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(43) **Pub. Date: Feb. 1, 2018**(54) **HEAT EXCHANGER, HEAT EXCHANGER
ASSEMBLING APPARATUS, AND HEAT
EXCHANGER ASSEMBLING METHOD**(30) **Foreign Application Priority Data**

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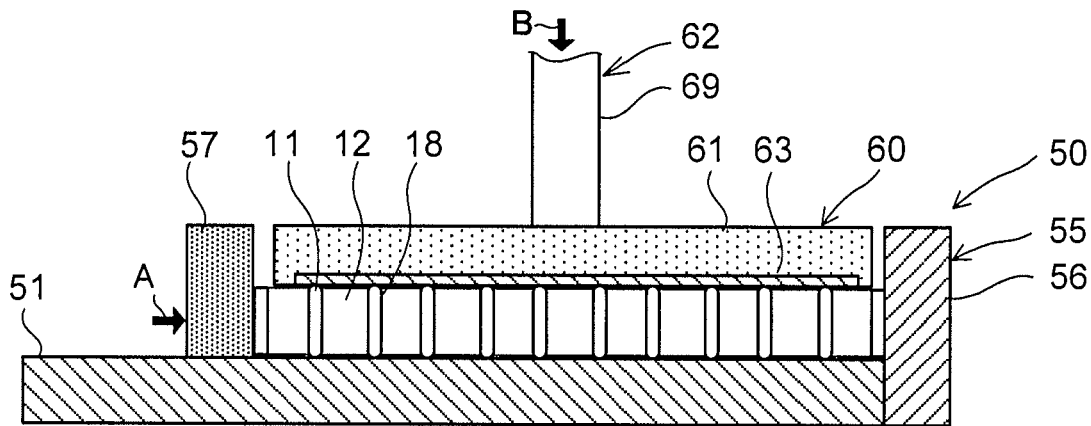
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(JP)(57) **ABSTRACT**

The present invention provides a heat exchanger, a heat exchanger assembling apparatus, and a heat exchanger assembling method, according to which assembling each of the laminated tubes with a tank can be accurately performed. A heat exchanger (10) including a plurality of laminated tubes (11) having an opening end (11d) to which a tank (13,14) is connected. A pressing portion (11g) is provided in the vicinity of the opening end of each tube, the tube being held by the pressing portion when the tank is connected to the opening ends of the tubes.

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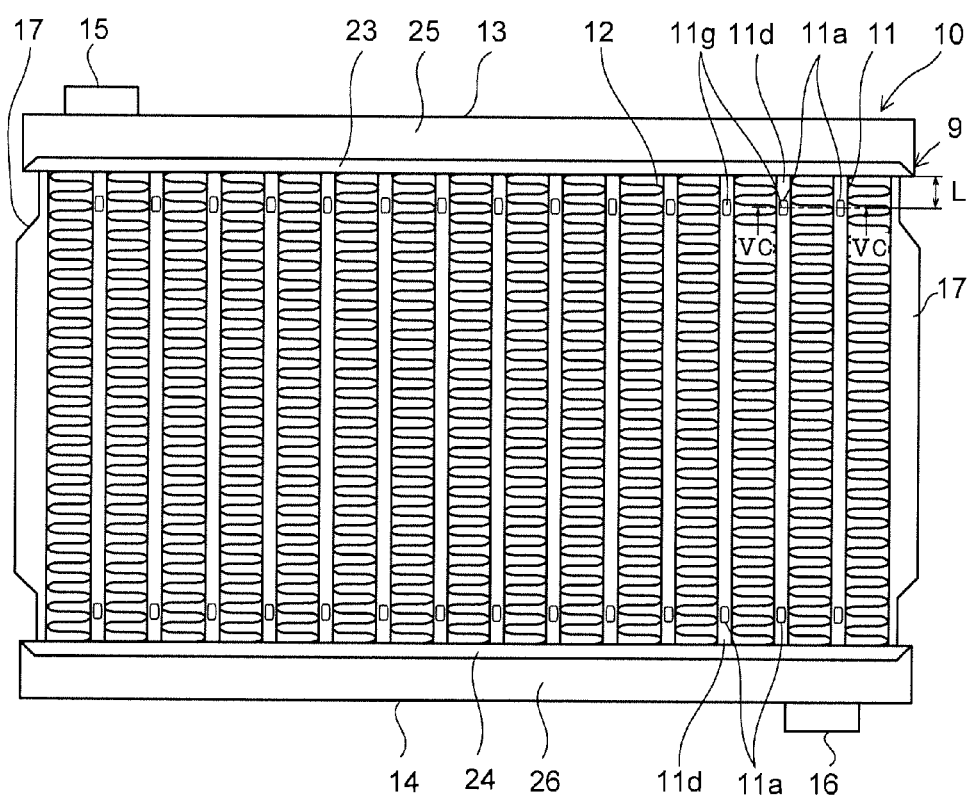


FIG. 1

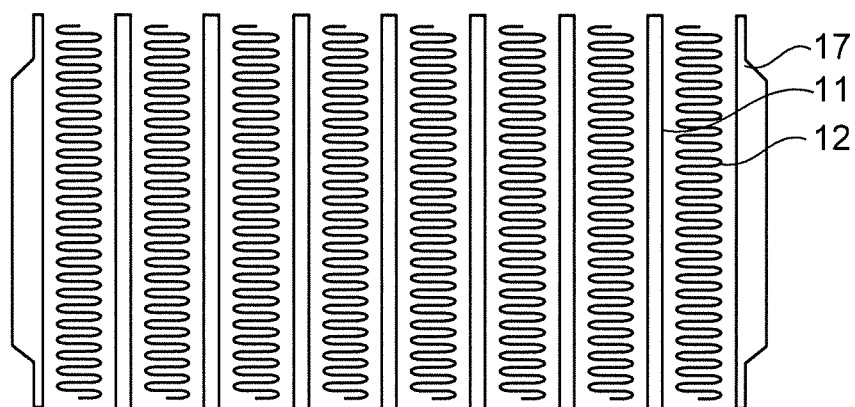


FIG. 2A

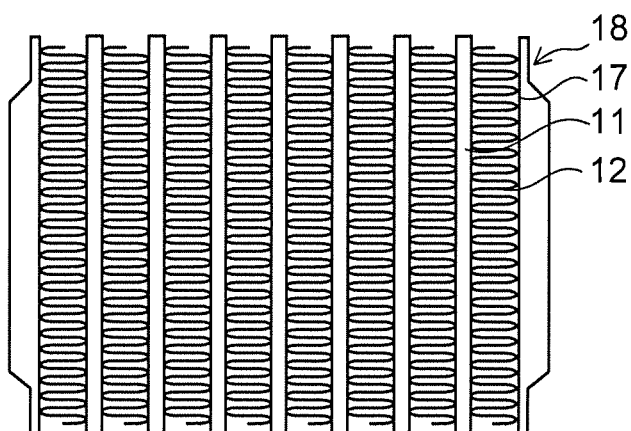


FIG. 2B

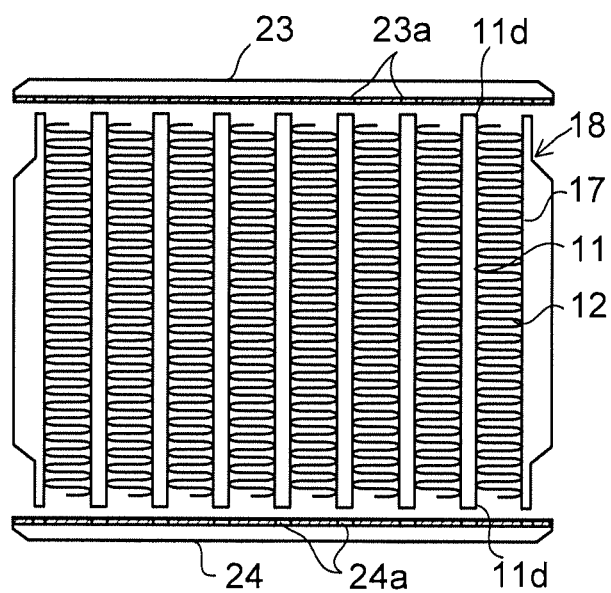


FIG. 2C

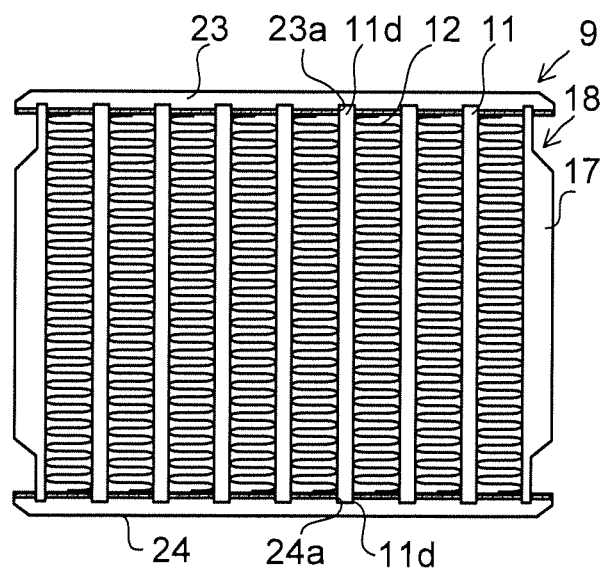


FIG. 2D

FIG. 3B

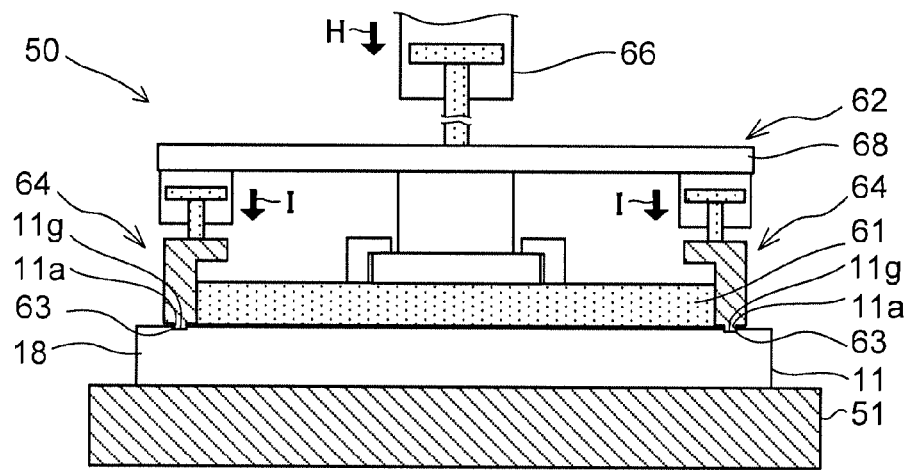


FIG.3C

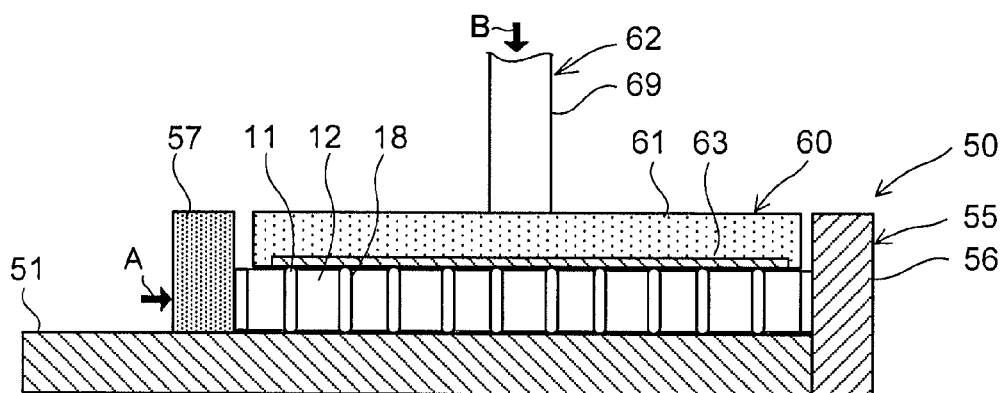


FIG. 4A

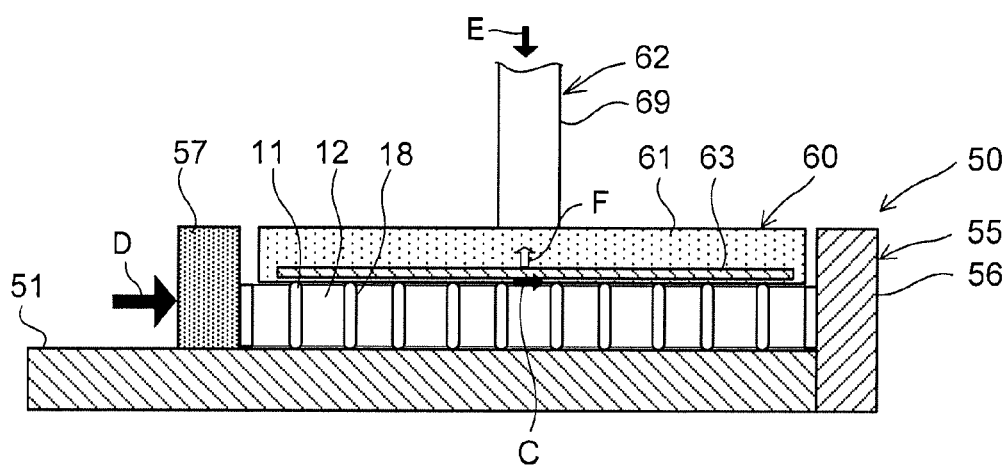


FIG. 4B

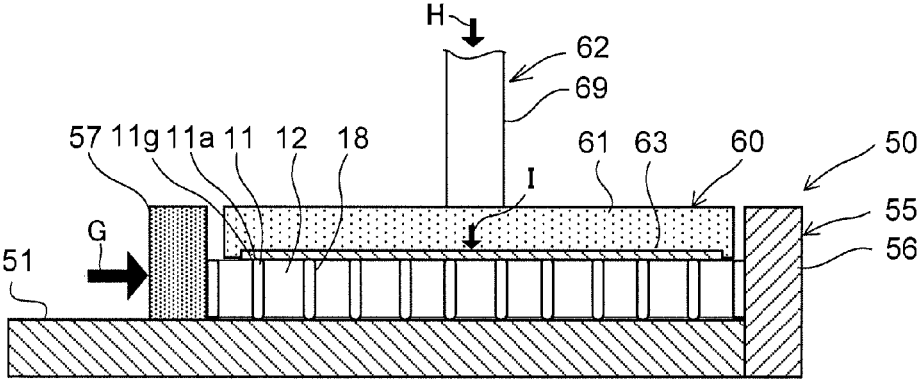


FIG.4C

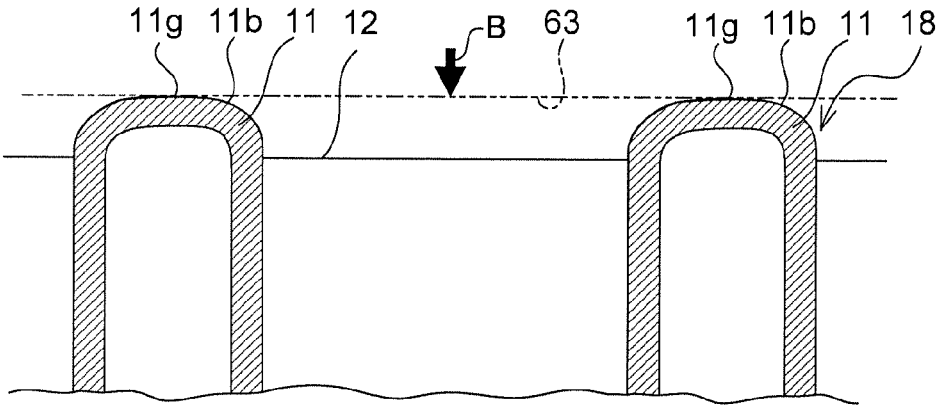


FIG. 5A

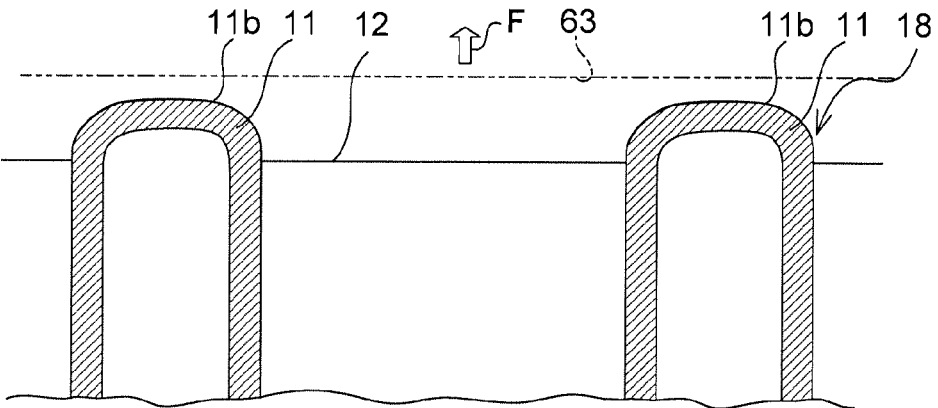


FIG. 5B

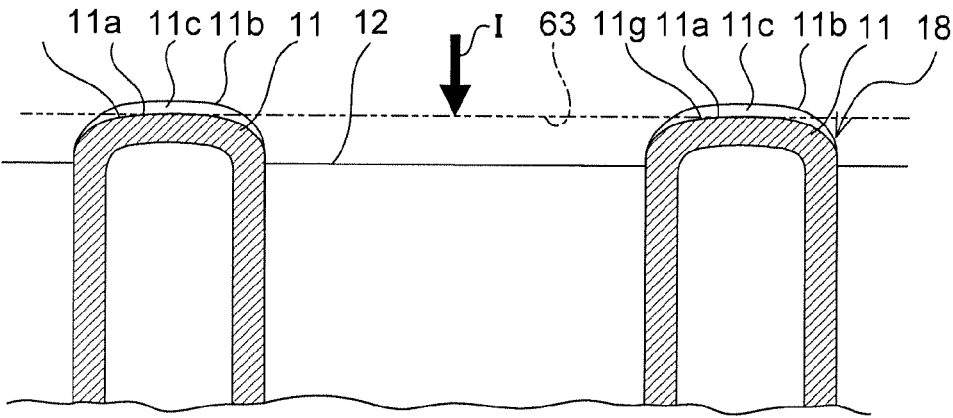


FIG.5C

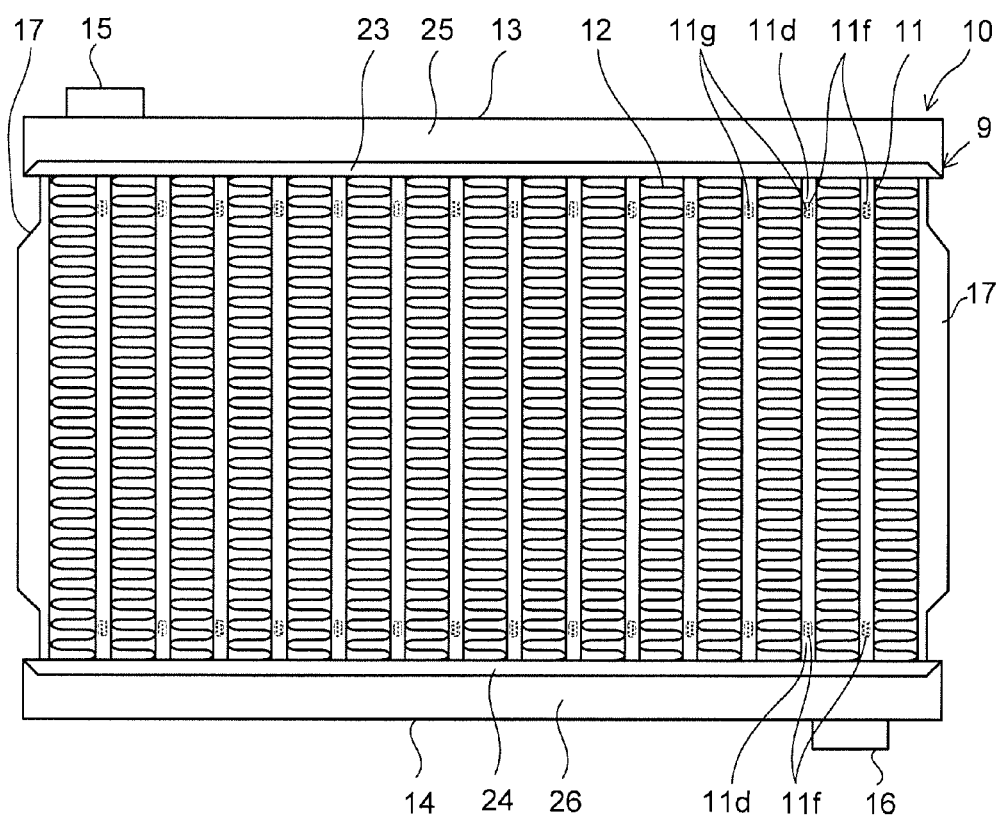


FIG. 6

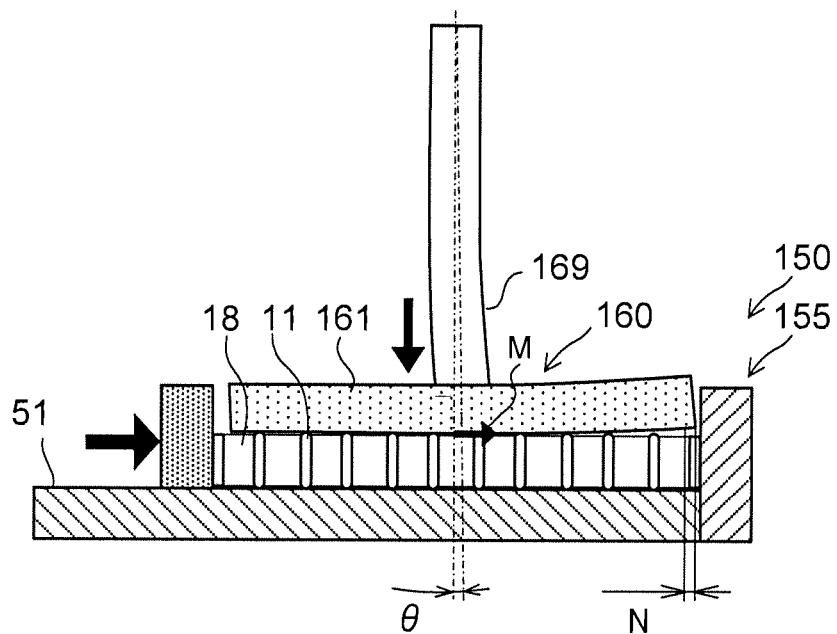


FIG. 7

HEAT EXCHANGER, HEAT EXCHANGER ASSEMBLING APPARATUS, AND HEAT EXCHANGER ASSEMBLING METHOD

TECHNICAL FIELD

[0001] The present invention relates to a heat exchanger, a heat exchanger assembling apparatus, and a heat exchanger assembling method.

BACKGROUND ART

[0002] A heat exchanger used for a radiator or the like of an automotive vehicle includes a plurality of tubes and fins, which are laminated, and a pair of tanks connected to opening ends of respective tubes. Automatically assembling this type of heat exchanger requires holding each laminated tube at a predetermined position.

[0003] As discussed in JP02-035630U, there is an assembling apparatus for a heat exchanger core including a compression claw for alternately laminating and arranging a plurality of tubes and fins on a set plate and compressing each of the tubes and fins in a laminate direction.

[0004] As discussed in JP61-025734A, there is a plate assembling apparatus for a heat exchanger core that alternately laminates and arranges a plurality of tubes and fins on a table, compresses respective tubes and fins in the laminate direction in a state where the tubes and fins are sandwiched between an upper guide plate and a lower guide plate from above and bottom, and inserts an opening end of each tube into a hole of a side plate (tank).

[0005] However, according to the apparatuses discussed in JP02-035630U and JP61-025734A, positional deviation occurs in each of the tubes laminated on the table or the like, and therefore accurately performing the assembling operation including inserting the opening end of each tube into the hole of the tank was difficult.

SUMMARY OF INVENTION

[0006] The object of the present invention is to provide a heat exchanger, a heat exchanger assembling apparatus, and a heat exchanger assembling method, in which assembling each of the laminated tubes with the tank can be accurately performed.

[0007] According to one aspect of the present invention, a heat exchanger including a plurality of laminated tubes having an opening end to which a tank is connected, the heat exchanger including a pressing portion is provided in the vicinity of the opening end of each tube, the tube being held by the pressing portion when the tank is connected to the opening end of the tubes is provided.

[0008] According to another aspect of the present invention, a heat exchanger assembling apparatus for connecting a tank with an opening end of a plurality of laminated tubes, the assembling apparatus includes: a table on which respective tubes can be laminated; a laminate-direction compressing unit configured to compress the plurality of tubes laminated on the table in a laminate direction; and a thickness-direction compressing unit configured to compress the plurality of tubes in a thickness direction perpendicular to the table, wherein the thickness-direction compressing unit includes a holding portion configured to press the vicinity of the opening end of the plurality of tubes, compressed in the laminate direction by the laminate-direction compressing

unit, against the table, and the holding portion holds the plurality of tubes when the tank is connected to the plurality of tubes is provided.

[0009] According to another aspect of the present invention, a heat exchanger assembling method for connecting a tank with an opening end of a plurality of laminated tubes, the method includes: a lamination process for laminating the plurality of tubes; a main compression process for compressing the plurality of tubes in a laminate direction; and an assembling process for connecting the tank to the plurality of tubes in a state where the plurality of tubes are held and pressed by a holding portion for holding the tubes in the vicinity of the opening end of the plurality of tubes compressed in the laminate direction is provided.

[0010] According to the above-mentioned aspects of the present invention, in the process for connecting the tank to each of the laminated tubes, the pressing portion provided in the vicinity of the opening end of each tube is pressed and therefore the positional deviation can be suppressed from occurring in each tube. Therefore, each of the laminated tubes can be accurately assembled with the tank.

BRIEF DESCRIPTION OF DRAWINGS

[0011] FIG. 1 is a front view illustrating a schematic configuration of a heat exchanger core according to an embodiment of the present invention;

[0012] FIG. 2A illustrates a process for assembling the heat exchanger core;

[0013] FIG. 2B illustrates a process for assembling the heat exchanger core;

[0014] FIG. 2C illustrates a process for assembling the heat exchanger core;

[0015] FIG. 2D illustrates a process for assembling the heat exchanger core;

[0016] FIG. 3A is a configuration diagram illustrating an operation of an assembling apparatus in a lamination process;

[0017] FIG. 3B is a configuration diagram illustrating an operation of the assembling apparatus in a main compression process;

[0018] FIG. 3C is a configuration diagram illustrating an operation of the assembling apparatus in an assembling process;

[0019] FIG. 4A is a configuration diagram illustrating an operation of the assembling apparatus in the lamination process;

[0020] FIG. 4B is a configuration diagram illustrating an operation of the assembling apparatus in the main compression process;

[0021] FIG. 4C is a configuration diagram illustrating an operation of the assembling apparatus in the assembling process;

[0022] FIG. 5A is a cross-sectional view of the tubes illustrating an operation of the assembling apparatus in the lamination process;

[0023] FIG. 5B is a cross-sectional view of the tubes illustrating an operation of the assembling apparatus in the main compression process;

[0024] FIG. 5C is a cross-sectional view of the tubes illustrating an operation of the assembling apparatus in the assembling process;

[0025] FIG. 6 is a front view illustrating a modified embodiment of the heat exchanger core; and

[0026] FIG. 7 is a configuration diagram illustrating an operation of an assembling apparatus according to a comparative example.

DESCRIPTION OF EMBODIMENTS

[0027] Hereinafter, embodiments of the present invention will be described with reference to attached drawings.

[0028] FIG. 1 is a front view illustrating a schematic configuration of a heat exchanger 10 according to an embodiment of the present invention.

[0029] The heat exchanger 10 performs heat exchange between a medium flowing inside thereof and external air or the like. The heat exchanger 10 can be used as a radiator for an internal combustion engine, in which cooling liquid flows as the internal medium. However, the heat exchanger 10 is not limited to the radiator and adoptable as a charge air cooler in which intake air flows as a medium or a condenser of an air conditioner or a cooling device in which a refrigerant gas flows as a medium.

[0030] The heat exchanger 10 includes a plurality of tubes 11 in which the internal medium flows, corrugated fins 12 arranged alternately with respective tubes 11, right and left reinforcements 17 disposed in such a way as to be aligned with both ends of a laminate body of respective tubes 11 and fins 12, and upper and lower tanks 13 and 14 to which opening ends 11d of respective tubes 11 are connected.

[0031] The flat tube 11 can be formed by bending a metal plate, such as an aluminum plate, into a cylindrical shape. However, the tube 11 is not limited to a specific type and may be formed by extruding a molten metal material into a cylindrical shape.

[0032] The tanks 13 and 14 include tank plates 23 and 24 to which opening ends 11d of respective tubes 11 are connected and dome-shaped tank bodies 25 and 26 assembled with the tank plates 23 and 24. The tank plates 23 and 24 have tube insertion holes 23a and 24a into which the opening ends 11d of respective tubes 11 are inserted (refer to FIG. 2D). The tank plates 23 and 24 are, for example, made of a metal member such as an aluminum. The tank bodies 25 and 26 are, for example, made of a resin member.

[0033] The manufacturing of the heat exchanger 10 includes assembling the tubes 11, the fins 12, the reinforcements 17, and the tank plates 23 and 24 by using an assembling apparatus 50 described below, constituting the heat exchanger core 9 by brazing the assembled members for joining them, and completing the heat exchanger 10 by assembling the heat exchanger core 9 with the tank bodies 25 and 26.

[0034] While the heat exchanger 10 is operating, the medium is supplied into the tank 13 from a medium inlet 15 of the tank body 25. The medium flows into each tube 11 from the tank 13 and subsequently into the tank 14, and is then discharged from a medium outlet 16 of the tank body 26. Thus, the medium circulating in the heat exchanger 10 exchanges heat with the air via the fins 12 while flowing through respective tubes 11.

[0035] FIGS. 2A to 2D illustrate assembling processes of the heat exchanger core 9. Hereinafter, exemplary processes of assembling the heat exchanger core 9 will be described.

[0036] First, alternately laminating a plurality of tubes 11 and fins 12 (refer to FIG. 2A) is performed. Subsequently, compressing the laminated tubes 11 and fins 12 in the laminate direction (refer to FIG. 2B) by using the assembling apparatus 50 (refer to FIGS. 3A to 3C and FIGS. 4A

to 4C) is performed. In this state, each fin 12 is hermetically in contact with neighboring tubes 11. In the following description, a predetermined number of tubes 11 and fins 12 laminated alternately with each other is referred to as “laminate body 18”. Further, the “laminate direction” is the direction along which the tubes 11 and the fins 12 are aligned.

[0037] The assembling apparatus 50 compresses the laminate body 18 constituted by the tubes 11 and the fins 12 until the interval between two tubes 11 neighboring in the laminate direction becomes equal to a predetermined interval. The predetermined interval is the interval between the tube insertion holes 23a and 24a of respective tank plates 23 and 24 (refer to FIG. 2C). In the following description, the interval between two neighboring tubes 11 is referred to as “tube pitch”.

[0038] Press-fitting the opening ends 11d of respective tubes 11 into corresponding tube insertion holes 23a and 24a of the tank plates 23 and 24 (refer to FIG. 2D) is performed in the compressed state where the tube pitch of the laminate body 18 is equal to the predetermined interval.

[0039] Subsequently, joining the constituent members by brazing is performed through heat treatment causing cladding layers applied to the surfaces of the tubes 11, the fins 12, and the tank plates 23 and 24 to melt. As a result, the tubes 11, the fins 12, the reinforcements 17, and the tank plates 23 and 24 are united to form the heat exchanger core 9.

[0040] FIGS. 3A to 3C are schematic configuration diagrams illustrating the assembling apparatus 50. FIGS. 4A to 4C are schematic configuration diagrams illustrating the assembling apparatus 50 seen from the direction of arrow J illustrated in FIG. 3A. An exemplary configuration of the assembling apparatus 50 will be described in detail below.

[0041] The assembling apparatus 50 includes a table 51, a laminate-direction compressing unit 55, a thickness-direction compressing unit 60, and a tank assembling unit (not illustrated).

[0042] The table 51 has a planer portion on which the laminate body 18 constituted by tubes 11 and fins 12, which are constituent components of the heat exchanger 10, is placed.

[0043] The laminate-direction compressing unit 55 is a mechanism which of compresses the laminate body 18 placed on the table 51 in the laminate direction. The laminate-direction compressing unit 55 includes a fixing portion 56 fixed to the table 51, a movable portion 57 supported by the table 51 so as to be movable in the laminate direction, and an actuator (not illustrated) that can move the movable portion 57.

[0044] The thickness-direction compressing unit 60 is a mechanism which compresses the laminate body 18 in a thickness direction perpendicular to the table 51. The thickness-direction compressing unit 60 includes a leveling plate 61 that can be moved by a driving mechanism 62 in the thickness direction, and a pair of holding portions 63 that can be moved by a driving mechanism 64 in the thickness direction. In the following description, the “thickness direction” is the direction perpendicular to the surface of the table 51 on which the laminate body 18 is placed.

[0045] The driving mechanism 62 of the leveling plate 61 includes a guide rod 69 (refer to FIGS. 4A to 4C) that supports the leveling plate 61 so as to be movable in the vertical direction, a support base 65, and an actuator 66 that

raises or lowers the support base **65** to move the leveling plate **61**. For example, a hydraulic cylinder is adoptable as the actuator **66**.

[0046] The leveling plate **61** has a planer portion, which extends parallel to the table **51**, to press each tube **11** placed on the table **51**.

[0047] The driving mechanisms **64** of the holding portions **63** include a pair of guide portions **67** each supporting the corresponding holding portion **63** so as to be movable in the vertical direction with respect to the support base **65**, and a pair of actuators **68** for raising and lowering corresponding guide portions **67** to move the holding portions **63**. For example, a hydraulic cylinder is adoptable as the actuator **68**.

[0048] The holding portion **63** is a convex portion protruding from each guide portion **67** and pressing each tube **11**. Each tube **11** has a pressing portion **11g**, against which the holding portion **63** is pressed, in the vicinity of the opening end **11d**. As illustrated FIG. 5C described below, the pressing portion **11g** has a concave portion **11a** (i.e., pressed mark), which is formed as a recess on a surface **11b** of the tube **11** when the holding portion **63** is pressed against the tube **11**.

[0049] Respective holding portions **63** are arranged with the table **51** sandwiched in the longitudinal direction of the tube **11** and extend parallel to both ends of the table **51**. Each holding portion **63** is disposed in such a way as to face a predetermined position of each tube **11** placed on the table **51**. As illustrated FIG. 1, the pressing portion **11g** provided on the tube **11** is spaced from the tank plates **23** and **24** by a predetermined distance L.

[0050] The holding portion **63** is formed integrally with the guide portion **67**, although the holding portion **63** can be formed separately of the guide portion **67**.

[0051] The leveling plate **61** and each holding portion **63** are, for example, made of a metal member such as an iron, whose hardness is higher than that of the tube **11**. The area where the leveling plate **61** comes into contact with respective tubes **11** is set to be greater than the area where respective holding portions **63** come into contact with respective tubes **11**. Such a configuration can prevent any plastic deformation from occurring on the tube **11** at a portion where the leveling plate **61** is pressed.

[0052] Exemplary operations of the assembling apparatus **50** will be described in detail below with reference to FIGS. 3A to 3C, FIGS. 4A to 4C, and FIGS. 5A to 5C. FIG. 5C corresponds to a cross-sectional view of the tube **11** taken along a line VC-VC illustrated in FIG. 1.

[0053] First, the assembling apparatus **50** performs the lamination process for laminating the laminate body **18** on the table **51** at a predetermined position thereof (refer to FIG. 3A, FIG. 4A, and FIG. 5A).

[0054] The lamination process includes placing the laminate body **18** constituted by a predetermined number of tubes **11** and fins **12** arranged respectively on the table **51**, and causing the driving mechanism **62** of the thickness-direction compressing unit **60** to lower the support base **65** toward the table **51** so that the laminate body **18** is pressed in the thickness direction by the leveling plate **61** and each holding portion **63** with a driving force B (refer to FIG. 3A). Each holding portion **63** is held at a position on the same plane (on the horizontal plane) as the leveling plate **61** and presses the laminate body **18** together with the leveling plate **61**. In this case, no plastic deformation occurs in the pressing

portion **11g** of the tube **11** pressed by each holding portion **63** (refer to FIG. 5A). However, the configuration is not limited to the above-mentioned example. The lamination process may include moving the holding portion **63** upward away from the laminate body **18** and pressing the laminate body **18** by only the leveling plate **61**.

[0055] The lamination process includes causing the laminate-direction compressing unit **55** to move the movable portion **57** toward the fixing portion **56** to compress the laminate body **18** with a driving force A in the laminate direction (refer to FIG. 4A). The compression by the laminate-direction compressing unit **55** in the lamination process continues until the tube pitch reaches, for example, 90% of the above-mentioned predetermined interval.

[0056] The driving force B required for the driving mechanism **62** to press the laminate body **18** against the table **51** is set to be appropriate in smoothly moving the tubes **11** and the fins **12** pressed by the movable portion **57** of the laminate-direction compressing unit **55** toward the fixing portion **56**. The driving force B of the driving mechanism **62** can be controlled based on a stroke amount required for the driving mechanism **62** to move the leveling plate **61** toward the table **51**, instead of setting the driving force B for the driving mechanism **62**. In this case, for example, the setting of the stroke amount is performed in such a way as to equalize the interval between the table **51** and the leveling plate **61** with the thickness of the laminate body **18**.

[0057] As mentioned above, in the lamination process, the laminate body **18** is compressed in both the thickness direction and the laminate direction and can be placed at a predetermined position on the table **51** without being lifted off the table **51**.

[0058] Next, the assembling apparatus **50** performs the main compression process for compressing the laminate body **18** until the tube pitch becomes equal to the above-mentioned predetermined interval (refer to FIGS. 3B, 4B, and 5B).

[0059] FIG. 7 is a configuration diagram illustrating an operation of an assembling apparatus **150** according to a comparative example. A thickness-direction compressing unit **160** of the assembling apparatus **150** does not have any holding portion and compresses the laminate body **18** by using only a leveling plate **161** in the thickness direction. When a laminate-direction compressing unit **155** compresses the laminate body **18** in the laminate direction, the thickness-direction compressing unit **160** is subjected to a frictional force M acting from the laminate body **18**. When the frictional force M is large, the frictional force M deforms a guide rod **169** supporting the leveling plate **161** so as to be inclined by an angle θ , while the leveling plate **161** is displaced in the laminate direction by a distance N and inclines with respect to the table **51**. Accordingly, if the orientation of the leveling plate **161** changes, undesirable positional deviation in which some of the tubes **11** are lifted off the table **51** may occur.

[0060] On the other hand, in the main compression process according to present embodiment, the driving mechanism **62** of the thickness-direction compressing unit **60** lowers the support base **65** toward the table **51** to cause the leveling plate **61** to press the laminate body **18** with a driving force E in the thickness direction (refer to FIG. 3B). On the other hand, each holding portion **63** moves upward away from the laminate body **18** as indicated by arrow F.

[0061] Further, in the main compression process, the laminate-direction compressing unit 55 compresses the laminate body 18 with a driving force D in the laminate direction to equalize the tube pitch with the above-mentioned predetermined interval (refer to FIG. 4B). The driving force D in the main compression process is set to be greater than the driving force A in the lamination process.

[0062] The driving force E required for the driving mechanism 62 to press the laminate body 18 against the table 51 is set to be greater than the driving force B in the lamination process and appropriate in smoothly moving the tubes 11 and the fins 12 pressed by the movable portion 57 of the laminate-direction compressing unit 55 toward the fixing portion 56. The driving force E of the driving mechanism 62 can be controlled based on a stroke amount required for the driving mechanism 62 to move the leveling plate 61 toward the table 51, instead of setting the driving force E of the driving mechanism 62. In this case, for example, the interval between the table 51 and the leveling plate 61 is set to be slightly smaller than the thickness of the laminate body 18.

[0063] In the main compression process, each holding portion 63 is separated from the laminate body 18 (refer to FIG. 5B) and the pressing force with which the holding portion 63 presses the laminate body 18 becomes zero. Therefore, when the laminate-direction compressing unit 55 compresses the laminate body 18 in the laminate direction, a frictional force C that the driving mechanism 62 of the thickness-direction compressing unit 60 receives from the laminate body 18 is suppressed to be smaller. As a result, the guide rod 69 supporting the leveling plate 61 or the like is suppressed from deflecting, and the orientation of the leveling plate 61 can be held to face the table 51 in parallel with each other. The orientation of the leveling plate 61 as mentioned above is maintained in the main compression process can prevent the positional deviation in which some of the tubes 11 are lifted off the table 51 can be prevented from occurring.

[0064] Next, the assembling process is performed for assembling the tank plates 23 and 24 with the laminate body 18 held on the table 51 (refer to FIGS. 3C, 4C, and 5C).

[0065] In the assembling process, the laminate-direction compressing unit 55 compresses the laminate body 18 with a driving force G in the laminate direction (refer to FIG. 4C), while the actuator 66 of the driving mechanism 62 presses the laminate body 18 by the leveling plate 61 with a driving force H in the thickness direction. In this state, the actuator 68 of the driving mechanism 64 presses the laminate body 18 by the holding portion 63 with a driving force I in the thickness direction (refer to FIG. 3C).

[0066] As illustrated in FIG. 5C, the surface 11b of the pressing portion 11g of the tube 11 curved into an arc shape is pressed by the holding portion 63 with driving force I and, as a result, the concave portion 11a is formed. The concave portion 11a has a pair of step portions 11c opposed to each other. Each step portion 11c extends in a direction (lateral direction) perpendicular to the longitudinal direction of the tube 11.

[0067] The driving force I required for the driving mechanism 64 to move the holding portion 63 is set to be appropriate such that the tube 11 pressed by the holding portion 63 deforms plastically and the concave portion 11a having a predetermined depth can be formed on the surface 11b of the pressing portion 11g of the tube 11. The load with which the holding portion 63 presses each tube 11 is set to

be greater than the load with which the leveling plate 161 presses the laminate body 18 in the comparative example illustrated in FIG. 7. Further, the driving force I of the driving mechanism 64 can be controlled based on a stroke amount required for the driving mechanism 64 to move the holding portion 63 toward the table 51, instead of setting the driving force I of the driving mechanism 64. In this case, for example, the stroke amount is set performed in such a manner that the interval between the table 51 and the holding portion 63 becomes smaller than the thickness of the tube 11 by a predetermined amount. Setting the stroke amount as mentioned above, thereby the concave portion 11a having the predetermined depth is formed on the surface of the pressing portion 11g of the tube 11. The depth of the concave portion 11a can be changed by adjusting the load or the stroke amount required for the holding portion 63 to press each tube 11. Further, as described below, in the pressing portion 11g of the tube 11, it is feasible to prevent the surface 11b of the tube 11 from plastically deforming so as not to form the concave portion 11a.

[0068] As mentioned above, the tank assembling unit (not illustrated) is operated to assemble the tank plates 23 and 24 with the laminate body 18 in a state where the laminate body 18 is held on the table 51. In this case, the laminate body 18 is compressed by the laminate-direction compressing unit 55 and is restricted from moving in the laminate direction. Further, because the holding portion 63 is pressed against the concave portion 11a, each tube 11 is restricted from moving in both the thickness direction and the longitudinal direction of the tube 11. Thus, because each tube 11 is held at a predetermined position on the table 51, press-fitting the opening ends 11d of respective tubes 11 into the tube insertion holes 23a and 24a of the tank plates 23 and 24 can be accurately performed.

[0069] Subsequently, the heat treatment is performed to cause the cladding layers applied beforehand to the surfaces of the tubes 11, the fins 12, and the tank plates 23 and 24 to melt and braze the constituent components together, thereby forming the heat exchanger core 9. Subsequently, the tank bodies 25 and 26 are united with the tank plates 23 and 24 to complete the heat exchanger 10.

[0070] Next, effects of the present embodiment will be described in detail below.

[0071] The present embodiment provides the heat exchanger 10 including the pressing portion 11g for holding the tube 11 when the tanks 13 and 14 are connected in the vicinity of the opening end 11d of each tube 11.

[0072] Further, the present embodiment provides the assembling apparatus 50 that includes the table 51 on which respective tubes 11 are laminated, the laminate-direction compressing unit 55 configured to compress respective tubes 11 laminated on the table 51 in the laminate direction, and the thickness-direction compressing unit 60 configured to compress respective tubes 11 in the thickness direction perpendicular to the table 51. The thickness-direction compressing unit 60 includes the holding portion 63 configured to press the vicinity of the opening ends 11d of respective tubes 11, compressed in the laminate direction by the laminate-direction compressing unit 55, against the table 51. The holding portion 63 holds the plurality of tubes 11 when the tanks 13 and 14 are connected to respective tubes 11.

[0073] Further, the present embodiment provides the assembling method including the lamination process for laminating respective tubes 11, the main compression pro-

cess for compressing respective tubes 11 in the laminate direction, and the assembling process for connecting the tanks 13 and 14 with respective tubes 11 in a state where the tubes 11 are held and pressed by the holding portion 63 for holding each tube 11 in the vicinity of the opening end 11d of respective tubes 11 compressed in the laminate direction.

[0074] The above-mentioned configuration can suppress the positional deviation from occurring in each laminated tube 11 because the holding portion 63 presses each tube 11 in the vicinity of the opening end 11d when the tanks 13 and 14 are connected to the laminated tubes 11. Therefore, the operation for assembling the tanks 13 and 14 with the laminated tubes 11 can be accurately performed. Accordingly, the tubes 11 and the tube insertion holes 23a and 24a of the tanks 13 and 14 can be prevented from being damaged. As a result, the brazing for joining the tubes 11 and the tube insertion holes 23a and 24a can be accomplished without causing any gap and the yield in the assembling operation of the heat exchanger 10 can be improved.

[0075] The present embodiment provides the heat exchanger 10 in which the pressing portion 11g includes the concave portion 11a recessed as the pressed mark on the surface 11b of the tube 11.

[0076] The above-mentioned configuration can suppress the positional deviation from occurring in each laminated tube 11 because the holding portion 63 presses and plastically deforms the surface 11b of each tube 11, and engages with the concave portion 11a which has been recessed by the pressing, when the tanks 13 and 14 are connected to the laminated tubes 11.

[0077] The present embodiment provides the heat exchanger 10 in which the pressing portions 11g are formed at positions apart from the tanks 13 and 14 by the predetermined distance L in the longitudinal direction of the tube 11.

[0078] The above-mentioned configuration can prevent the holding portion 63 pressed against the pressing portion 11g from interfering with the tanks 13 and 14 when the tanks 13 and 14 are assembled with the tubes 11. As a result, the operation for assembling the tanks 13 and 14 with the tubes 11 can be smoothly performed in a state where the holding portion 63 is pressed against the concave portion 11a.

[0079] The present embodiment provides the assembling apparatus 50 for the heat exchanger 10, in which the thickness-direction compressing unit 60 includes the leveling plate 61 aligned with the holding portion 63 and pressing respective tubes 11 against the table 11. The leveling plate 61 compresses each tube 11 in the thickness direction in a state where the holding portion 63 is separated from each tube 51.

[0080] The above-mentioned configuration can maintain the orientation of the leveling plate 61 when the laminate-direction compressing unit 55 compresses the laminate body 18 in the laminate direction, because the leveling plate 61 is in sliding contact with the laminate body 18 and the leveling plate 61 receives a smaller frictional force from the laminate body 18. Maintaining the orientation of the leveling plate 61 in the main compression process as mentioned above, the positional deviation in which some of the tubes 11 are lifted off the table 51 can be prevented from occurring.

[0081] Next, a modified embodiment of the heat exchanger 10 will be described with reference to FIG. 6.

[0082] The pressing portion 11g has a pressed mark portion 11f, which is formed as a pressed mark to be formed on the surface of each tube 11.

[0083] In the assembling process, the load or the stroke amount required for pressing the holding portion 63 against each tube 51 is appropriately set so that each tube 11 can return to the original surface shape without causing any plastic deformation even when the surface is deflected by the pressing of the holding portion 63 (refer to FIGS. 3C and 4C). As a result, the pressing portion 11g of each tube 11 is formed with the pressed mark portion 11f whose surface roughness is partly variable without forming any concave portion by pressing the holding portion 63.

[0084] In the assembling process, the holding portion 63 presses the surface of each tube 11 when the tanks 13 and 14 are connected, and therefore it is feasible to suppress the positional deviation from occurring in respective tubes 11 laminated on the table 51. Therefore, the operation for assembling the tanks 13 and 14 with the laminated tubes 11 can be accurately performed.

[0085] However, the configuration is not limited to the above-mentioned example. The assembling process can be configured such that any pressed mark does not remain on the surface of each tube 11 by appropriately setting the load or the stroke amount required for the holding portion 63 to press each tube 11.

[0086] Embodiments of this invention were described above, but the above embodiments are merely examples of applications of this invention, and the technical scope of this invention is not limited to the specific constitutions of the above embodiments.

[0087] In the above-mentioned embodiment, the leveling plate 61 and the holding portion 63 are configured to move vertically with respect to the table 51 so as to press the laminate body 18. However, the configuration is not limited to the above-mentioned example. A rotating mechanism using a hinge is adoptable to press the laminate body 18 from an inclined direction.

[0088] Further, in the above-mentioned embodiment, the laminate body 18 is constituted such that the tubes 11 and the fins 12 are laminated. However, the configuration is not limited to the above-mentioned example. The laminate body 18 can be configured to include only the tubes to be laminated without fins.

[0089] This application claims priority based on Japanese Patent Application No. 2015-025527 filed with the Japan Patent Office on Feb. 12, 2015 and Japanese Patent Application No. 2016-008445 filed with the Japan Patent Office on Jan. 20, 2016, the entire contents of which are incorporated into this specification.

1.-9. (canceled)

10. A heat exchanger including a laminate body constituted by a plurality of alternately laminated tubes and fins, the laminated tubes having an opening end to which a tank is connected, wherein

the laminate body includes a pressing portion provided in the vicinity of the opening end of each tube, the laminate body being held by the pressing portion when the tank is connected to the opening end of the tubes, and

the pressing portion is provided on the laminate body at two portions apart from each other in a longitudinal direction of the tube.

11. The heat exchanger according to claim 10, wherein the pressing portion is provided only on the tube.

12. The heat exchanger according to claim **10**, wherein the size of the fin in a thickness direction is smaller than the size of the tube in the thickness direction,

the fins are disposed at positions offset toward one end of the tubes in the thickness direction, and
the pressing portion is provided at the other end of the tubes in the thickness direction.

13. The heat exchanger according to claim **12**, wherein the fins and the one end of the tubes are disposed on the same plane.

14. The heat exchanger according to claim **10**, wherein the pressing portion includes a pressed mark to be formed on a surface of the tube.

15. The heat exchanger according to claim **14**, wherein the pressed mark is a concave portion recessed on the surface of the tube.

16. The heat exchanger according to claim **15**, wherein the concave portion has a depth smaller than a difference between the size of the fin in the thickness direction and the size of the tube in the thickness direction.

17. The heat exchanger according to claim **10**, wherein the pressing portion is formed at a position apart from the tank in a longitudinal direction of the tube.

18. A heat exchanger assembling apparatus for assembling a heat exchanger including a laminate body constituted by a plurality of alternately laminated tubes and fins, the laminated tubes having an opening end to which a tank is connected, the assembling apparatus comprising:

a table on which respective tubes and fins are laminated;
a laminate-direction compressing unit configured to compress the laminate body laminated on the table in a laminate direction; and

a thickness-direction compressing unit configured to compress the laminate body in a thickness direction perpendicular to the table, wherein

the thickness-direction compressing unit includes a holding portion configured to press the laminate body in the vicinity of the opening end of the plurality of tubes, compressed in the laminate direction by the laminate-direction compressing unit, against the table, and
the holding portion holds the laminate body at two portions apart from each other in a longitudinal direction of the plurality of tubes when the tank is connected to the plurality of tubes.

19. The heat exchanger assembling apparatus according to claim **18**, wherein the holding portion holds only the tubes.

20. The heat exchanger assembling apparatus according to claim **19**, wherein the thickness-direction compressing unit forms pressed marks on surfaces of the plurality of tubes with the holding portion.

21. The heat exchanger assembling apparatus according to claim **20**, wherein the size of the fin in the thickness direction is smaller than the size of the tube in the thickness direction,

the tubes and the fins are in contact with the table, and
the pressed marks are formed by the holding portion at the other ends of the fins, which are on the opposite side of one ends of the fins that are in contact with the table.

22. The heat exchanger assembling apparatus according to claim **21**, wherein the thickness-direction compressing unit includes a leveling plate aligned with the holding portion and pressing the plurality of tubes against the table, and

the leveling plate compresses the plurality of tubes in the thickness direction in a state where the holding portion is separated from the plurality of tubes.

23. A heat exchanger assembling method for assembling a heat exchanger including a laminate body constituted by a plurality of alternately laminated tubes and fins, the laminated tubes having an opening end to which a tank is connected, the method comprising:

a lamination process for laminating the plurality of tubes and fins;

a main compression process for compressing the laminate body in a laminate direction; and

an assembling process for connecting the tank to the plurality of tubes in a state where the laminate body are held and pressed at two portions apart from each other in a longitudinal direction of the plurality of tubes by a holding portion for holding the laminate body in the vicinity of the opening end of the plurality of tubes compressed in the laminate direction.

24. The heat exchanger assembling method according to claim **23**, wherein the holding portion holds only the tubes in the assembling process.

25. The heat exchanger assembling method according to claim **24**, wherein the assembling process includes forming pressed marks on surfaces of the plurality of tubes with the holding portion.

26. The heat exchanger assembling method according to claim **25**, wherein the size of the fin in a thickness direction is smaller than the size of the tube in the thickness direction, the lamination process includes disposing the fins at positions offset toward one ends of the tubes in the thickness direction, and

the pressed marks are formed by the holding portion, in the assembling process, at the other ends of the tubes, which are on the opposite side of the one ends of the tubes in the thickness direction.

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