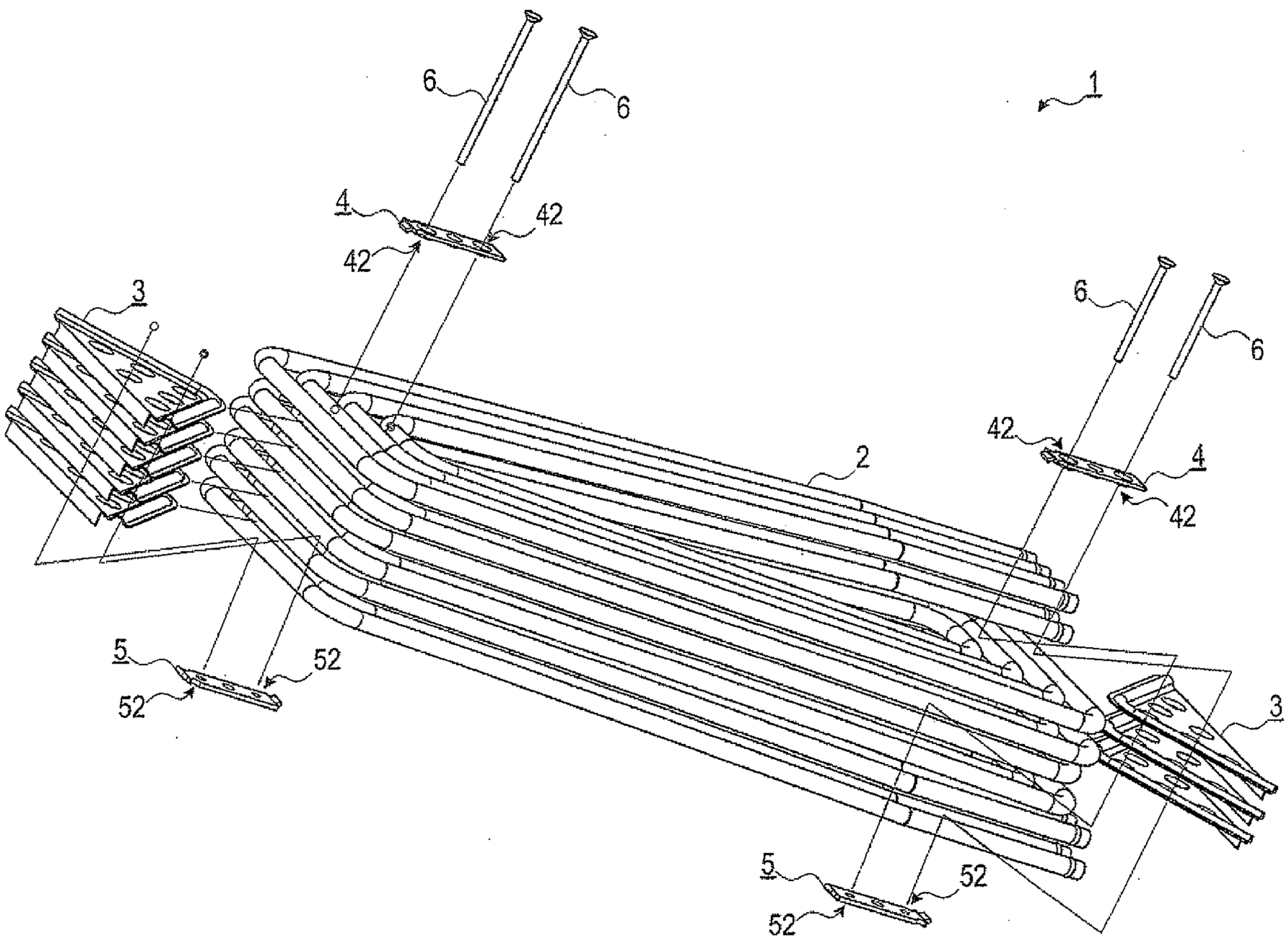
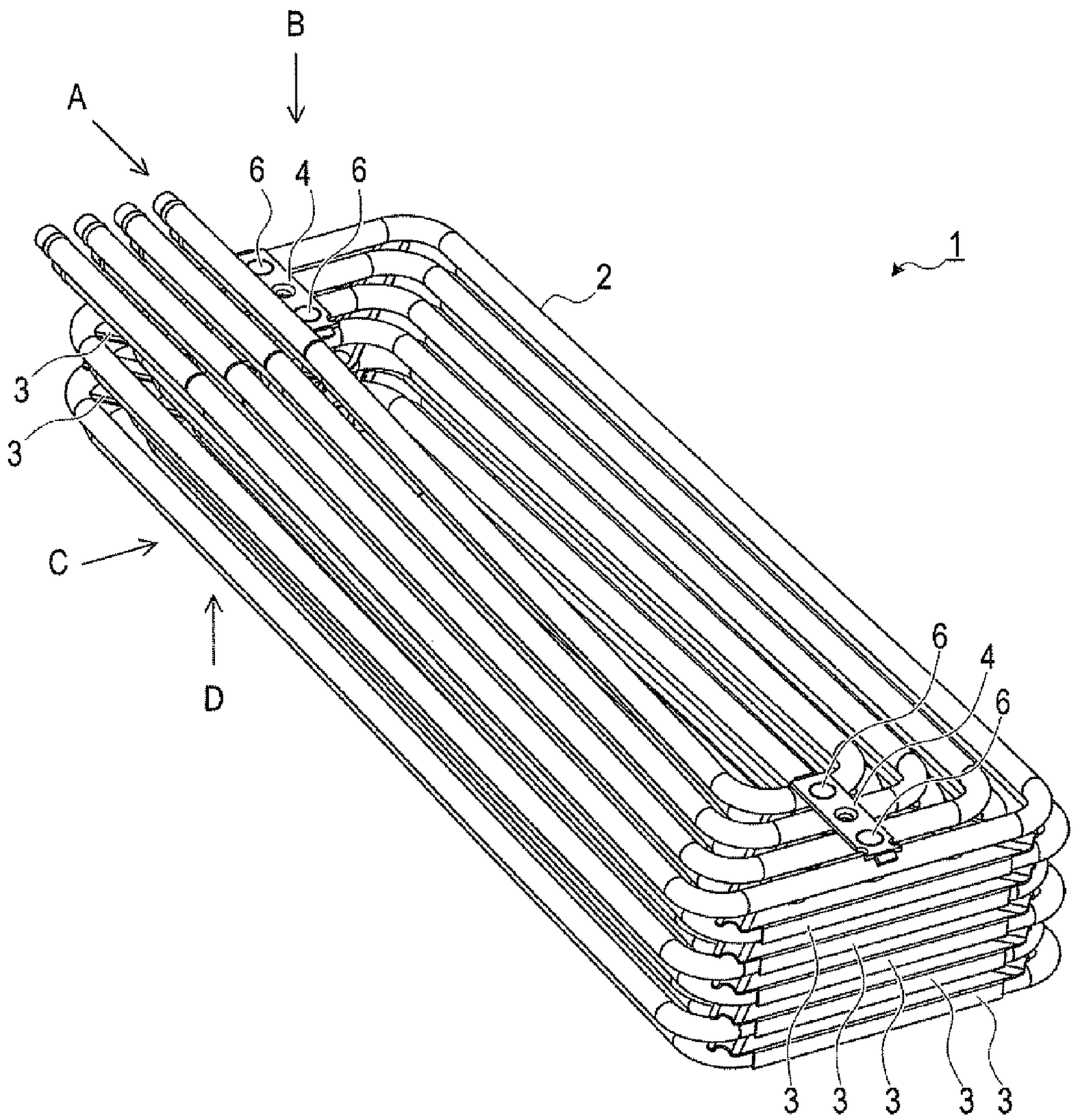


FIG.1



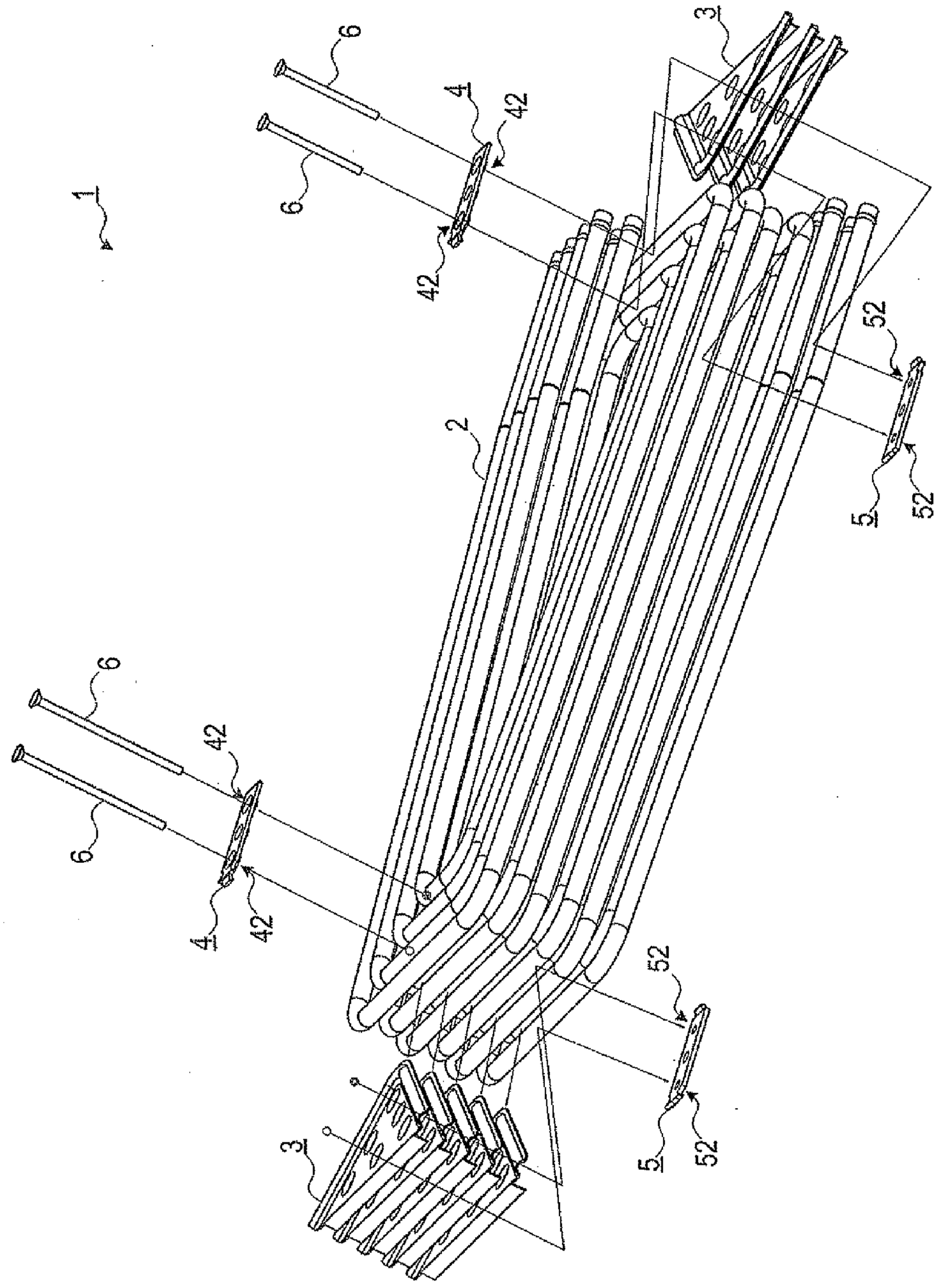


FIG. 2

FIG.3A

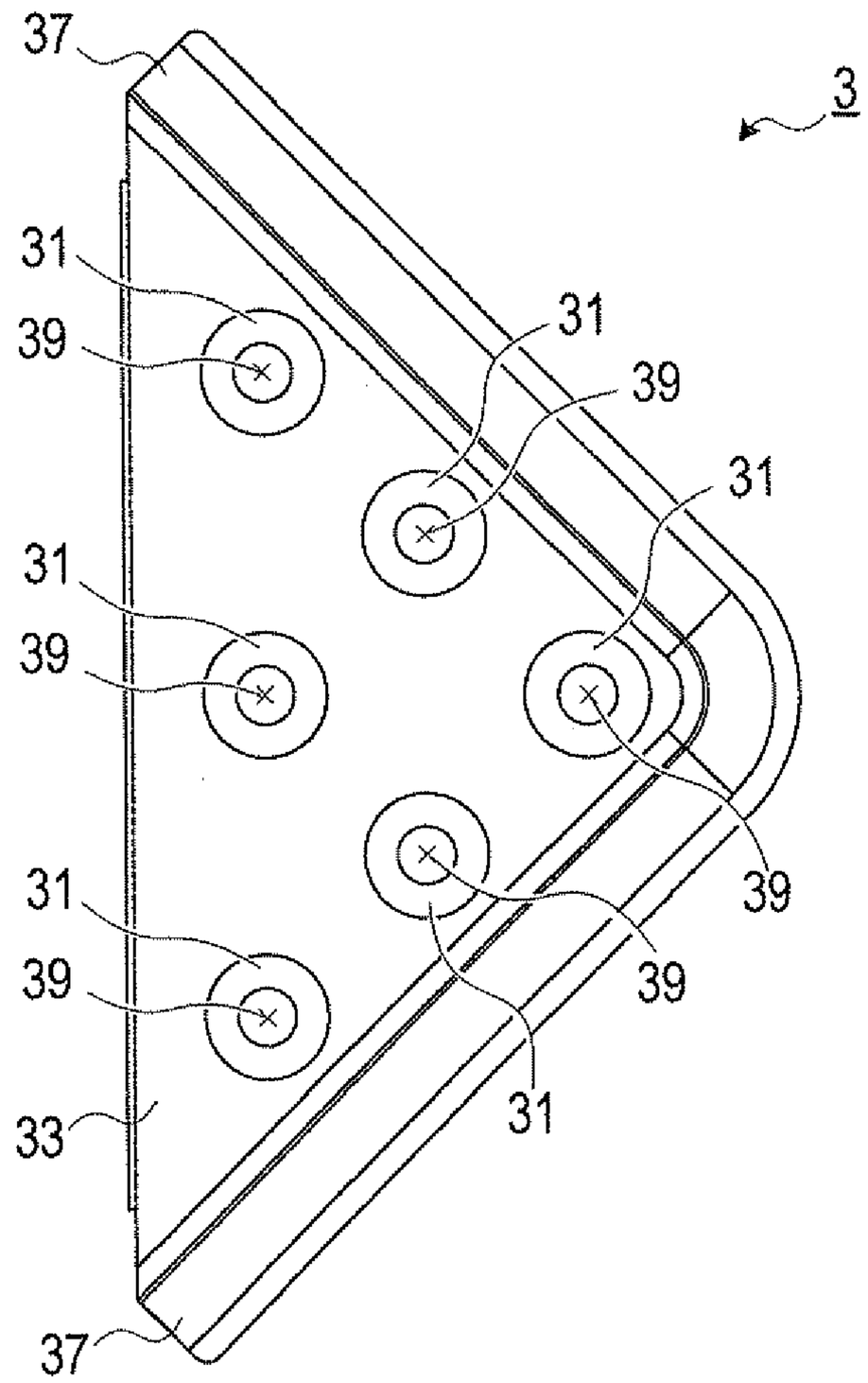


FIG.3B

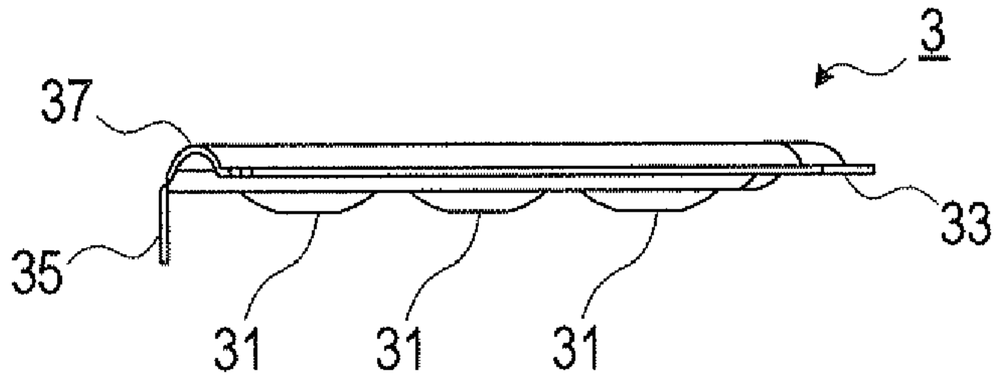


FIG.4A

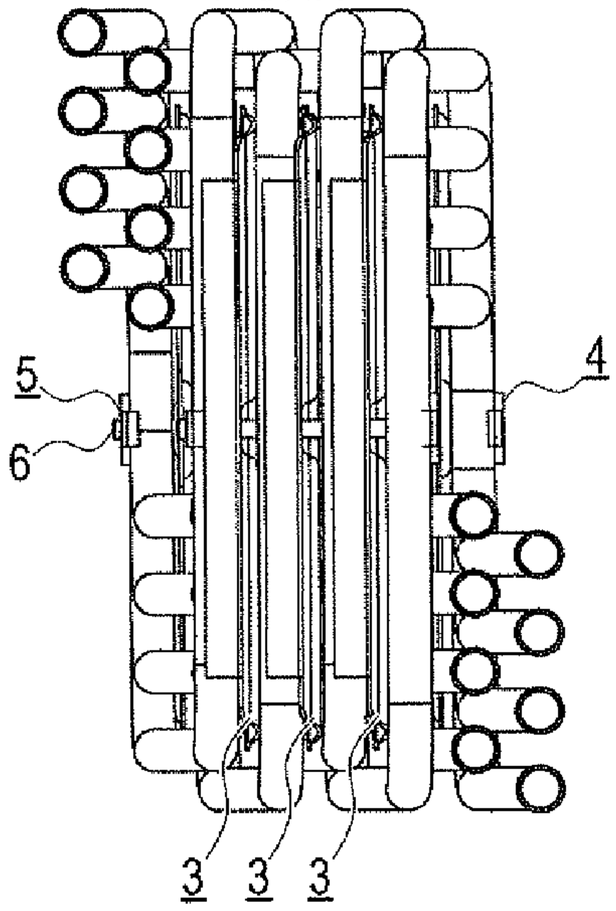


FIG.4B

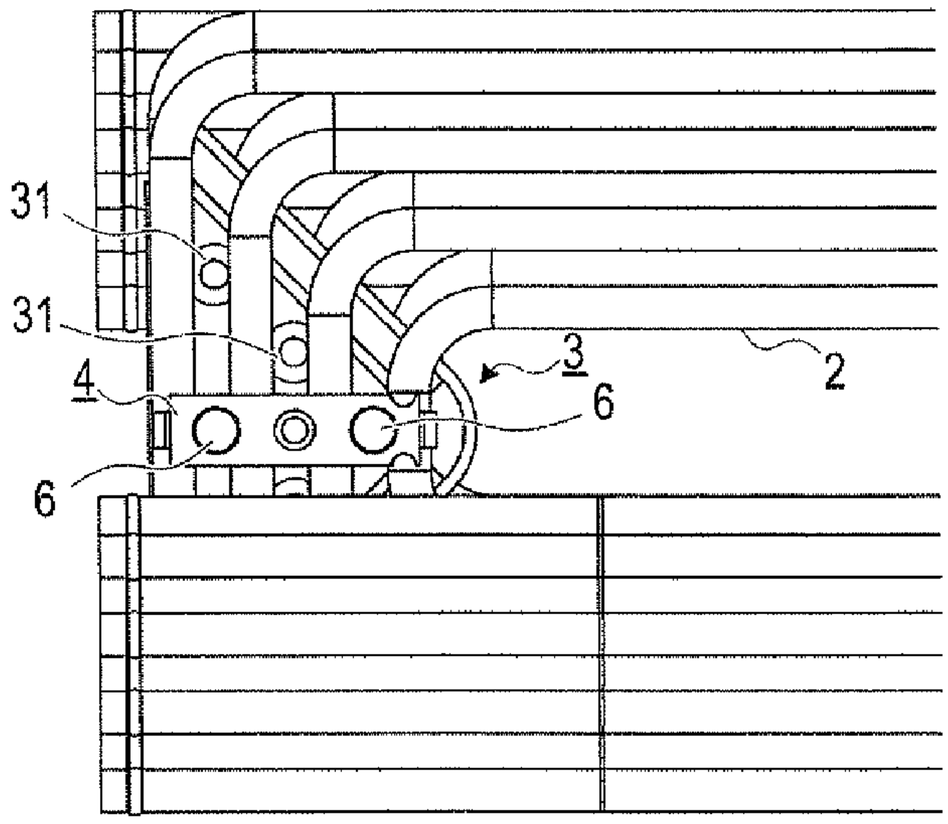


FIG.4C

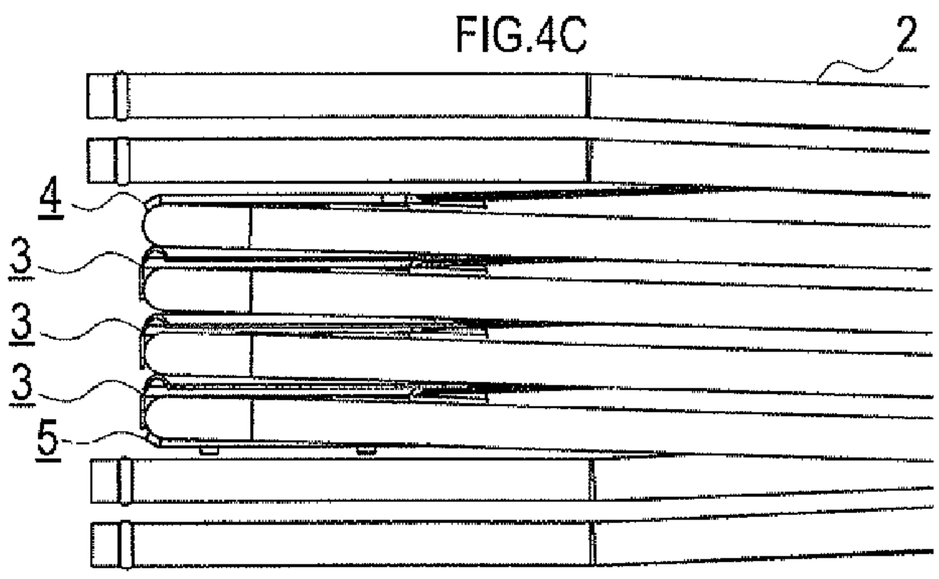
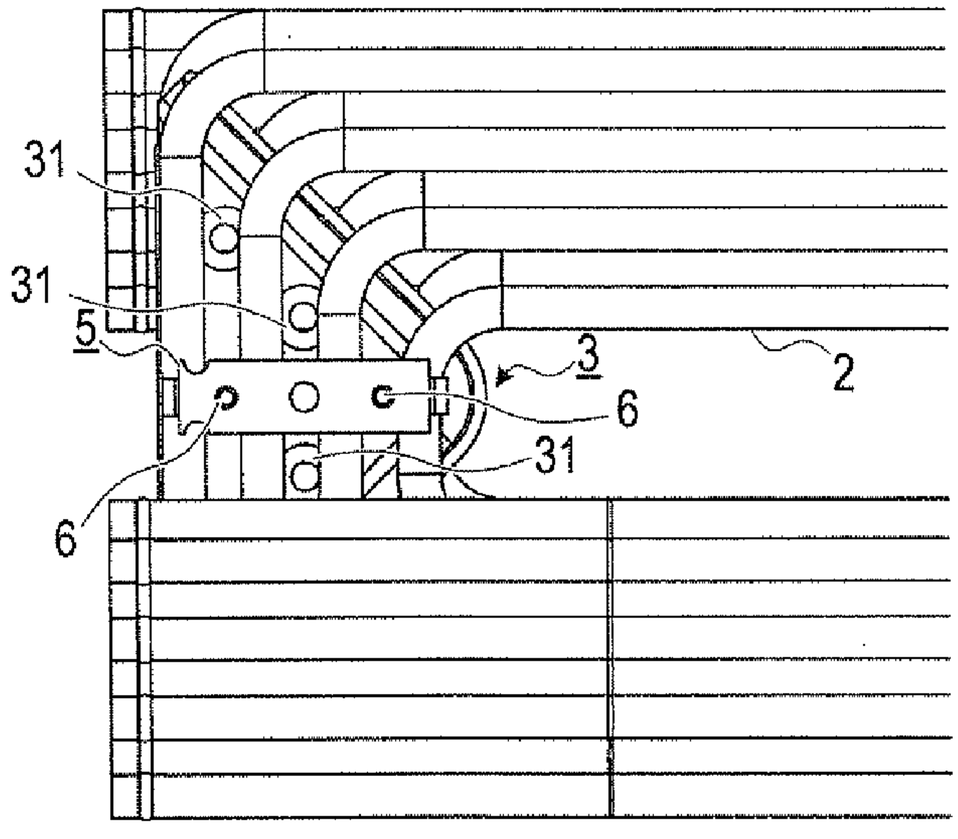


FIG.4D



SPACER, FIXING STRUCTURE AND HEAT EXCHANGER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Japanese Patent Application No. 2009-151220 filed Jun. 25, 2009 in the Japan Patent Office, the disclosure of which is incorporated herein by reference.

BACKGROUND

[0002] The present invention relates to a technique of stacking a plurality of pipe arrays including at least one pipe arranged along a predetermined plane.

[0003] For example, in a heat exchanger disclosed in Unexamined Japanese Patent Publication No. 2008-151473, a plurality of pipe arrays including a plurality of pipes arranged along a predetermined plane are stacked. Intervals between the adjacent two pipe arrays are controlled using a control member made of a wire rod.

SUMMARY

[0004] Since the above-described control member is a wire rod, the intervals between the pipe arrays can be maintained but intervals between or positions of the respective pipes in the pipe arrays cannot be properly maintained.

[0005] In one aspect of the present invention, it is preferable that not only the intervals between stacked plurality of pipe arrays but a position of at least one pipe in each of the plurality of pipe arrays can be properly maintained.

[0006] A first aspect of the invention provides a spacer including a plane portion and at least one positioning portion. The plane portion is interposed between two pipe arrays stacked one another. Each of the two pipe arrays is formed by arranging at least one pipe along a plane which crosses a stacking direction of the two pipe arrays. The at least one positioning portion positions the at least one pipe in at least one of the two pipe arrays on the plane portion.

[0007] In the spacer constituted as such, when the plane portion is arranged between the two pipe arrays, the at least one pipe in the at least one of the two pipe arrays can be positioned on the plane portion. Therefore, not only the intervals between the stacked two pipe arrays but also the position of the at least one pipe in the at least one of the two pipe arrays can be properly maintained.

[0008] The at least one positioning portion may be formed in any manner in order to position the at least one pipe in the at least one of the two pipe arrays on the plane portion.

[0009] The at least one positioning portion may be formed, for example, to protrude from the plane portion in at least one of two spots sandwiching an axis line of the at least one pipe.

[0010] In this case, the intervals between the two pipe arrays can be maintained with the spacer interposed between the two pipe arrays. Also, the position of the at least one pipe in the at least one of the two pipe arrays can be properly maintained by the at least one positioning portion protruding from the plane portion of the spacer.

[0011] The at least one positioning portion as above may be formed in any manner. For example, the at least one positioning portion may be formed as a member attached to the plane portion, a member formed by cutting and raising the plane portion, or a member integrally formed with the plane portion.

[0012] More particularly, the at least one positioning portion may be formed by denting the plane portion from one surface of the plane portion toward the other surface in the at least one spot.

[0013] In this case, the at least one positioning portion can be formed by easy processing such as denting the plane portion. The spacer can be easily formed from a mere plate-like member.

[0014] In the at least one positioning portion formed by denting the plane portion, a through hole may be formed which penetrates the at least one positioning portion.

[0015] In this case, fluid such as ambient air and moisture flow through the through hole. Thus, retention of the fluid can be restricted.

[0016] In case that such through hole is formed, the plane portion may be arranged between the two pipe arrays such that the at least one positioning portion protrudes in a direction of gravity.

[0017] This allows positioning of the at least one pipe which is located below the spacer. Moreover, it becomes easy for moisture inside the at least one positioning portion to be discharged downward from the through hole.

[0018] At least part of an end portion of the spacer extending along the plane portion may be bent. This allows improvement in bending strength of the spacer.

[0019] There is no specific limitation in which direction to bend the at least part of the end portion of the spacer. For example, the at least part of the end portion of the spacer may be bent in the same direction as or opposite direction to the direction in which the at least one positioning portion protrudes.

[0020] A second aspect of the invention provides a fixing structure including at least one spacer and a clamping portion. The at least one spacer includes a plane portion and at least one positioning portion. The plane portion is interposed between two pipe arrays stacked one another. Each of the two pipe arrays is formed by arranging at least one pipe along a plane which crosses a stacking direction of the two pipe arrays. The at least one positioning portion positions the at least one pipe in at least one of the two pipe arrays on the plane portion. The clamping portion clamps the at least one spacer together with a pipe group. The pipe group includes at least the two pipe arrays.

[0021] According to the fixing structure as such, the at least one spacer can maintain the intervals between the two pipe arrays, and also fixes the pipe group while properly maintaining the position of the at least one pipe in the at least one of the two pipe arrays.

[0022] The at least one positioning portion may be formed in any manner in order to position the at least one pipe in the at least one of the two pipe arrays on the plane portion. The at least one positioning portion may be formed, for example, to protrude from the plane portion in at least one of two spots sandwiching an axis line of the at least one pipe.

[0023] In this case, the intervals between the two pipe arrays can be maintained with the spacer interposed between the two pipe arrays. Also, the position of the at least one pipe in the at least one of the two pipe arrays can be properly

maintained by the at least one positioning portion protruding from the plane portion of the spacer.

[0024] The plane portion may include at least one through hole which penetrates at least one of the plane portion and the at least one positioning portion, in a position off the at least one pipe positioned on the plane portion by the at least one positioning portion.

[0025] In this case, the clamping portion may include a pair of clamping members and at least one connecting member. Between the pair of clamping members, the at least one spacer is arranged together with the pipe group. The at least one connecting member interconnects the pair of clamping members through the at least one through hole.

[0026] In the fixing structure as such, the spacer is interposed between the two pipe arrays, the pipe group is arranged between the pair of clamping, members, and the pair of clamping members are connected to each other by the at least one connecting member through the at least one through hole. Thereby, the pipe group can be fixed.

[0027] The spacer in the fixing structure according to the second aspect may be constituted in the same manner as the spacer according to the first aspect.

[0028] A third aspect of the invention provides a heat exchanger including a pipe group and at least one spacer. The pipe group is formed by at least two pipe arrays stacked one another. Each of the at least two pipe arrays is formed by arranging at least one heat-transfer pipe along a plane which crosses a stacking direction of the at least two pipe arrays. The at least one spacer includes a plane portion and at least one positioning portion. The plane portion is arranged between two pipe arrays in the at least two pipe arrays. At least one positioning portion positions the at least one heat-transfer pipe in at least one of the two pipe arrays on the plane portion.

[0029] The at least one positioning portion may be formed in any manner in order to position the at least one heat-transfer pipe in the at least one of the two pipe arrays on the plane portion. The at least one positioning portion may be formed, for example, to protrude from the plane portion in at least one of two spots sandwiching an axis line of the at least one heat-transfer pipe.

[0030] The heat exchanger as such may further include a clamping portion that clamps the at least one spacer together with the pipe group.

[0031] The plane portion may include at least one through hole which penetrates at least one of the plane portion and the at least one positioning portion, in a position off the at least one heat-transfer pipe positioned on the plane portion by the at least one positioning portion.

[0032] In this case, the clamping portion may include a pair of clamping members and at least one connecting member. Between the pair of clamping members, the at least one spacer is arranged together with the pipe group. The at least one connecting member interconnects the pair of clamping members through the at least one through hole.

[0033] In the heat exchanger constituted as such, the same operation and effect as the spacer of the first aspect or the fixing structure of the second aspect can be obtained.

[0034] The at least one heat-transfer pipe may be shaped so as to surround a predetermined space.

[0035] The at least one heat-transfer pipe may be arranged to form a space for air passage around the at least one heat-transfer pipe.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] The present invention will be described hereinafter by way of example with reference to the accompanying drawings, in which:

[0037] FIG. **1** is a perspective view of appearance of a heat exchanger according to an embodiment;

[0038] FIG. **2** is an exploded perspective view of the heat exchanger;

[0039] FIG. **3**A is a bottom view of a spacer;

[0040] FIG. **3**B is a side view of the spacer;

[0041] FIG. **4**A 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° counter-clockwise;

[0042] FIG. **4**B 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**;

[0043] FIG. **4**C 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**; and

[0044] FIG. **4**D 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**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0045] (1) Overall Constitution of Heat Exchanger

[0046] Referring to FIG. **1**, a heat exchanger **1** includes a plurality of heat-transfer pipes (hereinafter, simply referred to as "pipes") **2**. Each of these pipes **2** is shaped so as to surround a predetermined space, and spaced out from each other so that a space for air passage is formed around each of these pipes **2**.

[0047] More particularly, in the present embodiment, these pipes **2** are arranged in parallel to each other and shaped so as to helically surround a rectangular parallelepiped. With the plurality of pipes **2** arranged and shaped as such, a pipe group constituted from a plurality of pipe arrays stacked in an up and down direction in the figure is formed around the space. The plurality of pipe arrays are constituted from the plurality of pipes **2** arranged along a plurality of planes which cross the stacking direction of the pipe arrays.

[0048] As shown in FIG. **2**, on both longitudinal end sides of the pipe group, spacers **3** are interposed between the respective adjacent pipe arrays. The spacers **3** maintain intervals between the adjacent pipe arrays and intervals between the pipes **2** in the respective pipe arrays.

[0049] As shown in FIGS. **3**A and **3**B, each of the spacers **3** includes a plane portion **33** and a plurality of positioning portions **31** which protrude from the plane portion **33**.

[0050] The spacer **3** is a plate-like member shaped into a triangular plane, which includes a bent portion **35** and a convex portion **37**. The bent portion **35** is formed by bending a section extending from one side of the member. The convex portion **37** is formed along two sides other than the one side forming the bent portion **35**. In the present embodiment, the convex portion **37** protrudes from one surface of the spacer **3** facing upward (hereinafter, referred to as a "first surface") in a state that the spacer **3** is interposed between the pipe arrays, and the bent portion **35** is bent toward the other surface facing downward (hereinafter, referred to as a "second surface").

[0051] The positioning portions **31** position the respective pipes **2** located along the second surface of the spacer **3** interposed between the pipe arrays. More particularly, each of

the positioning portions **31** protrudes in a direction away from the second surface in one of two spots sandwiching an axis line of each of the pipes **2**, thereby to position each of the pipes **2** (see FIGS. **4**A to **4**D).

[0052] Also, these positioning portions **31** respectively protrude in the direction of the pipes **2** by denting at least one of two spots sandwiching the axis line of each of the pipes **2** in the plane portion **33** toward the pipes **2**. In the present embodiment, side surfaces of the positioning portions **31** slope so as to reduce cross-sectional area of positioning portions **31** toward the protruding direction. As a result, the positioning portion **31** is in the form of a cone as a whole.

[0053] In the present embodiment, the six positioning portions **31** are arranged along an outer edge of a triangle according to the shape of the spacer **3**. These positioning portions **31** position each of the pipes **2** in at least one of two spots sandwiching the axis line of each of the pipes **2**.

[0054] Moreover, in a protruding end of each of the positioning portions **31**, a through hole **39** is formed which penetrates in a thickness direction of the spacers **3**.

[0055] The spacers **3**, as shown in FIG. **2**, are fixed to the pipe group by a pair of clamping members **4** and **5** and bar-like connecting members **6**. The clamping members **4** and **5** clamp the pipe group in a stacking direction of the pipe arrays. The connecting members **6** connect the clamping members **4** and **5**.

[0056] The clamping members **4** and **5** are respectively made of a plate-like member extending in a certain direction and having through holes **42** and **52**. The connecting members **6** reach from the through holes **42** of the one clamping member **4** to the through holes **52** of the other clamping member **5**, passing through interspaces between the adjacent pipes **2** in the pipe arrays and the through holes **39** in the spacers **3** sequentially along the stacking direction of the pipe arrays. In this manner, the connecting members **6** connect the pair of clamping members **4** and **5**.

[0057] In the present embodiment, the connecting members **6** are configured as screw members. The tip ends of the screw members are fitted into the through holes **52** which are formed as screw holes in the other clamping member **5**. In this manner, connection between the clamping member **5** and the connecting members **6** is achieved (see FIGS. **4**A to **4**D). Also in the present embodiment, the two through holes **42** and **52** are formed along a longitudinal direction of the respective clamping members **4** and **5**. The connecting members **6** are passed through the respective through holes **42** and **52**.

[0058] (2) Operation and Effect

[0059] In the heat exchanger **1** constituted as such, the pipe group can be fixed by interposing the spacers **3** between the pipe arrays of the pipe group, arranging the pair of clamping members **4** and **5** to sandwich the pipe group, and passing the connecting members **6** through the through holes **42** and **52** of the clamping members **4** and **5**, the through holes **39** of the spacers **3**, and the interspaces of the adjacent pipes **2** in the respective pipe arrays.

[0060] Here, each of the spacers **3** can maintain the intervals between the pipe arrays by the convex portions **37** of the respective spacers **3**, and position the respective pipes **2** in the respective pipe arrays by the positioning portions **31** which protrude from the plane portion **33**. In this manner, the spacers **3** can maintain the intervals between the respective pipes **2**.

[0061] Also, due to the slope of the side surfaces of the positioning portions **31** which protrude from the plane portion **33**, the spacers **3** are slightly moved in a direction crossing the planes of the pipe arrays by tightening upon fixing the pipe group. As a result, the pipes **2** are slightly moved along the planes of the pipe arrays along sloped surfaces of the side surfaces of the positioning portions **31**. The pipes **2** can be fixed without backlash.

[0062] According to the above constituted spacer **3**, the positioning portions **31** can be easily formed by denting the plane portion **33**. Thus, the spacer **3** which is able to maintain the respective intervals of the pipes **2** can be easily formed from a mere plate-like member.

[0063] In the above constituted spacer **3**, a part of the through holes **39** formed in the positioning portions **31** can be used for fixing the spacer **3** and the pipe group.

[0064] The through holes **39** which are not used for fixing the spacer **3** and the pipe group can pass fluid such as ambient air and moisture. Therefore, it is advantageous to restrict retention of the fluid.

[0065] Moreover, the positioning portions **31** are formed to protrude from the surface side facing upward toward the surface side facing downward when the spacer **3** is interposed between the pipe arrays. Thus, the pipes **2** can be positioned which are located below the spacer **3**.

[0066] Especially in the above-described embodiment, the through holes **39** are positioned at the lower ends of the positioning portions **31**. Therefore, moisture (so-called drain) which is retained inside dents of the positioning portions **31** can be discharged downward through the through holes **39**.

[0067] Also in the above-described spacer **3**, bending strength of the spacer **3** can be improved by bending part of the end portion of the spacer **3** (the bent portion **35** and the convex portion **37**).

[0068] (3) Variations

[0069] In the above, an embodiment of the invention has been described. It goes without saying, however, that the present invention is not limited to the above-described embodiment, and can take various modes within the technical scope of the invention.

[0070] For example, in the above-described embodiment, the spacer **3** is applied to the pipe group in the heat exchanger **1**. As long as the same sort of pipe group is used, the spacer **3** can be applied to a pipe group provided in apparatus other than the heat exchanger **1**.

[0071] In the above-described embodiment, a fixing structure constituted from the spacers **3**, the clamping members **4** and **5** and the connecting members **6** is used for fixation of the pipe group in the heat exchanger **1**. As long as the same sort of pipe group is used, the fixing structure may be used for fixation of a pipe group provided in apparatus other than the heat exchanger **1**.

[0072] In the above-described embodiment, the positioning portion **31** of the spacer **3** is formed by denting the plane portion **33** so as to protrude in the dented direction. The positioning portion **31** only has to protrude from the plane portion **33**. For example, the positioning portion **31** may be formed by a member attached to the plane portion **33** or a member formed by cutting and raising the plane portion **33**. In this case, the positioning portion **31** is only required to protrude to such an extent that at least part of the positioning portion **31** comes into contact with the pipe **2**.

[0073] In the above-described embodiment, the positioning portion **31** of the spacer **3** protrudes from the first surface facing upward toward the second surface facing downward. The positioning portion **31** may be formed to protrude from

the second surface side toward the first surface side. Alternatively, the positioning portion **31** may be formed to protrude from both the first surface and the second surface.

[0074] In the above-described embodiment, the bent portion **35** of the spacer **3** is bent in the same direction as the direction in which the positioning portion **31** protrudes. The bent portion **35** may be bent in the opposite direction to the direction in which the positioning portion **31** protrudes.

[0075] In the above-described embodiment, the convex portion **37** of the spacer **3** protrudes in the opposite direction to the direction to which the positioning portion **31** protrudes. The convex portion **37** may protrude in the same direction as the direction to which the positioning portion **31** protrudes.

[0076] In the above-described embodiment, the planar shape of the spacer **3** is formed into an almost triangle. The planar shape of the spacer **3** is not limited to a triangle but may be a trapezoid, a rectangle or a circle.

[0077] In the above-described embodiment, the pipes **2** are shaped to helically surround a rectangular parallelepiped. The pipes **2** may be shaped so as to reciprocate within a predetermined space.

What is claimed is:

1. A spacer comprising:

a plane portion interposed between two pipe arrays stacked one another, each of the two pipe arrays being formed by arranging at least one pipe along a plane which crosses a stacking direction of the two pipe arrays; and

at least one positioning portion that positions the at least one pipe in at least one of the two pipe arrays on the plane portion.

2. The spacer according to claim **1**, wherein the at least one positioning portion is formed to protrude from the plane portion in at least one of two spots sandwiching an axis line of the at least one pipe.

3. The spacer according to claim **2**, wherein the at least one positioning portion is formed by denting the plane portion from one surface of the plane portion toward the other surface in the at least one spot.

4. The spacer according to claim **3**, wherein the at least one positioning portion includes a through hole which penetrates the at least one positioning portion.

5. The spacer according to claim **4**, wherein the plane portion is arranged between the two pipe arrays such that the at least one positioning portion protrudes in a direction of gravity.

6. The spacer according to claim **1**, wherein at least part of an end portion of the spacer extending along the plane portion is bent.

7. A fixing structure comprising:

at least one spacer including:

a plane portion interposed between two pipe arrays stacked one another, each of the two pipe arrays being formed by arranging at least one pipe along a plane which crosses a stacking direction of the two pipe arrays; and

at least one positioning portion that positions the at least one pipe in at least one of the two pipe arrays on the plane portion; and

a clamping portion that clamps the at least one spacer together with a pipe group, the pipe group including at least the two pipe arrays.

8. The fixing structure according to claim **7**, wherein at least one positioning portion is formed to protrude from the plane portion in at least one of two spots sandwiching an axis line of the at least one pipe.

9. The fixing structure according to claim **8**, wherein

the plane portion includes at least one through hole which penetrates at least one of the plane portion and the at least one positioning portion, in a position off the at least one pipe positioned on the plane portion by the at least one positioning portion, and

the clamping portion includes

a pair of clamping members, the at least one spacer being arranged together with the pipe group between the pair of clamping members; and

at least one connecting member that interconnects the pair of clamping members through the at least one through hole.

10. A heat exchanger comprising:

a pipe group that is formed by at least two pipe arrays stacked one another, each of the at least two pipe arrays being formed by arranging at least one heat-transfer pipe along a plane which crosses a stacking direction of the at least two pipe arrays; and

at least one spacer that includes

a plane portion arranged between two pipe arrays in the at least two pipe arrays and

at least one positioning portion that positions the at least one heat-transfer pipe in at least one of the two pipe arrays on the plane portion.

11. The heat exchanger according to claim **10**, wherein the at least one positioning portion is formed to protrude from the plane portion in at least one of two spots sandwiching an axis line of the at least one heat-transfer pipe.

12. The heat exchanger according to claim **10**, further comprising a clamping portion that clamps the at least one spacer together with the pipe group.

13. The heat exchanger according to claim **12**, wherein

the plane portion includes at least one through hole which penetrates at least one of the plane portion and the at least one positioning portion, in a position off the at least one heat-transfer pipe positioned on the plane portion by the at least one positioning portion, and

the clamping portion includes:

a pair of clamping members, the at least one spacer being arranged together with the pipe group between the pair of clamping members; and

at least one connecting member that interconnects the pair of clamping members through the at least one through hole.

14. The heat exchanger according to claim **10**, wherein the at least one heat-transfer pipe is shaped so as to surround a predetermined space.

15. The heat exchanger according to claim **10**, wherein the at least one heat-transfer pipe is arranged to form a space for air passage around the at least one heat-transfer pipe.

* * * * *