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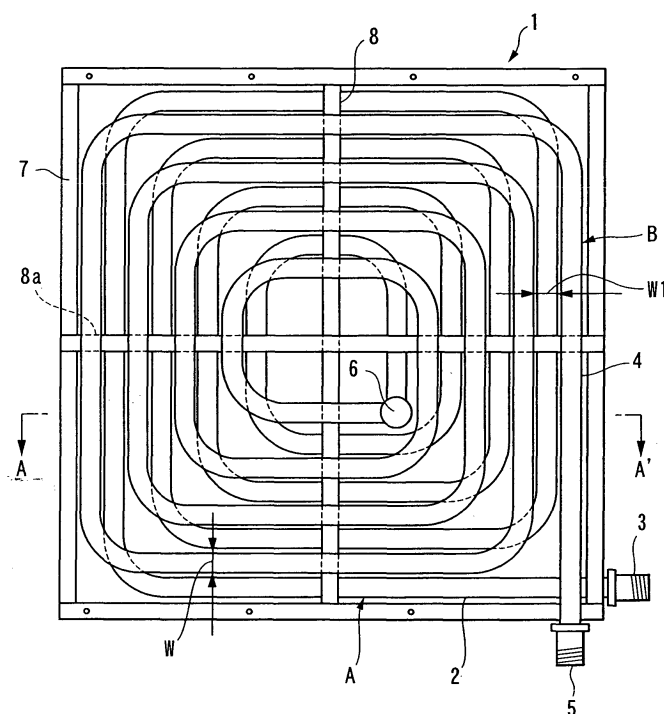
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(54) Heat exchange unit and heat exchanger using the heat exchange unit

(57) A heat exchange unit and a heat exchanger having simple structures which can be manufactured at low cost are provided. The capacity and efficiency of the heat exchanger can be set in accordance with conditions. Heat exchanger tubes 2 and 4 are coiled with predetermined gaps to form heat exchange unit elements A and B, respectively. The elements A and B are shifted from

each other so that the tubes 2 and 4 do not overlap each other. The elements A and B are connected to each other with a connection pipe 6 at inner ends thereof. Fluid enters the element A from an inlet header 12, flows into the element B through the connection pipe 6 at the center of element A, and then flows out of the element B through an outlet header 14. Heat is collected during this time.

FIG. 1



Description

Field of the Invention

[0001] The invention relates to a heat exchange unit for collecting latent or sensible heat and a heat exchanger using the heat exchange unit.

Background and Prior Art Known to the Applicant

[0002] In general, known heat exchangers for collecting latent or sensible heat include a heat exchanger tube provided with fins and installed in a snaking fashion, or multiple heat exchanger tubes disposed so as to extend through a flue or the like. These known heat exchangers have problems in that they occupy a relatively large space, and that manufacturing costs are high since the heat exchangers must be designed in accordance with the dimensions of the flue and exhaust temperature to ensure efficiency. In order to solve these problems, Japanese Unexamined Patent Application Publication No. H9(1997)-72679 discloses a heat exchanger including a coiled heat exchanger tube.

[0003] According to this published invention, in order to reduce the capacity of a boiler or the like, a water tube with a predetermined length is bent in the middle into a U-shape, and is coiled around the U-shaped bent portion. In this invention, since a single water tube is bent in the middle into a U-shape and is then coiled, difficult processing is required and manufacturing costs are high. In addition, when a plurality of coiled water tubes are disposed on one other, efficiency is reduced since the water tubes overlap one another. Accordingly, in order to obtain a certain efficiency, the size of the heat exchanger must be increased.

[0004] Japanese Unexamined Patent Application Publication No. H9(1997)-126688 discloses a coiled-plate cross-flow heat exchanger. The invention described in this publication provides a coiled-plate cross-flow heat exchanger having a cleaning device which is composed of a small number of components and which can be easily installed. The coiled-plate cross-flow heat exchanger includes a coiled flow passage and an axial flow passage, one of which receives heating fluid and the other receives fluid to be heated, and a cleaning device. The cleaning device includes a retaining member which extends in the radial direction of the coiled flow passage above a heat transfer plate, rotational driving means which rotates the retaining member in forward and reverse directions, and a rod-shaped member for removing adhered objects, the rod-shaped member movably hanging from the retaining member into the coiled axial flow passage.

[0005] In this known invention, the coiled flow passage is shaped like concentric annular rings, and does not exactly have a coiled structure like that disclosed in Japanese Unexamined Patent Application Publication No. H9(1997)-72679 in which fluid spirally flows toward or away

from the center.

[0006] In addition, according to this invention, the coiled flow passage is single-layered and is shaped like a flat rectangle in cross section. Therefore, the flow velocity distribution is not uniform in the flow passage and efficiency is low.

[0007] Japanese Unexamined Patent Application Publication No. H11(1999)-248377 relates to a spiral-plate heat exchanger with high heat transfer efficiency and low leakage which uses thin, long heat exchanger plates having irregular surfaces and fluoroplastic films lined or laminated thereon. String-shaped hollow gaskets are provided on a disc-shaped cover for sealing openings at the edges of the plates in the axial direction thereof, the gaskets having a thickness corresponding to a predetermined interval.

The hollow sections of the gaskets are expanded along the diameter by applying liquid pressure, so that the gaskets clamp the edges of the plates from the sides and thereby seal the openings airtight.

[0008] In this invention, although the heat exchanger tubes have a spiral shape, the plates have a particular use and cannot be used for collecting latent heat and sensible heat.

[0009] Japanese Unexamined Patent Application Publication No. 2003-510547 discloses a spiral heat exchanger including at least two spiral sheets extending around a common center axis and forming at least two substantially parallel, spiral flow channels. Each flow channel permits heat exchange fluid to flow in a substantially tangential direction with respect to the center axis. Each flow channel includes a radially outer orifice and a radially inner orifice, the radially outer orifice forming an outlet or an inlet of the flow channel and being located at a radially outer part of the flow channel and the radially inner orifice enabling communication between the flow channel and an inlet/outlet chamber corresponding to the flow channel. The centre axis extends through the inlet/outlet chamber of the radially inner orifice of each flow channel, and the spiral heat exchanger includes a centre body extending around the centre axis and being closed with respect to the flow channels.

[0010] According to this invention, although the two parallel flow channels are spiral, each flow channel is shaped like a flat rectangle in cross section, similar to the above-described three known structures. In addition, the flow channels have a dense spiral structure and are single-layered. Therefore, the structure is complex and large, and manufacturing costs are high.

SUMMARY OF THE INVENTION

Object of the Invention

[0011] An object of the present invention is to provide a heat exchange unit for collecting latent or sensible heat which has a simple structure and high heat exchange efficiency and with which the size and performance of a

heat exchanger can be freely selected in accordance with the equipment and conditions used, and to provide a heat exchanger using the heat exchange unit.

Means for Solving the Problems

[0012] In order to achieve the above-described object, according to the invention of Claim 1, a heat exchange unit includes two heat exchange unit elements A and B, the heat exchange unit elements A and B including heat exchanger tubes that are coiled in a single plane with predetermined gaps and being shifted from each other so that the tubes do not overlap each other when viewed from a direction perpendicular to the plane, wherein the tubes are connected to each other at inner or outer ends of the tubes, and wherein one of the elements A and B has a fluid inlet at the outer or inner end of the tube thereof and the other one of the elements A and B has a fluid outlet at the outer or inner end of the tube thereof.

[0013] In addition, according to the invention of Claim 2, a heat exchanger includes a plurality of heat exchange units arranged in a casing, a fluid inlet header, and a fluid outlet header, the fluid inlet header and the fluid header being disposed on the exterior of the casing. Each heat exchange unit includes two heat exchange unit elements A and B, the heat exchange unit elements A and B including heat exchanger tubes that are coiled in a single plane with predetermined gaps and being shifted from each other so that the tubes do not overlap each other when viewed from a direction perpendicular to the plane. In each heat exchange unit, the tubes are connected to each other at inner or outer ends of the tubes, one of the elements A and B has a fluid inlet at the outer or inner end of the tube thereof, and the other one of the elements A and B has a fluid outlet at the outer or inner end of the tube thereof, the fluid inlet and the fluid outlet being connected to the fluid inlet header and the fluid outlet header, respectively.

[0014] In addition, according to the invention of Claim 3, the heat exchanger tubes of the heat exchange units according to Claim 2 are connected in series.

[0015] In addition, according to the invention of Claim 4, the heat exchanger tubes according to one of claims 1, 2, and 3 are coiled in a circular shape, a rectangular shape, a conical shape, or a polygonal shape including a triangular shape.

[0016] In addition, according to the invention of Claim 5, a heat exchanger includes heat exchange unit elements A and B including heat exchanger tubes that are coiled in a conical shape, the heat exchange unit elements A and B being connected to each other in the same or opposite orientations at a central position.

[0017] In addition, according to the invention of Claim 6, the heat exchanger tubes according to one of Claims 1 to 5 include a corrugated flexible tube, a spiral flexible tube, a flexible tube with annular ridges, or a flexible tube with partially pressed annular ridges.

[0018] According to the invention of Claim 7, the heat

exchanger tubes of the elements A and B according to one of Claims 1 to 6 have different diameters.

Effects of the Invention

[0019] In the heat exchange unit and the heat exchanger according to the present invention, fluid enters the fluid inlet at, for example, the outer end of the heat exchanger tube of one of the unit elements from the fluid inlet header and flows through the heat exchanger tube toward the center. Then, the fluid enters the heat exchanger tube of the other unit element at the center, flows outward through this heat exchanger tube, and reaches the fluid outlet header. While the fluid flows inward and outward through the coiled heat exchanger tubes, heat, for example, is collected from exhaust which travels through the spaces outside the heat exchanger tubes. The present invention provides the following effects:

1. Since the unit elements A and B are combined such that the coiled heat exchanger tubes do not overlap one another, only small portions of the unit elements A and B obstruct the flow of exhaust in a duct. Therefore, pressure loss of the exhaust is low.
2. Since the unit elements A and B have simple structures, they can be easily manufactured.
3. Since the heat exchanger is simply composed of the unit elements A and B, the heat exchanger has a simple structure and is easily manufactured with low cost.
4. The number of units in the heat exchanger disposed in the duct may be increased or reduced. Accordingly, the heat exchanger can be designed and manufactured in accordance with the use thereof.
5. When the heat exchanger is structured by combining unit elements A and B formed in conical and inverted conical shapes and is attached to a narrow or thin flue, a required heat transfer area can be ensured.
6. The heat exchanger tubes of the unit elements A and B may have different diameters. In such a case, when liquid-gas conversion occurs, liquid is guided into a small-diameter tube and gas is guided into a large-diameter tube so that the pressure is balanced. Accordingly, pressure loss can be reduced compared to the case in which heat exchanger tubes have the same diameter.

Brief Description of the Drawings

[0020] The invention will be described with reference to the accompanying drawings, in which:

- Fig. 1 is a front view of a heat exchange unit according to the present invention;
 Fig. 2 is a sectional view of Fig. 1 taken along line A-A';
 Fig. 3 is a front view of a heat exchanger according

to the present invention connected to headers;
 Fig. 4 is a diagram showing an example in which the heat exchanger according to the present invention is attached to an exhaust duct to collect latent heat;
 Fig. 5 is a front view of a heat exchange unit according to Example 2;
 Fig. 6 is a diagram showing a heat exchanger according to Example 2;
 Fig. 7 is a diagram showing a heat exchanger according to Example 3;
 Fig. 8(A) is a front view of a flexible tube with annular ridges coiled in a circular shape;
 Fig. 8(B) is a side view of the flexible tube with annular ridges coiled in a circular shape;
 Fig. 9(A) is a front view of a flexible tube with annular ridges coiled in a square shape;
 Fig. 9(B) is a side view of the flexible tube with annular ridges coiled in a square shape;
 Fig. 10(A) is a front view of a flexible tube with annular ridges coiled in a rectangular shape;
 Fig. 10(B) is a plane view of the flexible tube with annular ridges coiled in a rectangular shape;
 Fig. 11 (A) is a diagram showing a corrugated flexible tube;
 Fig. 11(B) is a diagram showing a spiral flexible tube;
 Fig. 11 (C) is a diagram showing a flexible tube with annular ridges;
 Fig. 11(D) is a sectional view showing a flexible tube with partially pressed annular ridges;
 Fig. 12(A) is a front view of a heat exchange unit including conically coiled flexible tubes;
 Fig. 12(B) is a side view of the heat exchange unit including the conically coiled flexible tubes;
 Fig. 13(A) is a front view showing heat exchange units connected to headers in parallel;
 Fig. 13(B) is a side view showing the heat exchange units connected to the headers in parallel;
 Fig. 14(A) is a front view showing heat exchange units connected in series;
 Fig. 14(B) is a side view showing the heat exchange units connected in series;
 Fig. 15(A) is a front view showing a structure in which unit elements A and B are connected in series at the center;
 Fig. 15(B) is a side view showing the structure in which the unit elements A and B are connected in series at the center;
 Fig. 16 is a front view showing an example in which unit elements A and B have different diameters; and
 Fig. 17 is a front view of a heat exchange unit including unit elements A and B assembled in a snaking fashion.

Key to Reference Letters

[0021]

1: heat exchange unit

2: heat exchanger tube
 3: fluid inlet
 4: heat exchanger tube
 5: fluid outlet
 6: connection pipe
 7: unit frame
 8 and 8a: fixed frames
 9: fixing bands
 10: heat exchanger
 10a: ends
 11: casing
 12: inlet header
 13: inlet tube
 14: outlet header
 15: outlet tube
 16: glass window
 17: exhaust duct members
 18: inlet/outlet header
 20 a: flue

DESCRIPTION OF THE PREFERRED EMBODIMENTS

EXAMPLE 1

[0022] Fig. 1 is a front view showing a heat exchange unit 1 according to the invention of Claims 1 to 3. Fig. 2 is a sectional view of Fig. 1 taken along line A-A'. Fig. 3 is a front view of a heat exchanger. Fig. 4 is a diagram showing a structure in which the heat exchanger according to the present invention is attached to an exhaust duct to collect latent heat.

[0023] Reference numeral 1 denotes a heat exchange unit. The heat exchange unit 1 includes a unit element A composed of a heat exchanger tube 2 and a unit element B composed of a heat exchanger tube 4. The heat exchanger tube 2 has a fluid inlet 3 at an outer end thereof and is coiled toward the center with predetermined gaps W between successive windings. The heat exchanger tube 4 has a fluid outlet 5 at an outer end thereof and is coiled toward the center with predetermined gaps W1. The heat exchanger tubes 2 and 4 of the unit elements A and B, respectively, are connected to each other with a connection pipe 6 at the inner ends thereof. The heat exchanger tubes 2 and 4 are disposed in the gaps W1 and W, respectively, when viewed from the front so that the heat exchanger tubes 2 and 4 do not overlap each other.

[0024] Reference numeral 7 denotes a rectangular unit frame on which the unit elements A and B are assembled and fixed, and reference numerals 8 and 8a denote tube-fixing frames connecting the opposing sides of the unit frame 7 at the midpoints thereof.

[0025] The heat exchanger tubes 2 and 4 are connected to the fixed frames 8 and 8a with fixing bands 9 (see Fig. 4) in every turn.

[0026] The heat exchange unit 1 having the above

structure may, of course, be used by itself. Typically, however, a plurality of heat exchange units are arranged in a casing to form a heat exchanger, which is attached to an exhaust duct or the like when used.

[0027] Figs. 3 and 4 show a heat exchanger obtained by arranging a plurality of units between exhaust duct members. A heat exchanger 10 includes five units 1 arranged in a rectangular casing 11 with open ends 10a. Nipples 3a which communicate with fluid inlets 3 of the units 1 and nipples 5a which communicate with fluid outlets 5 of the units 1 face outward from a side surface and a bottom surface, respectively, of the casing 11. An inlet header 12 is connected to the nipples 3a with inlet tubes 13 and lock nuts 13a, and an outlet header 14 is connected to the nipples 5a with outlet tubes 15 and lock nuts 15a. In Fig. 4, reference numeral 16 denotes a glass window formed at side of casing 11 and thereby the inside can be observed, and reference numeral 17 denotes exhaust duct members. The casing of the heat exchanger 10 is being connected to the exhaust duct members 17 at the ends 10a thereof.

[0028] In this structure, when high temperature exhaust flows between the exhaust duct members 17, the exhaust travels through the spaces between the coiled heat exchanger tubes 2 and 4 of the unit elements A and B, respectively, in the heat exchanger 10 and thereby imparts heat to fluid which flows through the heat exchanger tubes 2 and 4. Accordingly, the fluid which flows through the heat exchanger tubes 2 and 4 is heated.

[0029] In Example 1, the heat exchange units 1 are all made of stainless steel. However, the heat exchange units 1 may also be made of copper, titanium, titanium alloy, nickel-based corrosion resistant alloy, super austenitic stainless steel, super duplex stainless steel, super ferritic stainless steel, etc., as long as the resistance to corrosion, heat, and impact requirements are satisfied.

[0030] In Example 1, the external shape of the heat exchange units 1 is rectangular since the duct members 17 have a rectangular shape. However, the heat exchange units are formed in a circular shape if the duct members 17 are circular in cross section. In special applications, the heat exchange units may also be triangular, pentagonal, or hexagonal.

EXAMPLE 2

[0031] In Example 2, a heat exchanger tube 2 is coiled in a single plane. The coiled heat exchanger tube 2 may be used by itself. Alternatively, similar to Example 1, a heat exchange unit 1 may be obtained by combining unit elements A and B together. In Fig. 5, reference numeral 6 denotes a connection pipe which connects heat exchanger tubes 2 of the unit elements A and B to each other at a central position. Fig. 6 shows a heat exchanger 10 obtained by arranging a plurality of heat exchange units 1 having the above structure. In Fig. 6, reference numeral 18 denotes an inlet/outlet header in which a fluid inlet and a fluid outlet are combined. Similar to Example

1, fluid from the header 18 enters, for example, the element A at an outer end of the element A, flows into the element B through the connection pipe 6, and returns to the header 18 from the element B at the outer end of the element B.

[0032] Also in Example 2, the heat exchanger 10 may be designed to have a desired number of units 1. When the element A or B is used by itself, the fluid may flow into the coiled tube at the outer end and out of the coiled tube at the center. In reverse, the fluid may also flow into the coiled tube at the center and out of the coiled tube at the outer end.

EXAMPLE 3

[0033] Example 3 corresponds to the invention of Claim 4. As shown in Fig. 7, Example 3 differs from Examples 1 and 2 in that heat exchanger tubes 2 and 4 are helically coiled into a conical shape and an inverted conical shape, respectively, instead of being coiled in a single plane. An element A and an element B having the conical and inverted conical shapes are connected to each other with a connection pipe 6 to form a heat exchange unit 1. The heat exchange unit 1 is installed in, for example, a flue a.

[0034] When a plurality of heat exchange units 1 having the above structure are combined, the heat exchange units 1 may be arranged along the longitudinal direction thereof. Such a structure is advantageous in increasing a heat transfer area while keeping pressure loss in the flue a as low as possible when the diameter of the flue a is small.

[0035] In addition, pressure loss of fluid which flows through the heat exchanger tubes 2 and 4 is also reduced and the performance is effectively improved.

[0036] In Examples 1 to 3, the heat exchanger tubes 2 and 4 are straight tubes. However, a flexible tube such as a corrugated flexible tube shown in Fig. 11 (A), a spiral flexible tube shown in Fig. 11 (B), a flexible tube with annular ridges shown in Fig. 11 (C), or a flexible tube with partially pressed annular ridges shown in Fig. 11 (D) may be used to increase the heat transfer area and to improve the heat exchange efficiency by causing turbulent flow at the ridges.

[0037] Figs. 8(A) and 8(B) show an example of a circular heat exchange unit including flexible tubes with annular ridges. Fig. 9 shows an example of a square heat exchange unit including similar flexible tubes. Figs. 10 (A) and 10(B) show an example of a rectangular heat exchange unit including similar flexible tubes. Figs. 12 (A) and 12(B) show a heat exchange unit 1 obtained by combining conical elements A and B such that the elements A and B overlap each other. This structure is advantageous in ensuring the heat transfer area while reducing the outer diameter of the unit 1.

[0038] Figs. 13(A) and 13(B) show an example in which circular heat exchange units 1 are connected to inlet and outlet headers 12 and 14 in parallel. Figs. 14

(A) and 14(B) show an example in which heat exchanger tubes 2 and 4 of a plurality of heat exchange units 1 are connected in series with connection pipes 6a. Figs. 15 (A) and 15(B) show an example in which a fluid inlet 3 and a fluid outlet 5 of elements A and B are connected to flanges 3b and 5b, respectively, at the center. The adjacent heat exchange units 1 can be connected to each other in series using the flanges 3b and 5b. This structure is advantageous when there is no space for installing the headers 12 and 14.

[0039] Fig. 16 shows an example in which a small-diameter unit element A and a large-diameter unit element B are connected to each other with a tapered coupling 6b at a central position. When liquid which enters the small-diameter element A vaporizes, the vapor is collected through the large-diameter element B.

[0040] In reverse, gas may, of course, be injected into the large-diameter element B and be liquidized, and the liquid may be collected through the small-diameter element A.

[0041] Fig. 17 shows an example in which heat exchanger tubes 2 and 4 of unit elements A and B are assembled in a snaking fashion. Although the heat exchanger tubes 2 and 4 are not coiled, the technique of the present invention is used in that the elements A and B are combined together to form a unit.

[0042] In Figs. 8 to 17, components similar to those explained in Examples 1 to 3 are denoted by the same reference numerals, and explanations thereof are omitted to avoid redundancy.

Industrial Applicability

[0043] The heat exchange unit and the heat exchanger according to the present invention have the following applications:

1. Heat exchangers for collecting latent heat from exhaust emitted from various facilities.
2. Heat exchangers for exchanging heat between liquid and liquid or between liquid and gas in various apparatuses.
3. Heat exchangers for air conditioning.

Claims

1. A heat exchange unit comprising two heat exchange unit elements A and B, the heat exchange unit elements A and B including heat exchanger tubes that are coiled in a single plane with predetermined gaps and being shifted from each other so that the tubes do not overlap each other when viewed from a direction perpendicular to the plane, wherein the tubes are connected to each other at inner or outer ends of the tubes, and wherein one of the elements A and B has a fluid inlet at the outer or inner end of the tube thereof and the other one of the elements A and B

has a fluid outlet at the outer or inner end of the tube thereof.

2. A heat exchanger comprising a plurality of heat exchange units arranged in a casing, a fluid inlet header, and a fluid outlet header, the fluid inlet header and the fluid outlet header being disposed on the exterior of the casing, wherein each heat exchange unit includes two heat exchange unit elements A and B, the heat exchange unit elements A and B including heat exchanger tubes that are coiled in a single plane with predetermined gaps and being shifted from each other so that the tubes do not overlap each other when viewed from a direction perpendicular to the plane, and wherein, in each heat exchange unit, the tubes are connected to each other at inner or outer ends of the tubes, one of the elements A and B has a fluid inlet at the outer or inner end of the tube thereof, and the other one of the elements A and B has a fluid outlet at the outer or inner end of the tube thereof, the fluid inlet and the fluid outlet being connected to the fluid inlet header and the fluid outlet header, respectively.
3. The heat exchanger according to Claim 2, wherein the heat exchanger tubes of the heat exchange units are connected in series.
4. The heat exchanger unit or the heat exchanger according to one of Claims 1, 2, and 3, wherein the heat exchanger tubes are coiled in a circular shape, a rectangular shape, a conical shape, or a polygonal shape, including a triangular shape.
5. A heat exchanger comprising heat exchange unit elements A and B including heat exchanger tubes that are coiled in a conical shape, the heat exchange unit elements A and B being connected to each other in the same or opposite orientations at a central position.
6. The heat exchanger unit or the heat exchanger according to one of Claims 1 to 5, wherein the heat exchanger tubes comprise a corrugated flexible tube, a spiral flexible tube, a flexible tube with annular ridges, or a flexible tube with partially pressed annular ridges.
7. The heat exchanger unit or the heat exchanger according to one of Claims 1 to 6, wherein the heat exchanger tubes of the elements A and B have different diameters.

FIG. 1

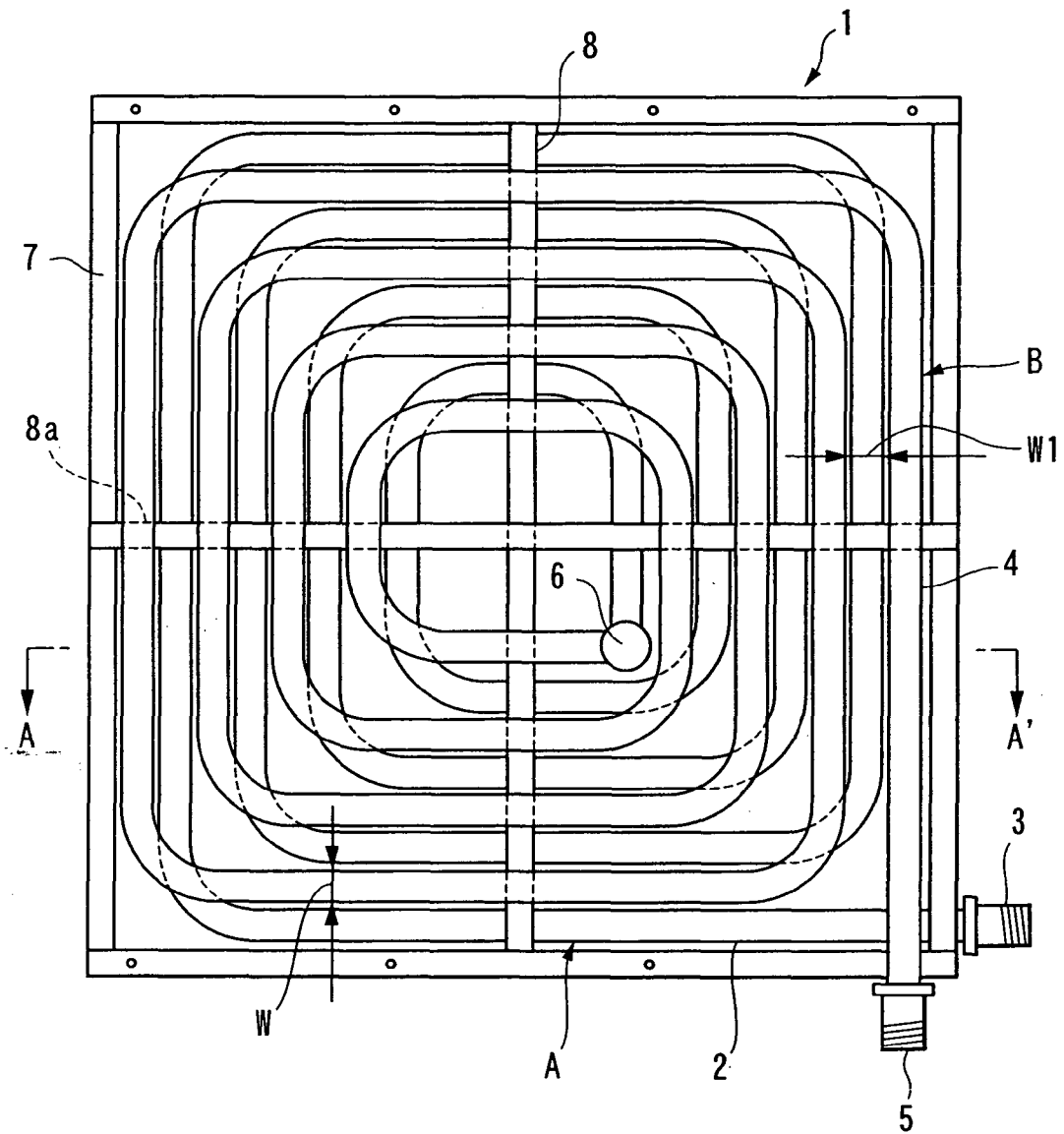


FIG. 2

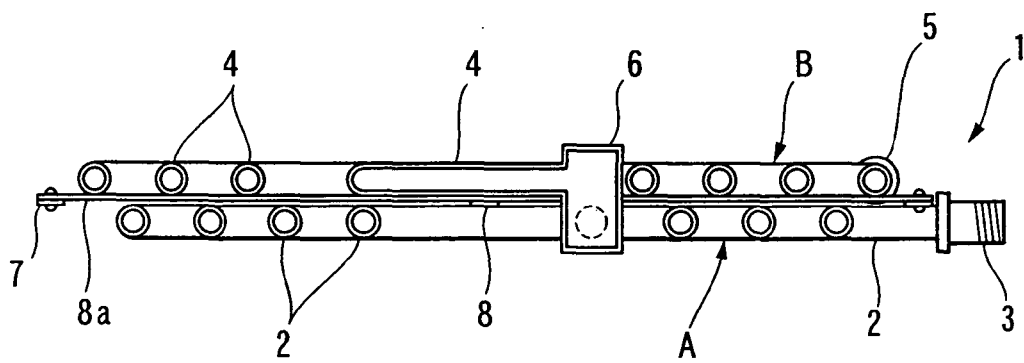


FIG. 3

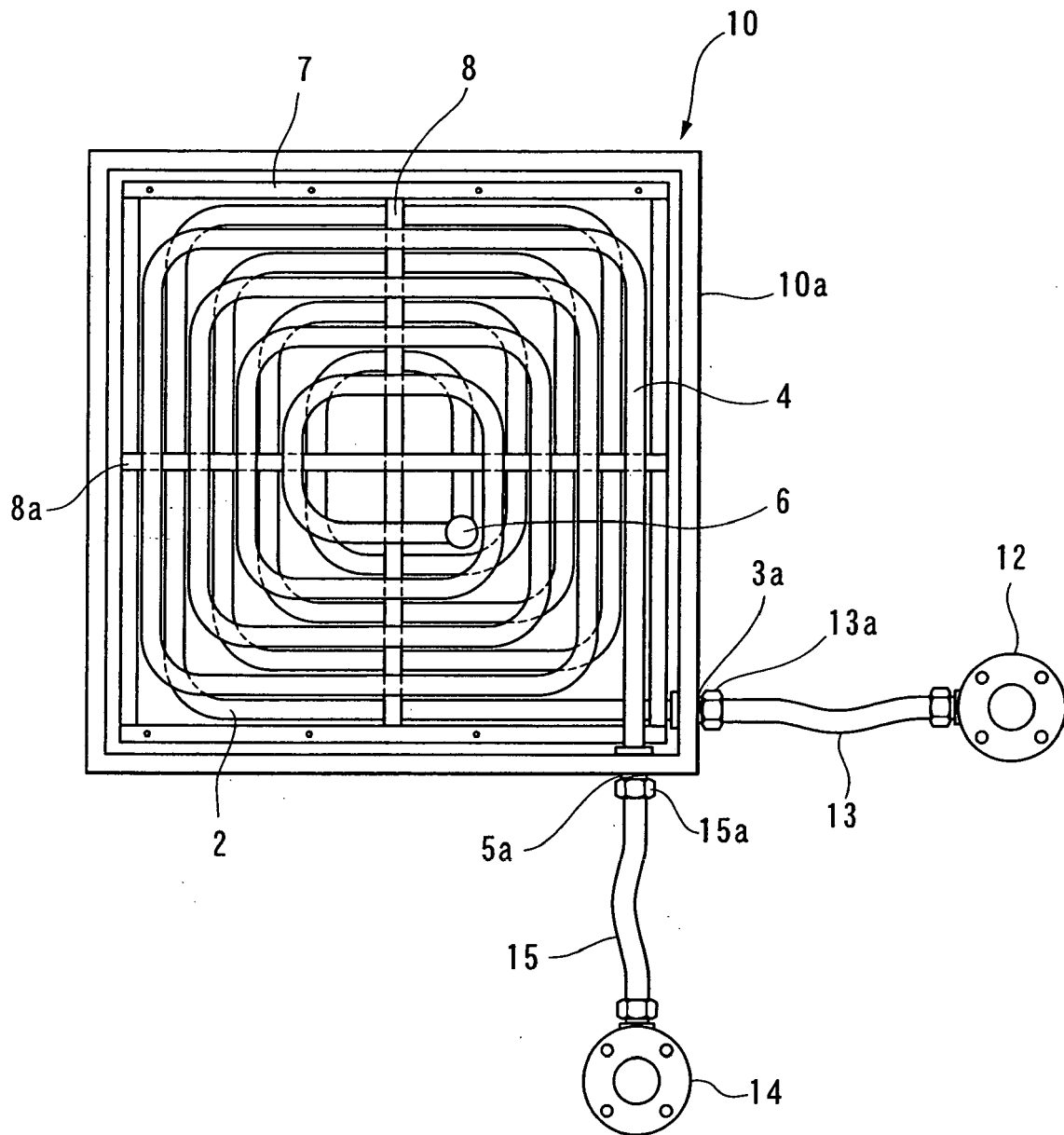


FIG. 4

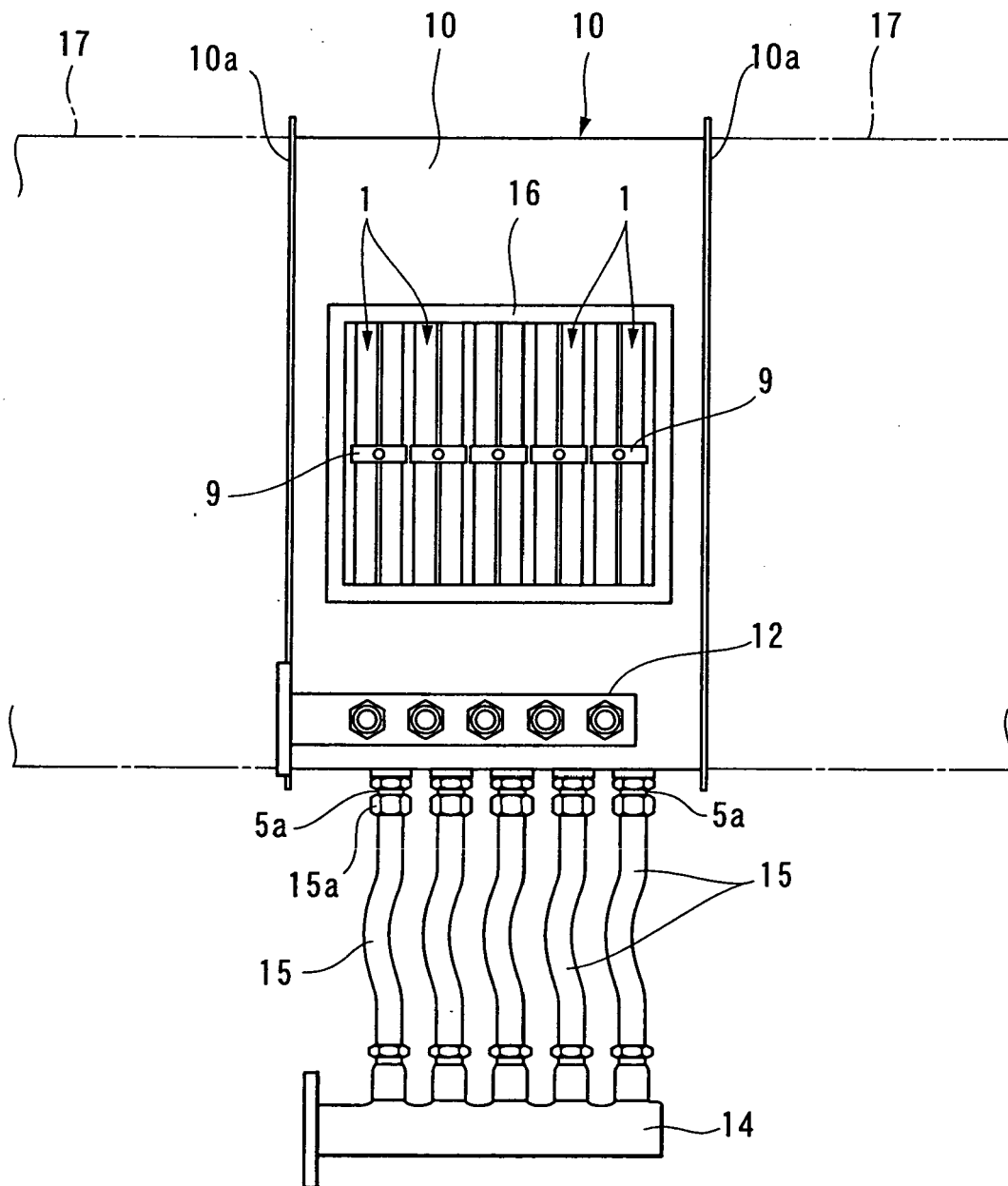


FIG. 5

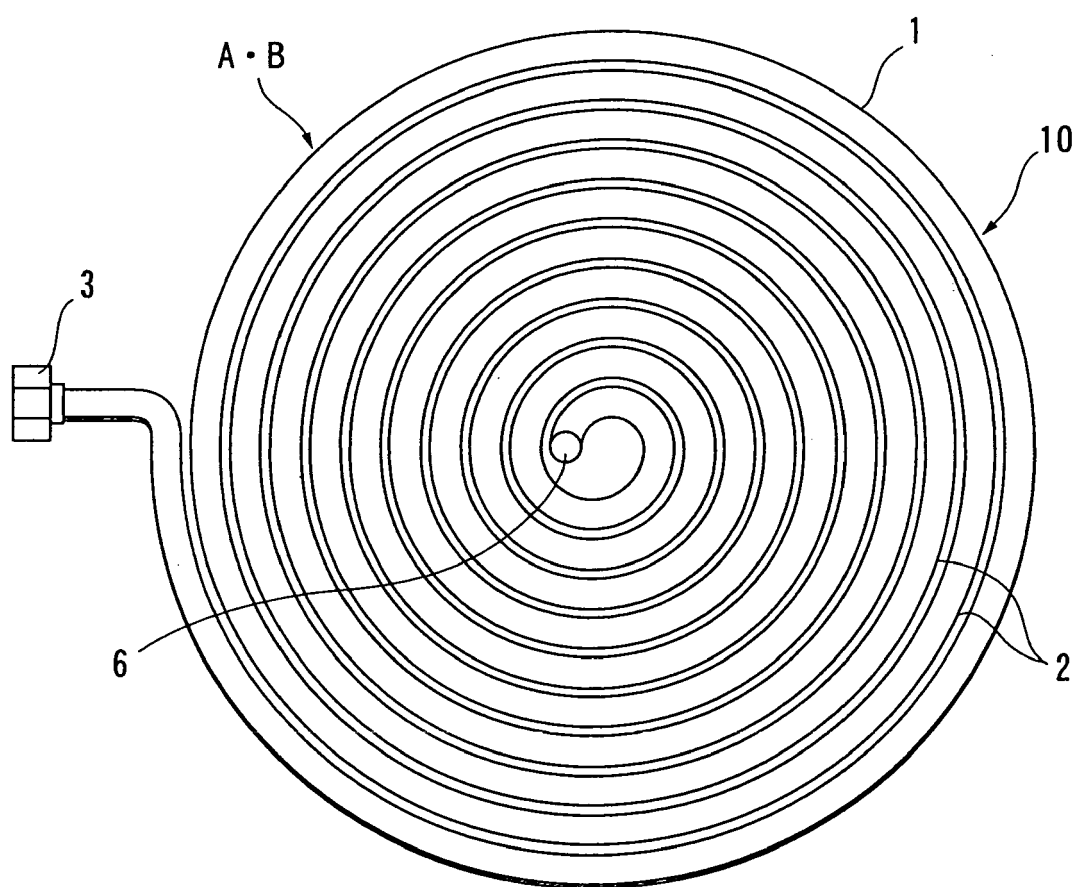


FIG. 6

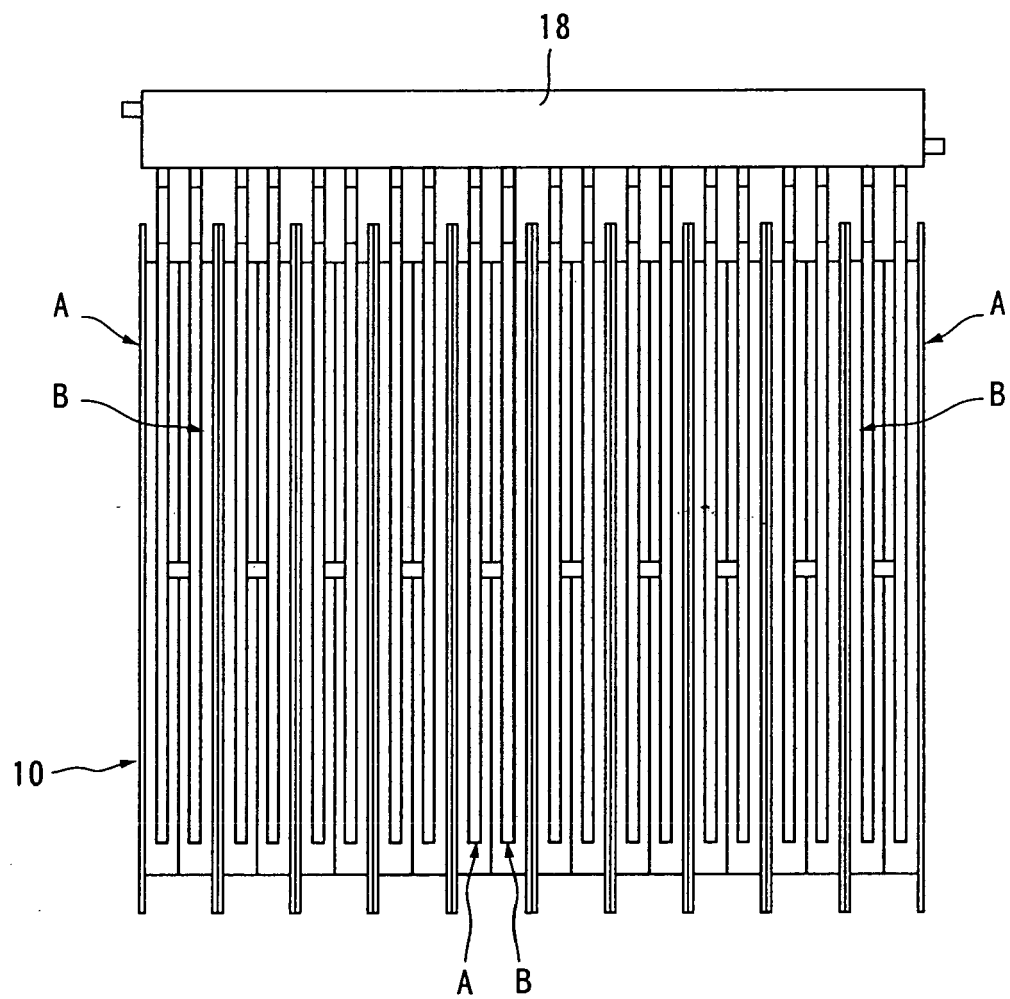


FIG. 7

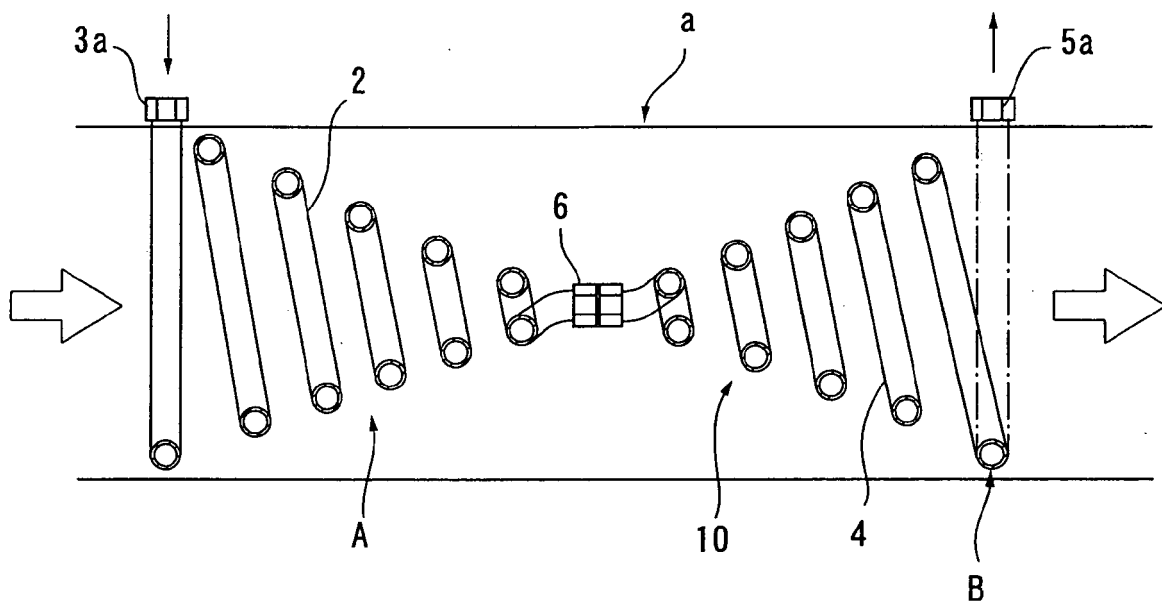


FIG. 8(B)

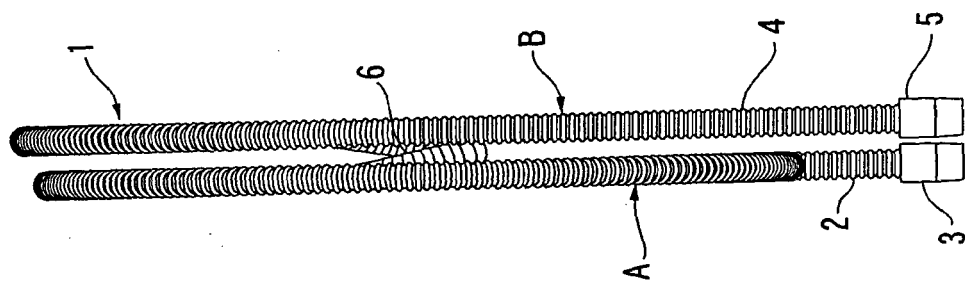
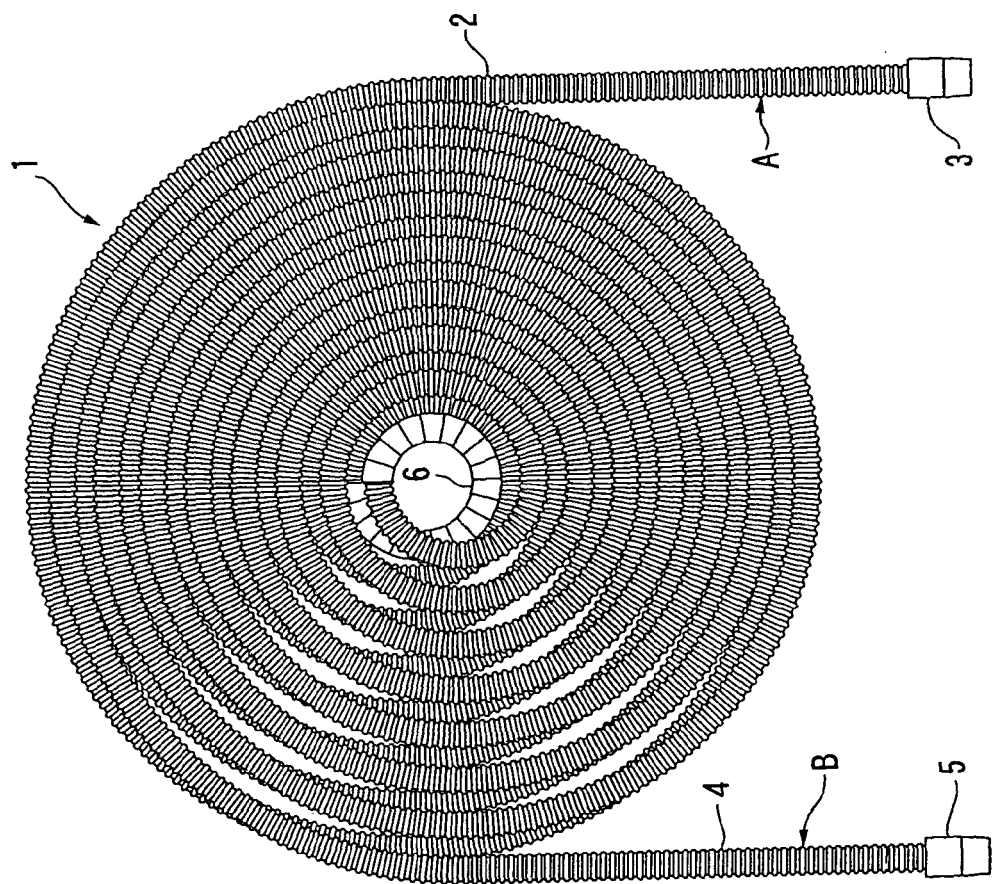


FIG. 8(A)



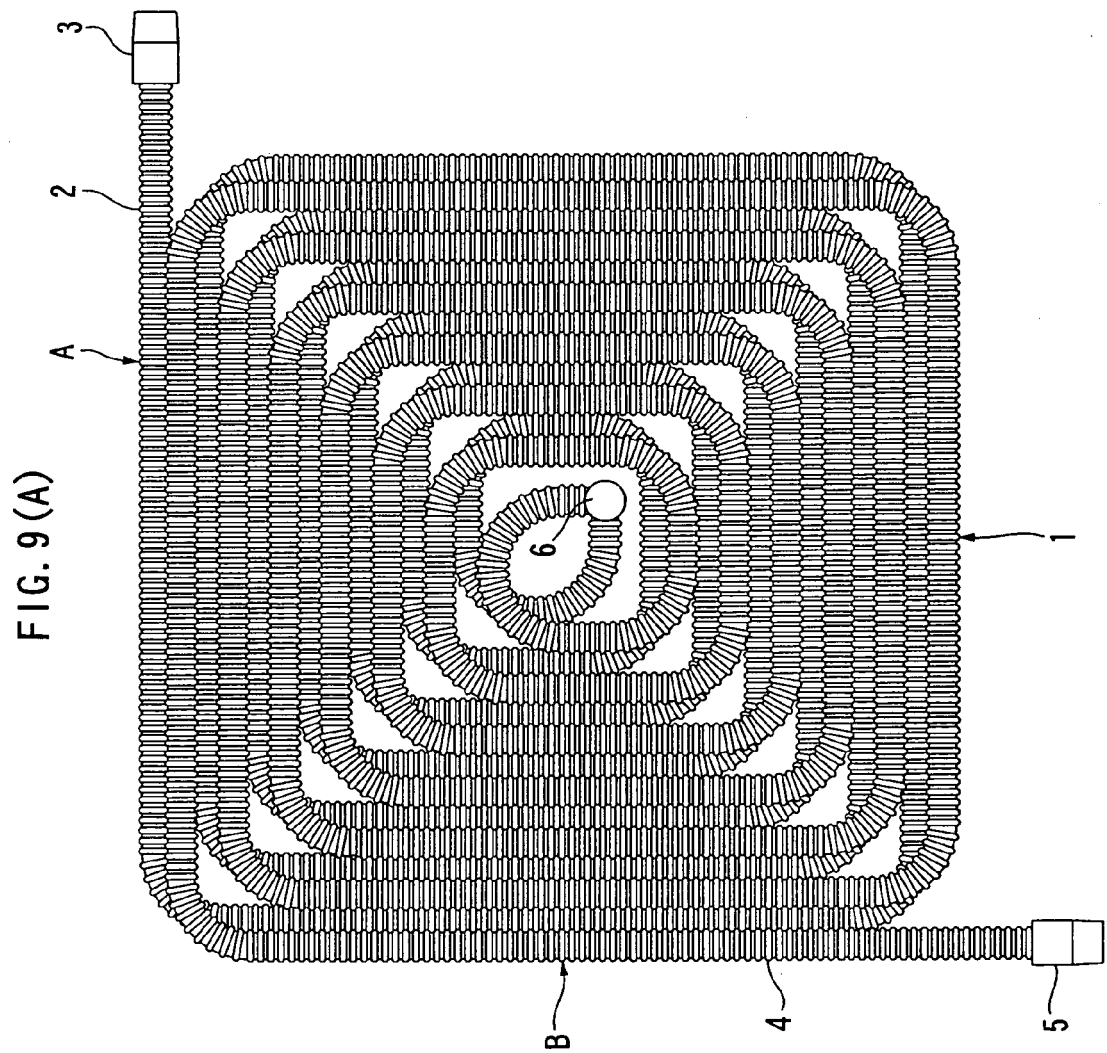
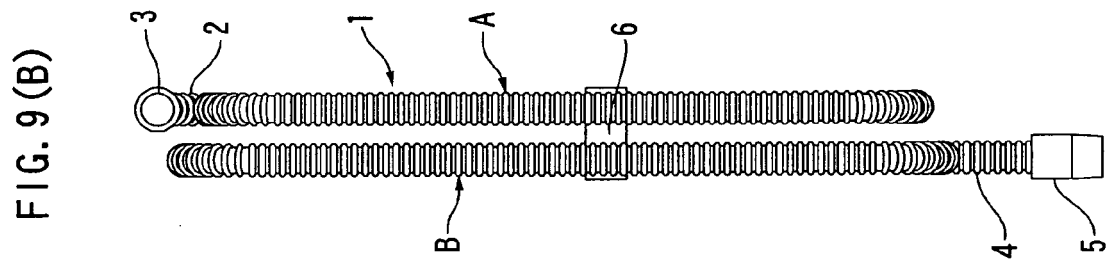


FIG. 10(A)

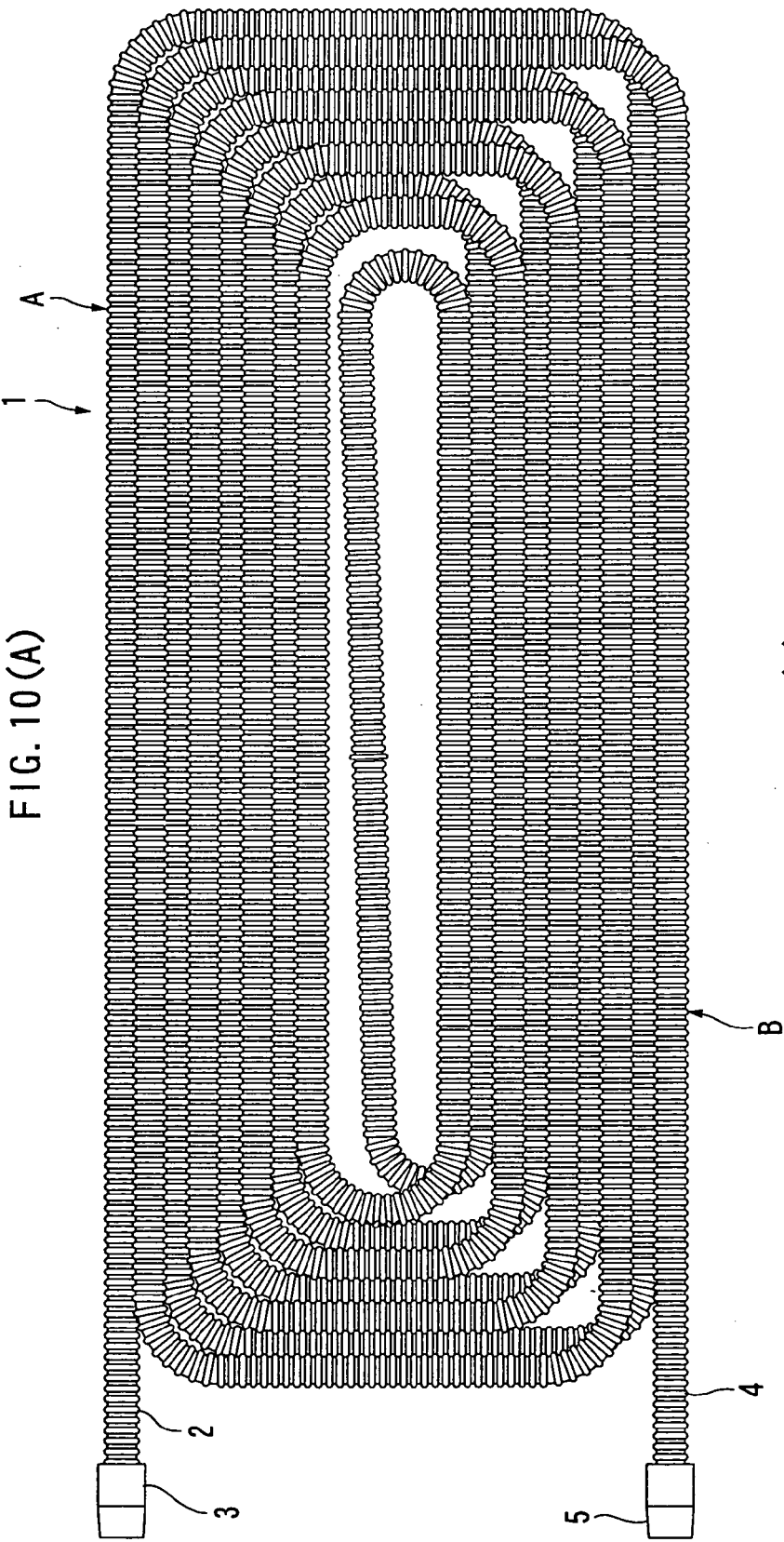


FIG. 10(B)

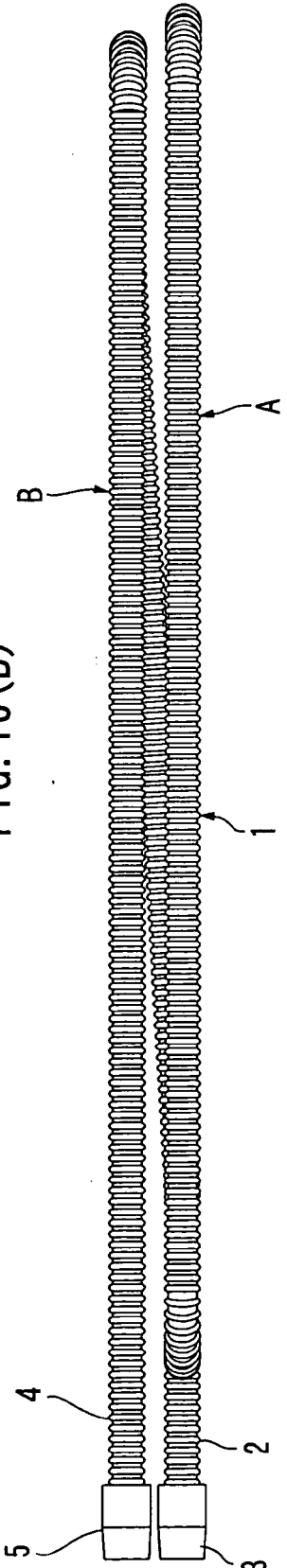


FIG. 11 (A)

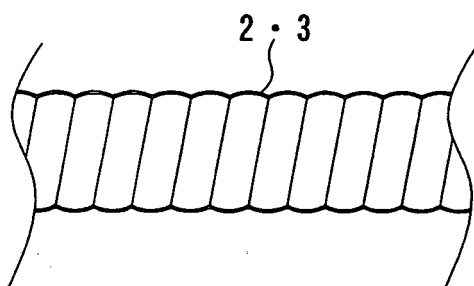


FIG. 11 (B)

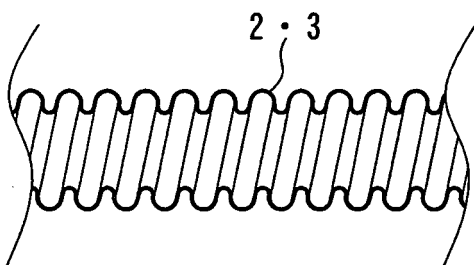


FIG. 11 (C)

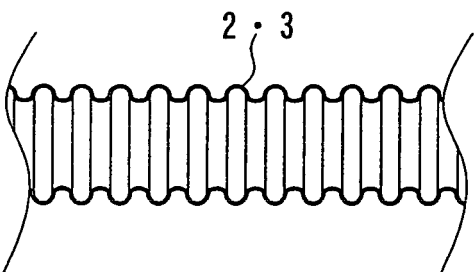


FIG. 11 (D)

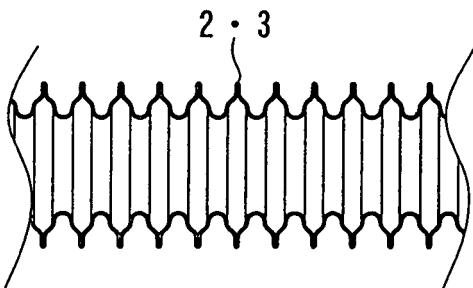


FIG. 12(A)

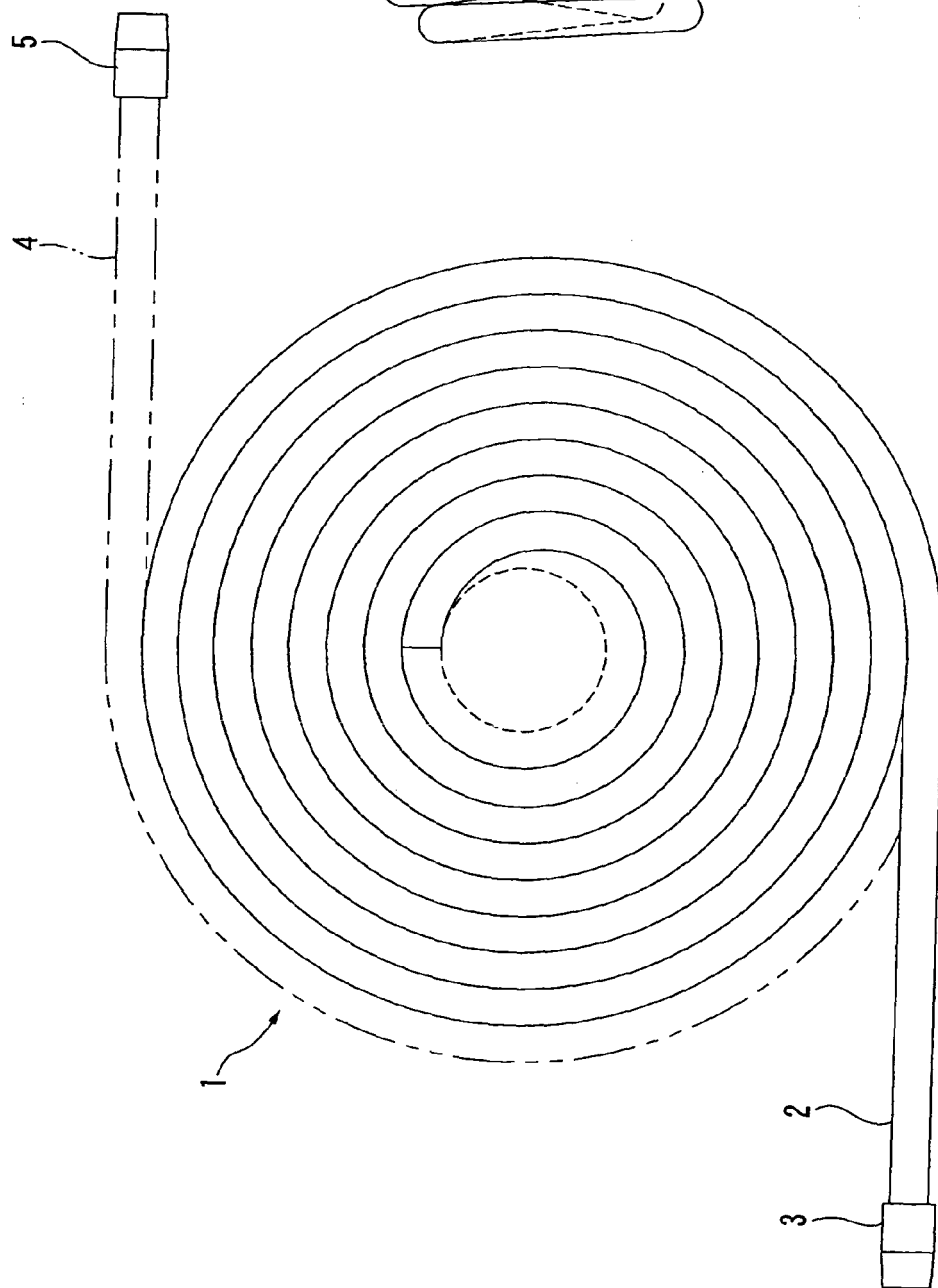


FIG. 12(B)

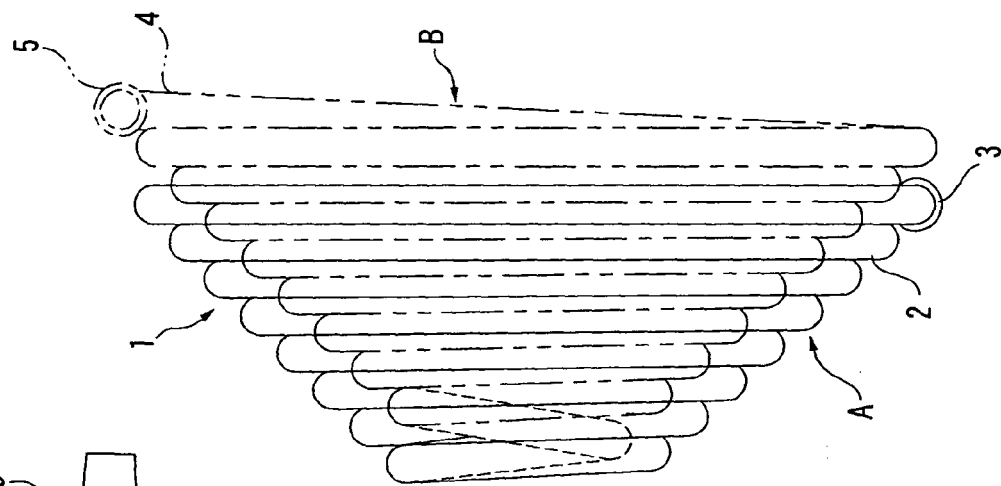


FIG. 13(A)

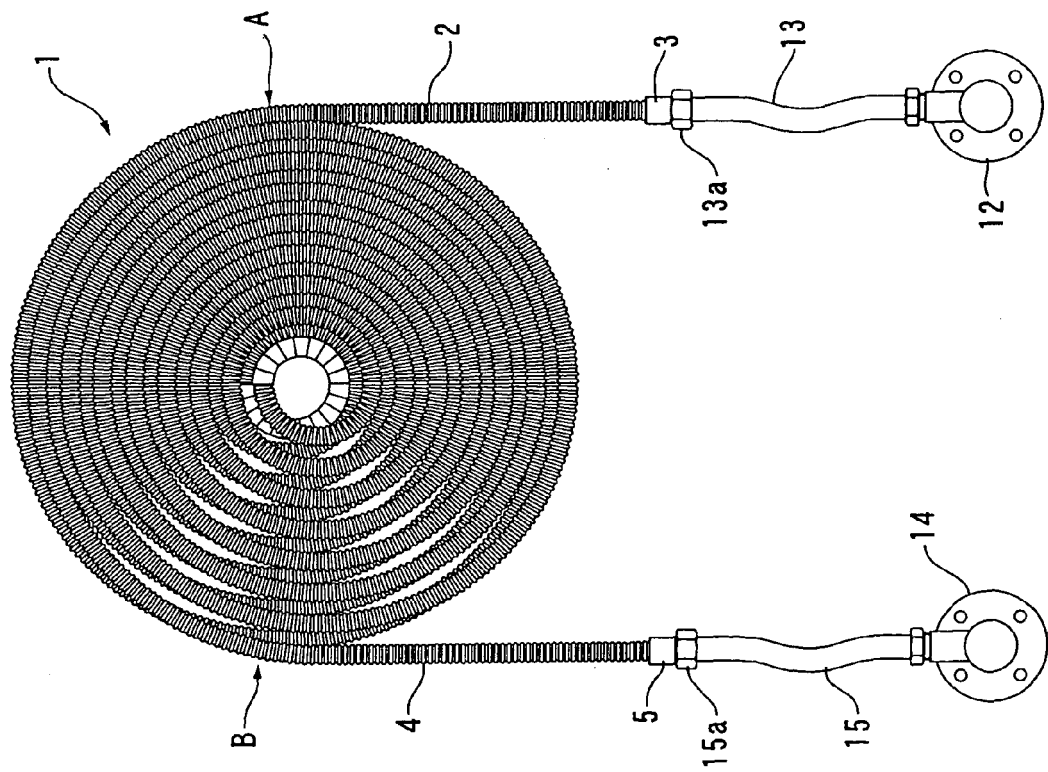
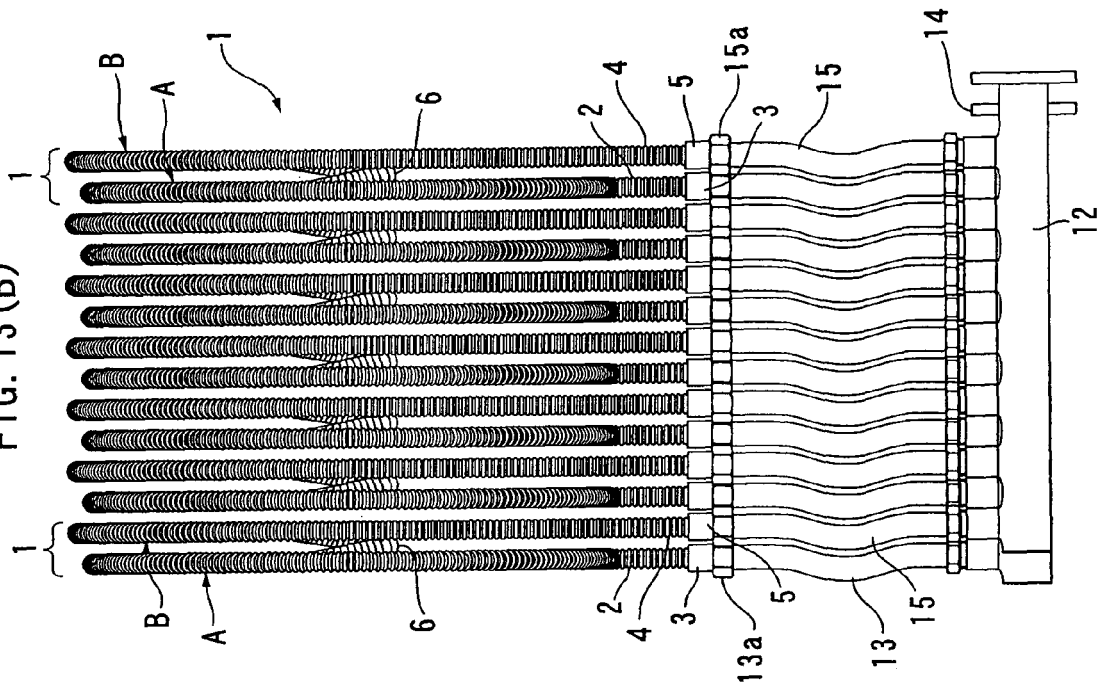
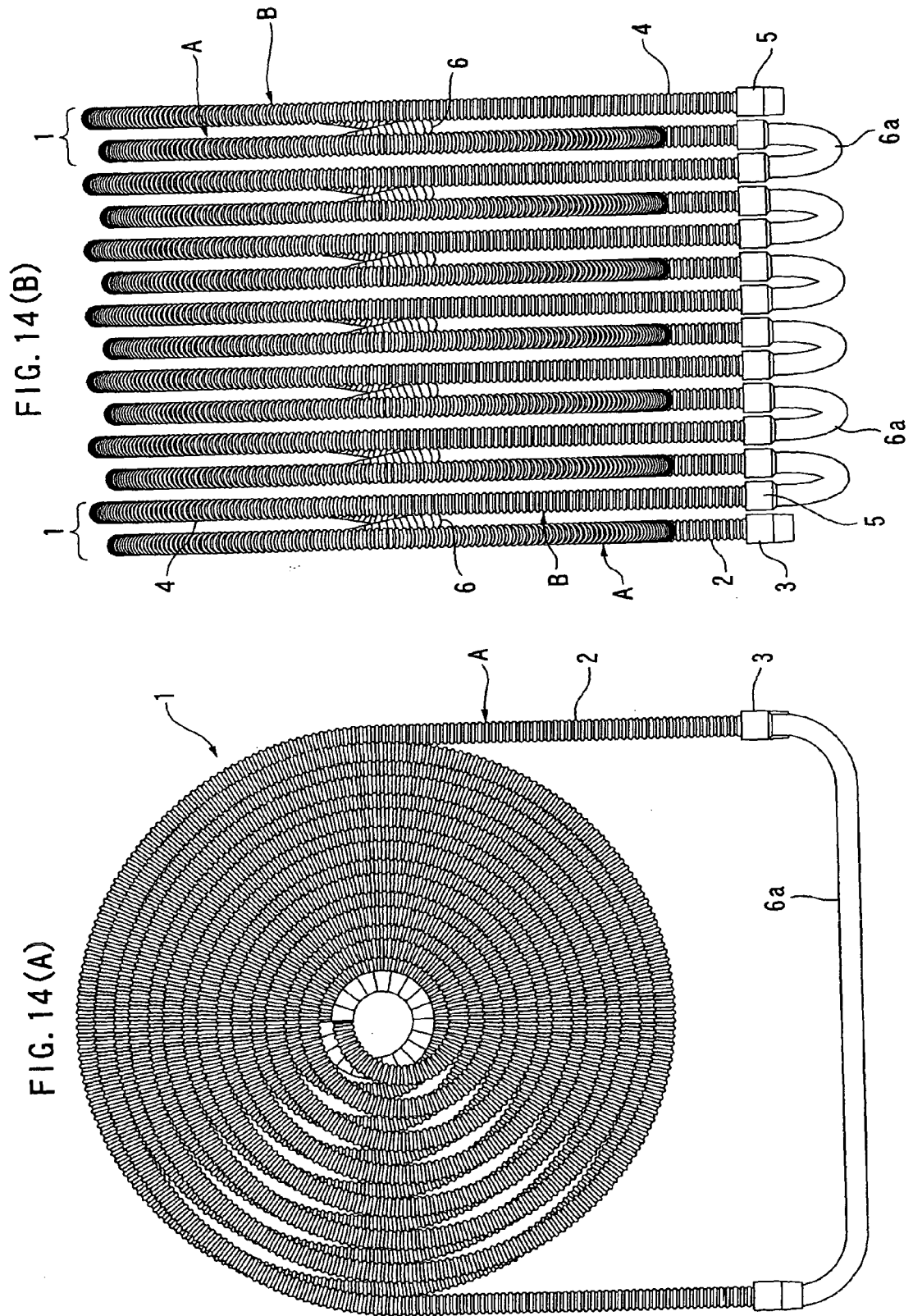


FIG. 13(B)





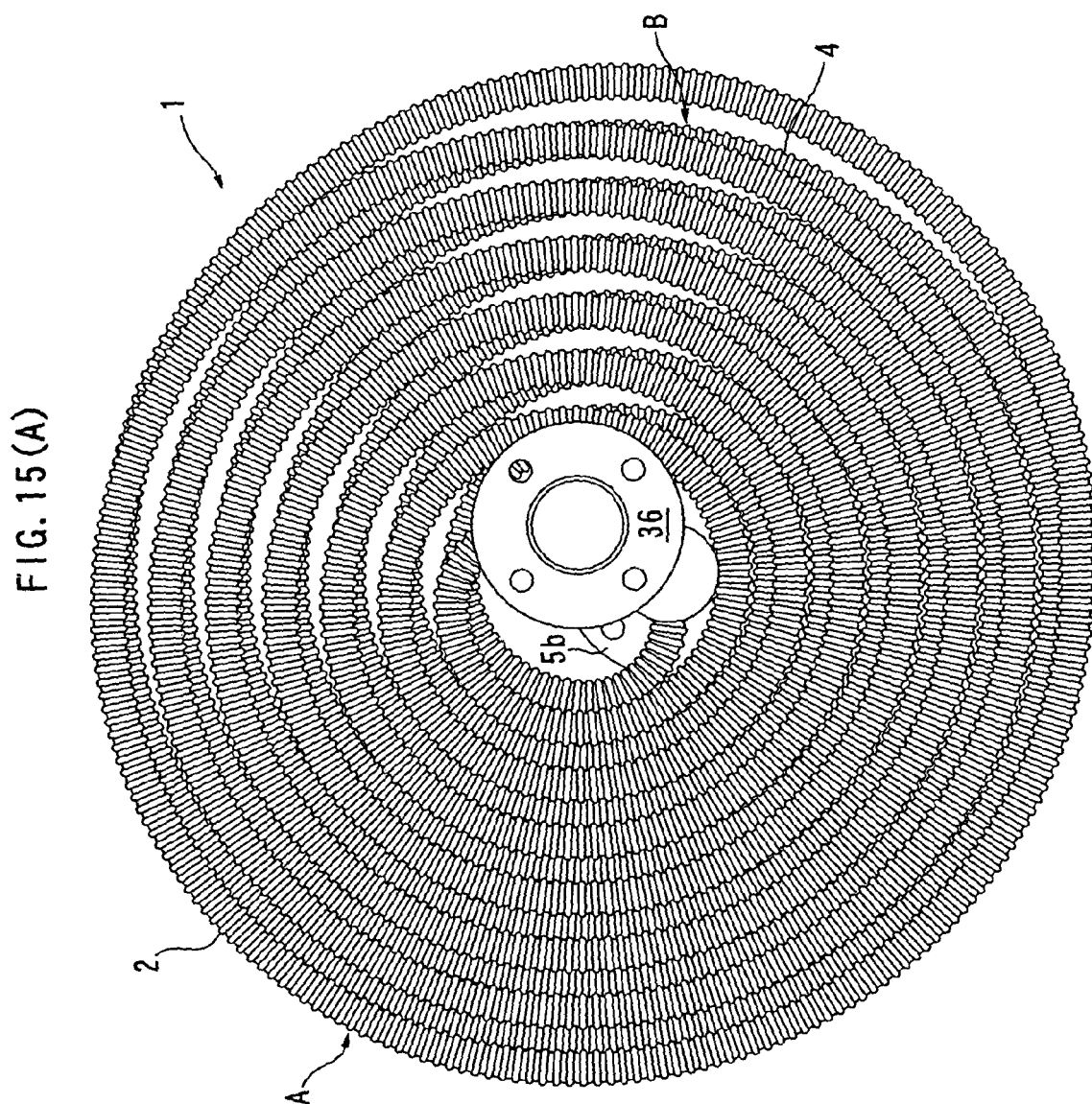
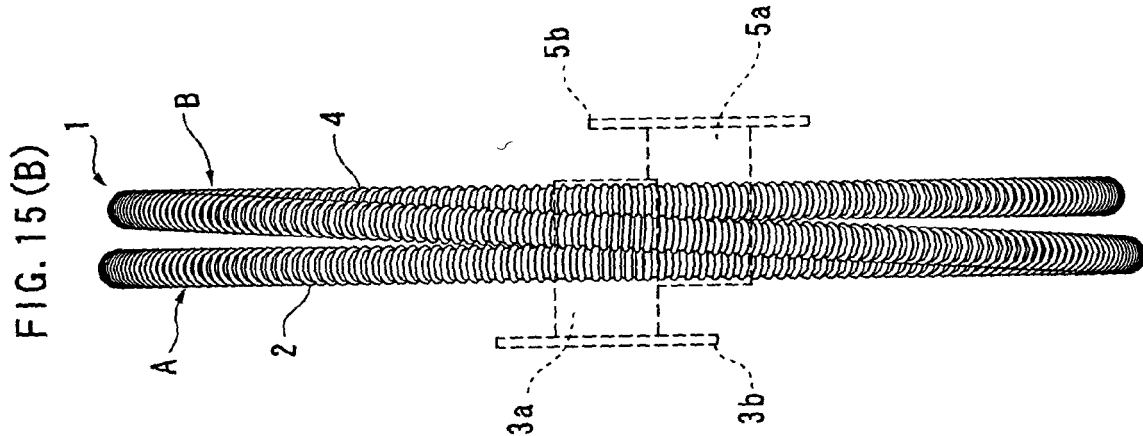


FIG. 16

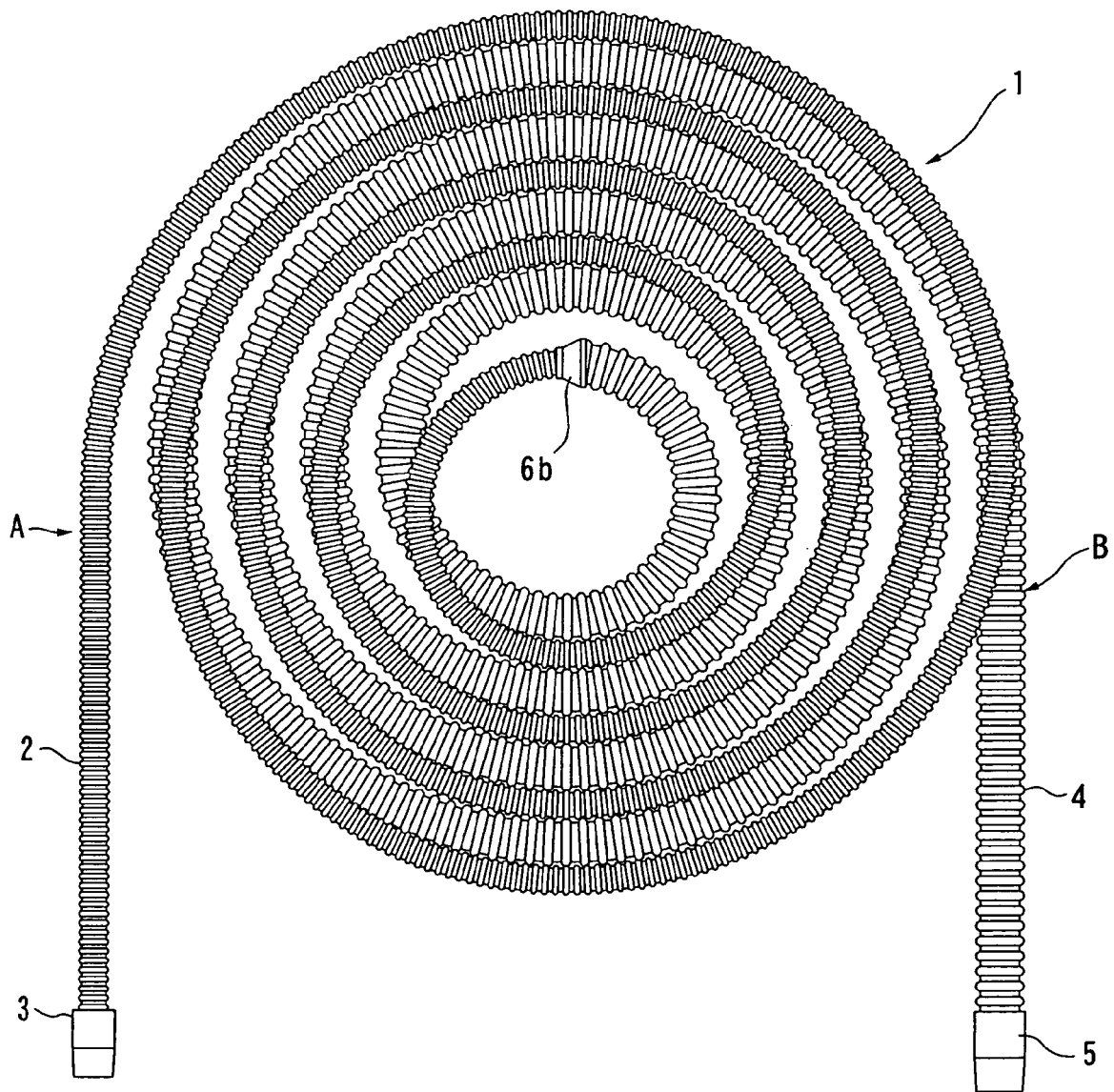
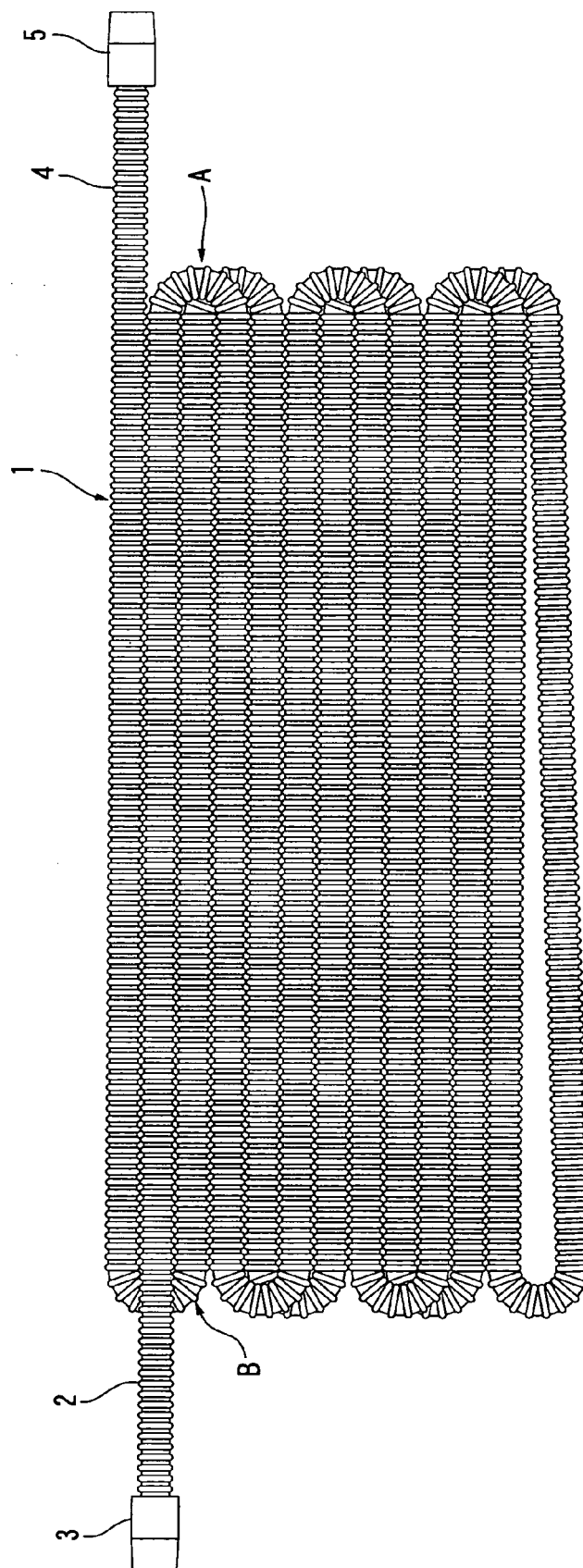


FIG. 17





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EUROPEAN SEARCH REPORT

Application Number
EP 05 25 3085

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 27 October 2005	Examiner Mellado Ramirez, J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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27-10-2005

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