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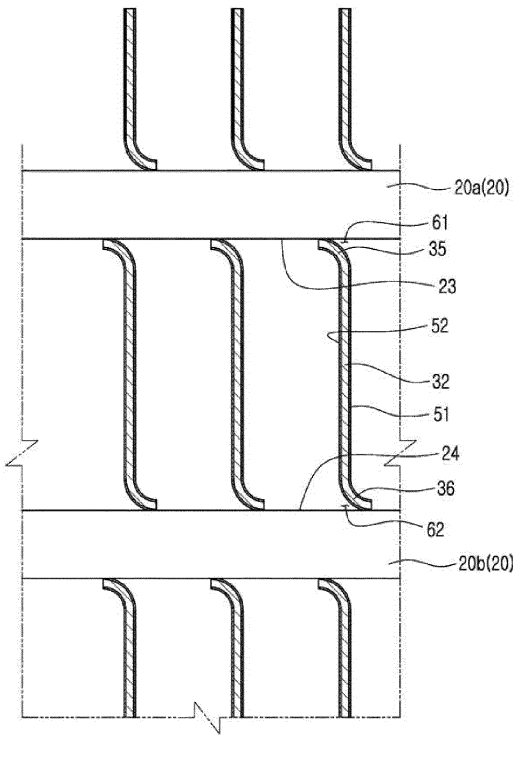
(54) **Heat exchanger**

(57) A heat exchanger having an improved structure which allows refrigerant tubes to be firmly bonded to heat exchange fins. The heat exchanger includes a plurality of refrigerant tubes spaced apart from each other, headers coupled to both end portions of the refrigerant tubes, and heat exchange fins coupled to the refrigerant tubes and disposed spaced apart from each other. Each of the heat exchange fins includes insertion grooves allowing the refrigerant tubes to be inserted thereinto, and bonding plates bonded to the refrigerant tubes. Each of the bonding plates includes a first bonding portion curved from one end portion thereof in a first direction and bonded to one surface of a corresponding one of the refrigerant tubes, and a second bonding portion curved from the other end portion thereof in a second direction and bonded to the other surface of the corresponding one of the refrigerant tubes.

FIG. 5



**Description**

**[0001]** The following description relates to a heat exchanger having an improved structure of bonding of a refrigerant tube and heat exchange fins.

**[0002]** A heat exchanger is mounted in devices operating based upon a refrigeration cycle, such as air conditioners and refrigerators. The heat exchanger includes a plurality of heat exchange fins and refrigerant tubes connected to the heat exchanger fins to guide a refrigerant. Contact area between the heat exchange fins and external air introduced into the heat exchanger is increased to improve the efficiency of heat exchange between the refrigerant flowing through the refrigerant tubes and the external air.

**[0003]** The heat exchange fins are generally bonded to the refrigerant tubes by assembling the heat exchange fins and the refrigerant tubes together and then applying a bonding material to the portions of the heat exchange fins and the refrigerant tubes at which the heat exchange fins and the refrigerant tubes are bonded to each other, or by assembling the heat exchange fins and the refrigerant tubes which have the bonding material laminated on the surfaces thereof and then heating the same to melt the bonding material such that the bonding material flows to the portions of the heat exchange fins and refrigerant tubes to be bonded to each other.

**[0004]** In the latter case, if the melted bonding material does not uniformly flow to the portions of the heat exchange fins and refrigerant tubes to be bonded to each other, certain portions of the heat exchange fins and the refrigerant tubes may not be completely bonded, or the heat exchange fins may be easily separated from the refrigerant tubes, and thereby heat exchanger efficiency may be greatly lowered.

**[0005]** Therefore, it is an aspect of the present disclosure to provide a heat exchanger having an improved structure which allows refrigerant tubes to be firmly bonded to heat exchange fins.

**[0006]** Additional aspects of the disclosure will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the disclosure.

**[0007]** In accordance with an aspect of the present disclosure, a heat exchanger includes a plurality of refrigerant tubes spaced apart from each other a plurality of headers coupled to both end portions of the refrigerant tubes, and a plurality of heat exchange fins coupled to outer surfaces of the refrigerant tubes and disposed spaced apart from each other in a direction perpendicular to a direction in which the refrigerant tubes extend, wherein each of the heat exchange fins include a plurality of insertion grooves allowing the refrigerant tubes to be inserted thereinto, and a plurality of bonding plates bonded to the refrigerant tubes when the refrigerant tubes are inserted into the insertion grooves, wherein each of the bonding plates includes a first bonding portion curved from one end portion thereof in a first direction and bonded to one surface of a corresponding one of the refrigerant tubes, and a second bonding portion curved from the other end portion thereof, opposite to the one end portion, in a second direction opposite to the first direction and bonded to the other surface of the corresponding one of the refrigerant tubes opposite to the one surface of the corresponding one of the refrigerant tubes.

**[0008]** The first direction may be parallel with the direction in which the refrigerant tubes extend.

**[0009]** The first direction may be perpendicular to a direction in which the refrigerant tubes are inserted into the heat exchange fins.

**[0010]** The heat exchange fins may be formed of a plurality of layers of aluminum alloys having different melting points.

**[0011]** A bonding member melting at a temperature over a predetermined temperature to bond the heat exchange fins to the refrigerant tubes is provided on both surfaces of each of the heat exchange fins.

**[0012]** The bonding member may include a first bonding member provided on one surface of each of the heat exchange fins, and melting at a temperature over a first predetermined temperature to flow into a gap formed between the one surface of the corresponding one of the refrigerant tubes and the first bonding portion, and a second bonding member provided on the other surface of each of the heat exchange fins opposite the one surface, and melting at a temperature over a second predetermined temperature to flow into a gap formed between the other surface of the corresponding one of the refrigerant tubes and the second bonding portion.

**[0013]** The first bonding portion may include a first guide surface to guide the melted first bonding member into the gap formed between the one surface of the corresponding one of the refrigerant tubes and the first bonding portion, and the second bonding portion comprises a second guide surface to guide the melted second bonding member into the gap formed between the other surface of the corresponding one of the refrigerant tubes and the second bonding portion.

**[0014]** Each of the bonding plates may include a louver formed between the first bonding portion and the second bonding portion, wherein the louver may include a plurality of guide holes formed by cutting at least one portion of the bonding plate; and a plurality of guide plates to guide air passing through the guide holes.

**[0015]** In accordance with another aspect of the present disclosure, a heat exchanger includes a plurality of refrigerant tubes provided with a channel allowing a refrigerant to flow therethrough; and a plurality of heat exchange fins contacting the refrigerant tubes to mediate heat exchange between the refrigerant and external air, wherein each of the heat exchange fins includes a plurality of insertion grooves allowing the refrigerant tubes to be inserted thereinto, and a bonding plate disposed between the refrigerant tubes when the refrigerant tubes are inserted into the insertion grooves, wherein one surface of the bonding plate is bonded to a first refrigerant tube neighboring one end portion of the bonding plate, and the other surface of the bonding plate opposite to the one surface of the bonding plate is bonded to a second refrigerant tube neighboring the other end portion of the bonding plate opposite to the one end portion of the bonding plate.

**[0016]** The heat exchanger may further include a first bonding member combined to the one surface of the bonding plate and melting at a temperature over a first predetermined temperature to flow into a gap formed between the one surface of the bonding plate and the first refrigerant tube, and a second bonding member combined to the other surface of the bonding plate and melting at a temperature over a second predetermined temperature to flow into a gap formed between the other surface of the bonding plate and the second refrigerant tube.

**[0017]** The first bonding member and the second bonding member may be formed of an aluminum alloy.

**[0018]** The heat exchanger may further include a first header and a second header respectively coupled to both end portions of the refrigerant tubes and communicating with the refrigerant tubes.

**[0019]** One end portion of the bonding plate neighboring the first refrigerant tube is curved toward the first header, and the other end portion of the bonding plate neighboring the second refrigerant tube is curved toward the second header.

**[0020]** These and/or other aspects of the disclosure will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1 is a perspective view illustrating a heat exchanger according to an exemplary embodiment of the present disclosure;

FIG. 2 is an exploded perspective view illustrating components of the heat exchanger of

FIG. 1 which are separated from each other;

FIG. 3 is an enlarged perspective view illustrating a part of the heat exchange fins shown in FIG. 2;

FIG. 4 is a perspective view illustrating coupling of the refrigerant tubes to the heat exchange fins;

FIG. 5 is a partial cross-sectional view illustrating coupling of the refrigerant tubes to the heat exchange fins before the bonding member is melted; and

FIG. 6 is a partial cross-sectional view illustrating introduction of the melted bonding member into the portions of the refrigerant tubes and the heat exchange fins contacting each other.

**[0021]** Reference will now be made in detail to the embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like components throughout.

**[0022]** FIG. 1 is a perspective view illustrating a heat exchanger according to an exemplary embodiment of the present disclosure, and FIG. 2 is an exploded perspective view illustrating components of the heat exchanger of FIG. 1 which are separated from each other.

**[0023]** As show in FIGS. 1 and 2, the heat exchanger 10 includes a plurality of refrigerant tubes 20 through which a refrigerant flows, a plurality of the heat exchange fins 30 coupled to the outer surfaces of the refrigerant tubes 20, and a first header 41 and a second header 42 connected to both end portions of the refrigerant tubes 20. A refrigerant inlet pipe 43 and outlet pipe 44 are connected to the first header 41 and the refrigerant enters to and exits from the refrigerant tube through the inlet pipe 43 and the outlet pipe 44, respectively.

**[0024]** Each of the refrigerant tubes 20 includes a plurality of channels 21 formed to be hollow to allow a refrigerant to flow therethrough, and partitions 22 dividing the channels 21 from each other. The channels 21 are disposed spaced apart from each other in the widthwise direction of the refrigerant tubes 20.

**[0025]** As a refrigerant, various materials including R-134a and R410A which are formed by mixing different types of Freon having different properties may be used.

**[0026]** The refrigerant exchanges heat with the external air when the phase thereof changes from a gas state to a liquid state (compression) or from the liquid state to the gas state (expansion). When the phase of the refrigerant changes from the gas state to the liquid state, the heat exchanger 10 is used as a condenser. When the phase of the refrigerant changes from the liquid state to the gas state, the heat exchanger 10 is used as an evaporator.

**[0027]** The first header 41 and the second header 42 are respectively connected to both end portions of each of the refrigerant tubes 20 to allow the refrigerant to flow through the refrigerant tubes 20. The refrigerant tubes 20 may be formed to extend a long distance to increase the area for heat exchange between the refrigerant flowing through the refrigerant tubes 20 and the external air, but the space for extension of the refrigerant tubes 20 in one direction is limited. The first header 41 and the second header 42 are coupled to both end portions of the refrigerant tubes 20 to connect the refrigerant tubes 20 to each other such that the refrigerant flow in the direction opposite the direction in which the refrigerant tubes 20 extend from both end portions of the heat exchanger 10.

**[0028]** When the refrigerant flows along the channels 21 formed in the refrigerant tubes 20, it is compressed or expanded to discharge heat to the surroundings or absorb heat from the surroundings. For the refrigerant to efficiently discharge or absorb heat through compression or expansion, heat exchange fins 30 are coupled to the refrigerant tubes 20.

**[0029]** A plurality of heat exchange fins 30 are disposed spaced a predetermined distance apart from each other in a direction perpendicular to the direction in which the refrigerant tubes 20 extend. The heat exchange fins 30 may be formed of, for example, aluminum with high heat conductivity, and bonded to the outer surfaces of the refrigerant tubes 20 to substantially increase the area of heat exchange between the external air and the refrigerant tubes 20.

**[0030]** Narrowing the space between the stacked heat exchange fins 30 may allow more heat exchange fins 30 to be disposed. However, if the space is too narrow, it may impede the inflow of the external air into the heat exchanger 10, resulting in pressure loss.

**[0031]** Therefore, the space between the heat exchange fins 30 may be properly adjusted. FIG. 3 is an enlarged perspective view illustrating a part of the heat exchange fins shown in FIG. 2, and FIG. 4 is a perspective view illustrating coupling of the refrigerant tubes to the heat exchange fins. FIG. 5 is a partial cross-sectional view illustrating coupling of the refrigerant tubes to the heat exchange fins before the bonding member is melted, and FIG. 6 is a partial cross-sectional view illustrating introduction of the melted bonding member into the portions of the refrigerant tubes and the heat exchange fins contacting each other. Here, the direction to the first header 41 is defined as a first direction A, the direction to the second header 42 is defined as a second direction B, and the direction which is perpendicular to the first and second directions A and B is defined as a third direction C. The first direction A and the second direction B are both perpendicular to the third direction C in which the heat exchange fins 30 are inserted into the refrigerant tubes 20.

**[0032]** As shown in FIGS. 2 to 6, each of the heat exchange fins 30 includes a plurality of insertion grooves 31 into which the refrigerant tubes 20 are inserted, and a plurality of bonding plates 32 to be bonded to the refrigerant tubes 20 with the refrigerant tubes 20 inserted into the insertion grooves 31.

**[0033]** The insertion grooves 31 are formed in a shape corresponding to at least one portion of each of the heat exchange fins 30 to allow the portions of the heat exchange fins 30 to be inserted thereinto, and are formed between the bonding plates 32 disposed spaced apart from each other in the direction in which the heat exchange fins 30 extend. Each of the bonding plates 32 includes a first bonding portion 35 curved from one end portion thereof in a round shape in the first direction A and bonded to one surface 23 of a corresponding one of the refrigerant tubes 20, and a second bonding portion 36 curved from the other end portion of the bonding plate 32 opposite to the one end portion in a round shape in the second direction B opposite to the first direction A and bonded to the other surface 24 of the corresponding one of the refrigerant tubes 20 opposite to the one surface 23 of the corresponding one of the refrigerant tubes 20.

**[0034]** The first bonding portion 35 includes a first guide surface 35a to guide a melted first bonding member 51 to a gap 61 formed between one surface 23 of a corresponding one of the refrigerant tubes 20 and the first bonding portion 35, and the second bonding portion 36 includes a second guide surface 36a to guide a melted second bonding member 52 to a gap 62 formed between the other surface 24 of the corresponding one of the refrigerant tubes 20 and the second bonding portion 36. The first guide surface 35a and the second guide surface 36a are provided on opposite surfaces of each of the bonding plates 32.

**[0035]** The shape of the first bonding portion 35 and the second bonding portion 36 is not limited to the round shape. The first bonding portion 35 and the second bonding portion 36 may be formed to be inclined, slanted or bent with respect to the bonding plate 32, or formed in a hook shape.

**[0036]** In addition, the bonding plates 32 includes a louver 33 formed between the first bonding portion 35 and the second bonding portion 36. The louver 33 includes a plurality of guide holes 33a formed by cutting a part of the bonding plates 32, and a plurality of guide plates 33b to guide air passing through the guide holes 33a.

**[0037]** The guide holes 33a are disposed spaced apart from each other in the third direction C in which the heat exchange fins 30 are inserted into the refrigerant tubes 20. The guide holes 33a guide the external air introduced into the heat exchanger 10 such that the external air flows along the one surface of each the guide plates 33b and thereby heat transfer between the guide plates 33b and the external air is smoothly proceeds.

**[0038]** The guide plates 33b form a predetermined angle with the bonding plates 32, and are disposed spaced apart from and parallel to each other. The external air introduced into the guide holes 33a contacts the guide plates 33b to perform heat exchange, flowing along the bonding plates 32. The guide plates 33b substantially increase the contact area between the heat exchange fins 30 and the external air, thereby enhancing the heat exchange efficiency.

**[0039]** In addition, the guide plates 33b prevent or retard frost formation. The frost formation occurs when moisture in the external air is frozen and attached to the surfaces of the heat exchange fins 30. In particular, frost is well formed on a plane on which moisture exceeding a predetermined amount easily condenses. Forming the guide plates 33b as above makes it difficult for the moisture to condense beyond a predetermined amount, thereby preventing or retarding frost formation.

**[0040]** The bonding members 51 and 52 which melt at a specific temperature to bond the heat exchange fins 30 and the refrigerant tubes 20 are laminated to both surfaces of the heat exchange fins 30.

**[0041]** The bonding members 51 and 52 include a first bonding member 51 provided on one surface of the heat exchange fin 30 and adapted to melt at temperatures above a specific temperature and flow into the gap 61 formed between one surface 23 of the refrigerant tube 20 and the first bonding portion 35, and a second bonding member 52 provided on the other surface of the heat exchange fin 30 opposite to the one surface of the heat exchange fin 30 and adapted to melt at temperatures above a specific temperature and flow into the gap 62 formed between the other surface 24 of the refrigerant tubes 20 and the second bonding portion 36. The one surface of the heat exchange fins 30 is a surface on which the first guide surface 35a is formed, and the other surface of the heat exchange fins 30 is a surface on which the second guide surface 36a is formed.

**[0042]** The heat exchange fins 30, the first bonding member 51 and the second bonding member 52 may be formed of aluminum alloys having different melting points. Since the first bonding member 51 and the second bonding member 52 may be melt at a lower temperature than the heat exchange fins 30 to bond the refrigerant tubes 20 and the heat exchange fins 30, the melting points of the first bonding member 51 and the second bonding member 52 are lower than the melting point of the heat exchange fins 30.

**[0043]** Hereinafter, the operation of bonding the refrigerant tubes 20 and the heat exchange fins 30 will be described.

**[0044]** As shown in FIG. 5, the heat exchange fins 30 and the refrigerant tubes 20 coupled to each other are placed in a heating unit (not shown) and heated. When the temperature within the heating unit rises above the melting points of the first bonding member 51 and the second bonding member 52, the first bonding member 51 and the second bonding member 52 melt.

**[0045]** As shown in FIG. 6, the melted first bonding member 51 flow along the first guide surface 35a to the gap 61 formed between the one surface 23 of the first refrigerant tube 20a and the first bonding portion 35, while the melted second bonding member 52 flows along the second guide surface 36a to the gap 62 formed between the other surface 24 of the refrigerant tube 20b and the second bonding portion 36.

**[0046]** The first bonding portion 35 is formed to be curved from one end portion of the bonding plate 32 in the first direction A to form a fine gap 61 together with one surface 23 of the first refrigerant tube 20a to generate capillary force which guides the melted first bonding member 51 flowing along one surface of the heat exchange fin 30 into the fine gap 61 between the first bonding portion 35 and the one surface 23 of the first refrigerant tube 20a. In addition, the first bonding portion 35 prevents the melted second bonding member 52 flowing along the other surface of the heat exchange fin 30 from flowing into the fine gap 61 formed between the first bonding portion 35 and the one surface 23 of the first refrigerant tube 20a.

**[0047]** The second bonding portion 36 is formed to be curved from the one end portion of the bonding plate 32 in the second direction B opposite to the first direction A to form a fine gap 62 together with one surface 24 of the second refrigerant tube 20b, thereby generating capillary force which guides the melted second bonding member 52 flowing along the other surface of the heat exchange fin 30 into the fine gap 62 between the second bonding portion 36 and the one surface 24 of the second refrigerant tube 20b. In addition, the second bonding portion 36 prevents the melted first bonding member 51 flowing along the one surface of the heat exchange fin 30 from flowing into the fine gap 62 formed between the second bonding portion 36 and the other surface 24 of the second refrigerant tube 20b.

**[0048]** If heating is stopped after the first bonding member 51 flows into the gap 61 formed between the one surface 23 of the first refrigerant tube 20a and the first bonding portion 35 and the second bonding member 52 flows into the gap 62 formed between the other surface 24 of the second refrigerant tube 20b and the second bonding portion 36, the first bonding member 51 solidifies to bond the one surface 23 of the first refrigerant tube 20a to the first bonding portion 35, and the second bonding member 52 solidifies to bond the other surface 24 of the second refrigerant tube 20b to the second bonding portion 36. That is, one surface of the bonding plate 32 on which the first guide surface 35a is formed is bonded to the first refrigerant tube 20a neighboring one end portion of the bonding plate 32, and the other surface of the bonding plates 32 on which the second guide surface 36a is formed is bonded to the second refrigerant tube 20b neighboring the other end portion of the bonding plate 32.

**[0049]** As such, the bonding members 51 and 52 combined with the both surfaces of the heat exchange fins 30 does not move in both directions, but in single directions opposite to each other when melted, and thus the bonding members 51 and 52 are uniformly supplied to the portions of the refrigerant tubes 20 and the heat exchange fins 30 adjoining each other, and thereby a quality of bonding between the refrigerant tubes 20 and the heat exchange fins 30 may be ensured.

**[0050]** As is apparent from the above description, according to embodiments of the present disclosure, a bonding material is uniformly supplied to the portions of heat exchange fins and refrigerant tubes adjoining each other, and therefore a quality of bonding between the refrigerant tubes and the heat exchange fins may be stably ensured. In addition, the performance of the heat exchanger is stably maintained.

**[0051]** Although a few embodiments of the present disclosure have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles of the disclosure, the scope of which is defined in the claims and their equivalents.

## Claims

**1.** A heat exchanger comprising:

a plurality of refrigerant tubes spaced apart from each other;
a plurality of headers coupled to end portions of the refrigerant tubes; and

a plurality of heat exchange fins coupled to outer surfaces of the refrigerant tubes and disposed spaced apart from each other in a direction perpendicular to a direction in which the refrigerant tubes extend,
wherein each of the heat exchange fins comprises:

a plurality of insertion grooves to allow the refrigerant tubes to be inserted thereinto; and
a plurality of bonding plates bonded to the refrigerant tubes when the refrigerant tubes are inserted into the insertion grooves,
wherein each of the bonding plates comprises:

a first bonding portion curved from one end portion thereof in a first direction and bonded to one surface of a corresponding one of the refrigerant tubes; and
a second bonding portion curved from the other end portion thereof, in a second direction opposite to the first direction and bonded to a corresponding one of the refrigerant tubes.

**2.** The heat exchanger according to claim 1, wherein the first direction is parallel with the direction in which the refrigerant tubes extend.

**3.** The heat exchanger according to claim 1 or 2, wherein the first direction is perpendicular to a direction in which the refrigerant tubes are inserted into the heat exchange fins.

**4.** The heat exchanger according to any one of claims 1 to 3, wherein the heat exchange fins are formed of a plurality of layers of aluminum alloys having different melting points.

**5.** The heat exchanger according to any one of claims 1 to 4, wherein a bonding member melting at a temperature over a predetermined temperature to bond the heat exchange fins to the refrigerant tubes is provided on both surfaces of each of the heat exchange fins.

**6.** The heat exchanger according to claim 5, wherein the bonding member comprises:

a first bonding member provided on one surface of each of the heat exchange fins, and melting at a temperature over a first predetermined temperature to flow into a gap formed between the one surface of the corresponding one of the refrigerant tubes and the first bonding portion; and
a second bonding member provided on the other surface of each of the heat exchange fins opposite the one surface, and melting at a temperature over a second predetermined temperature to flow into a gap formed between the other surface of the corresponding one of the refrigerant tubes and the second bonding portion.

**7.** The heat exchanger according to claim 6, wherein:

the first bonding portion comprises a first guide surface to guide the melted first bonding member into the gap formed between the one surface of the corresponding one of the refrigerant tubes and the first bonding portion; and
the second bonding portion comprises a second guide surface to guide the melted second bonding member into the gap formed between the other surface of the corresponding one of the refrigerant tubes and the second bonding portion.

**8.** The heat exchanger according to any one of claims 1 to 7, wherein each of the bonding plates comprises a louver formed between the first bonding portion and the second bonding portion,
wherein the louver comprises:

a plurality of guide holes formed by cutting at least one portion of the bonding plate; and
a plurality of guide plates to guide air to pass through the guide holes.

**9.** The heat exchanger according to any one of claims 6 to 8, wherein the first bonding member and the second bonding member are formed of an aluminum alloy.

**10.** The heat exchanger according to any one of claims 1 to 9, further comprising a first header and a second header respectively coupled to both end portions of the refrigerant tubes and to communicate with the refrigerant tubes.

**11.** The heat exchanger according to claim 10, wherein:

one end portion of the bonding plate neighboring the first refrigerant tube is curved toward the first header; and
the other end portion of the bonding plate neighboring the second refrigerant tube is curved toward the second header.

FIG. 1

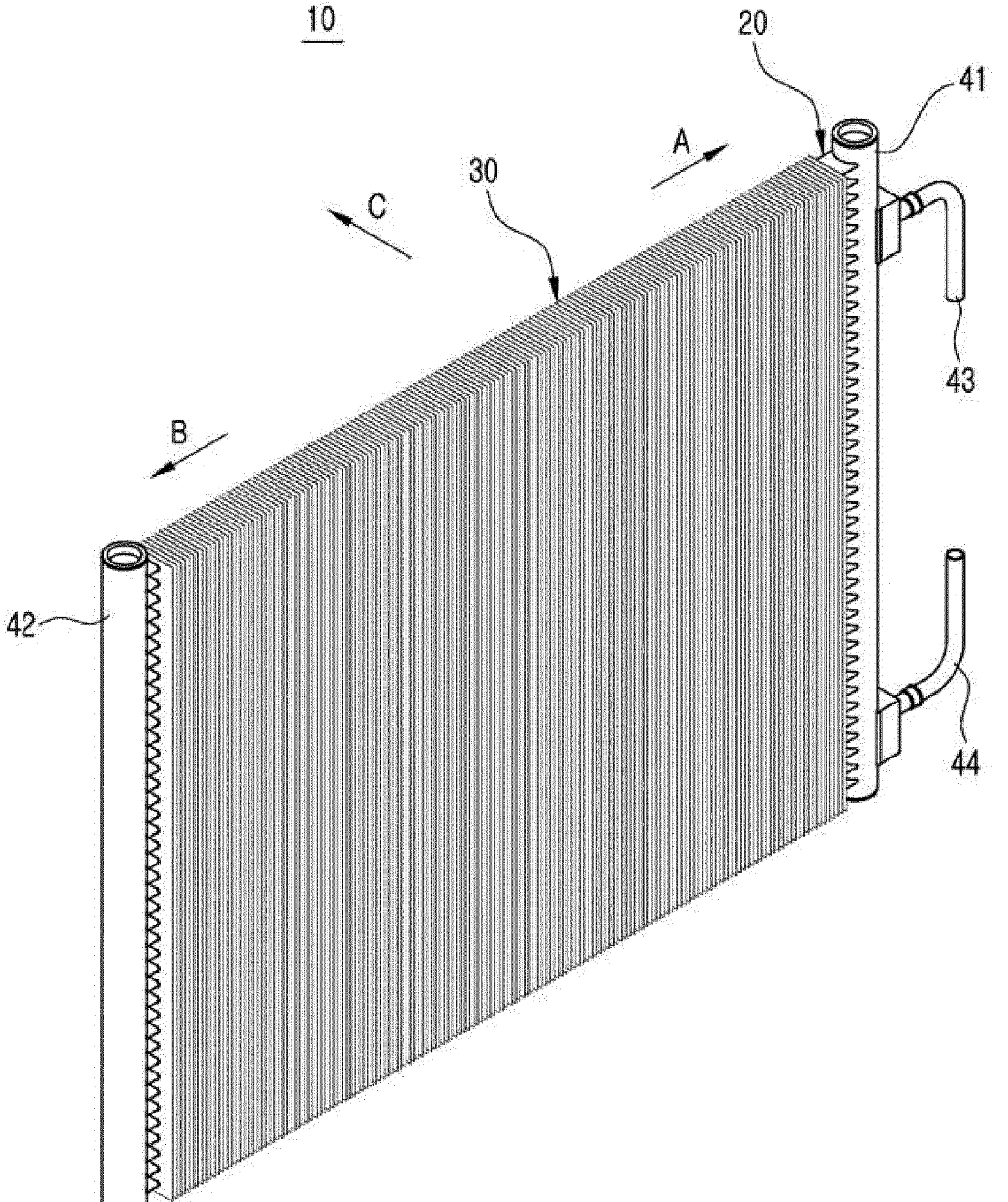


FIG. 2

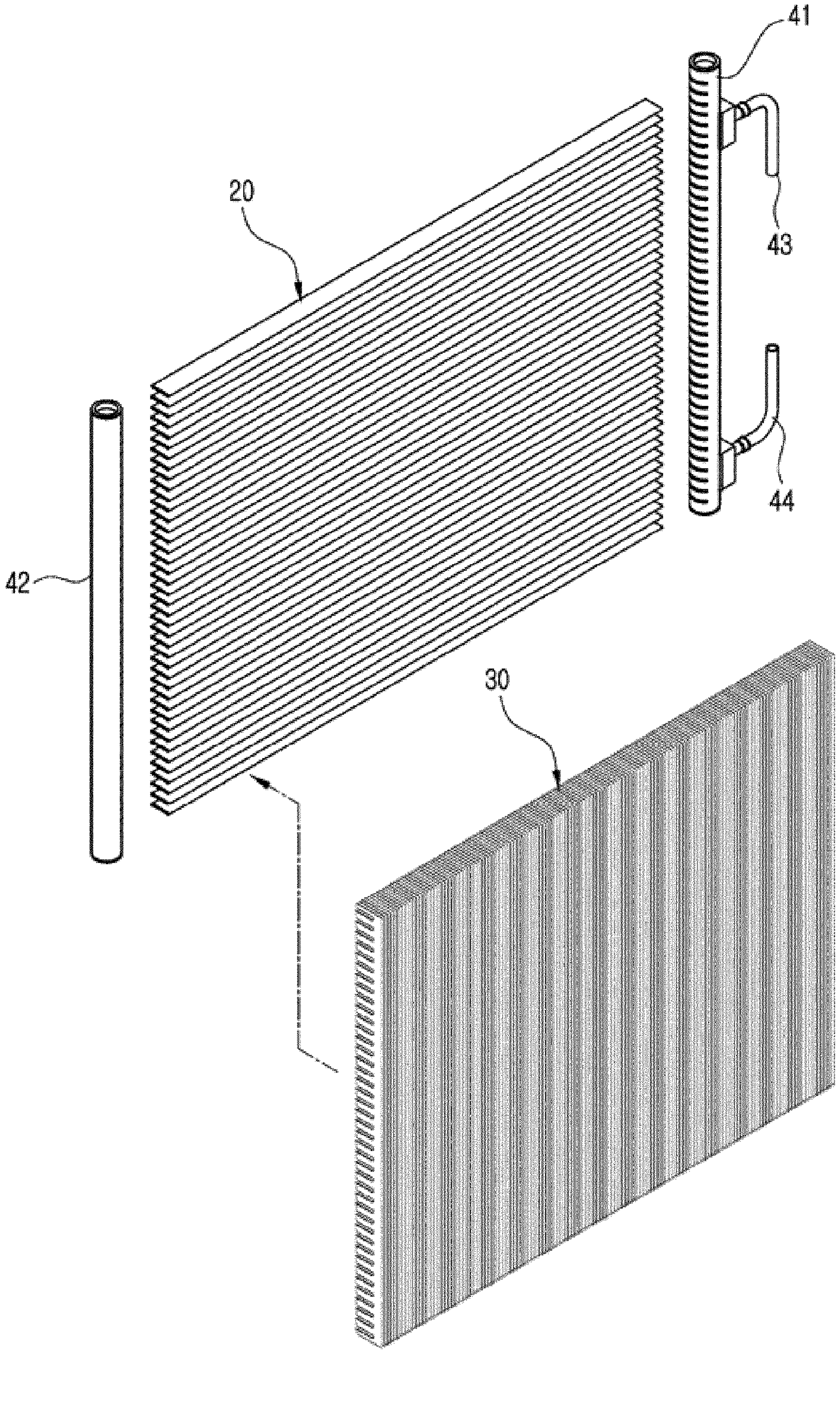


FIG. 3

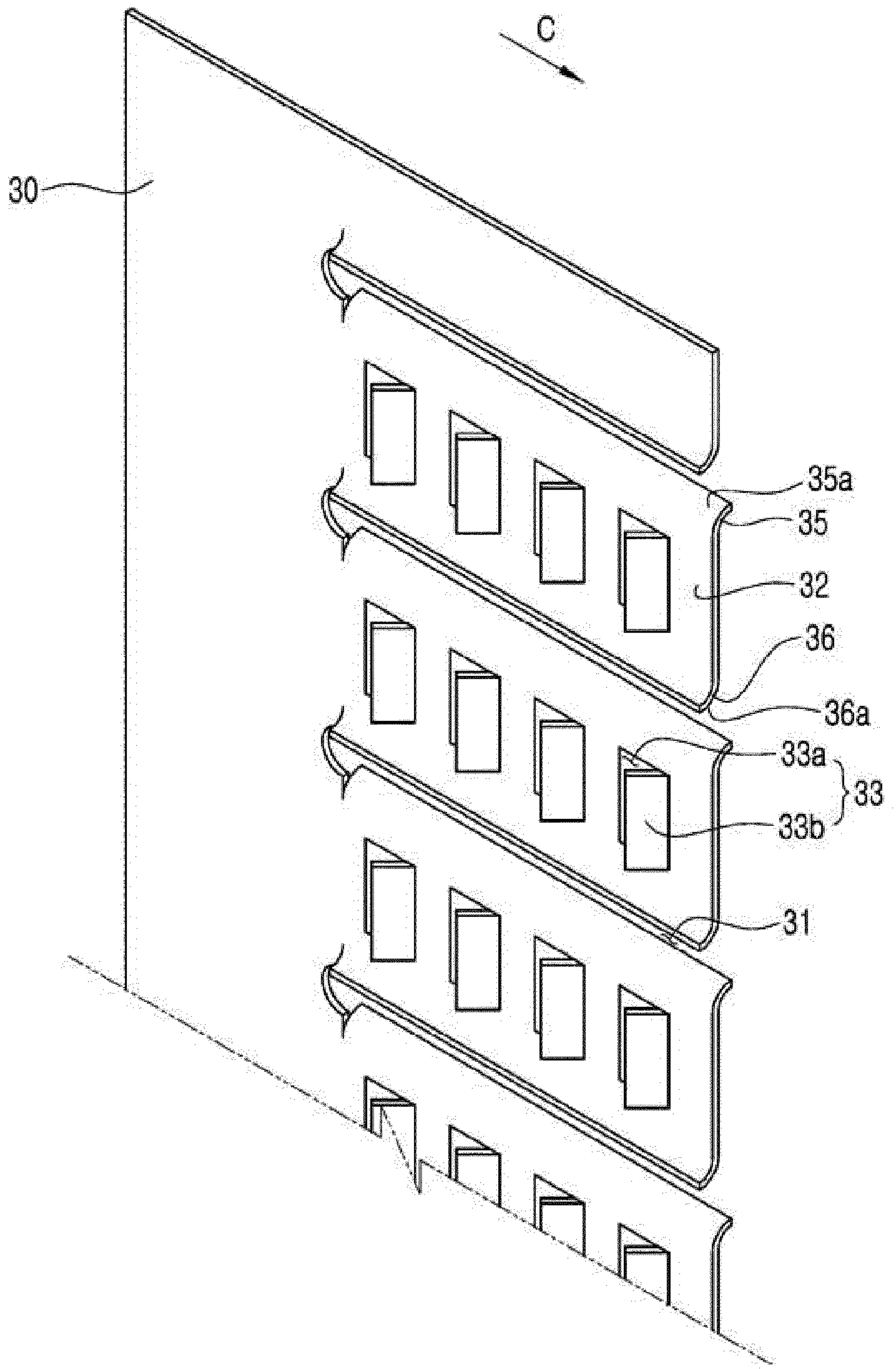


FIG. 4

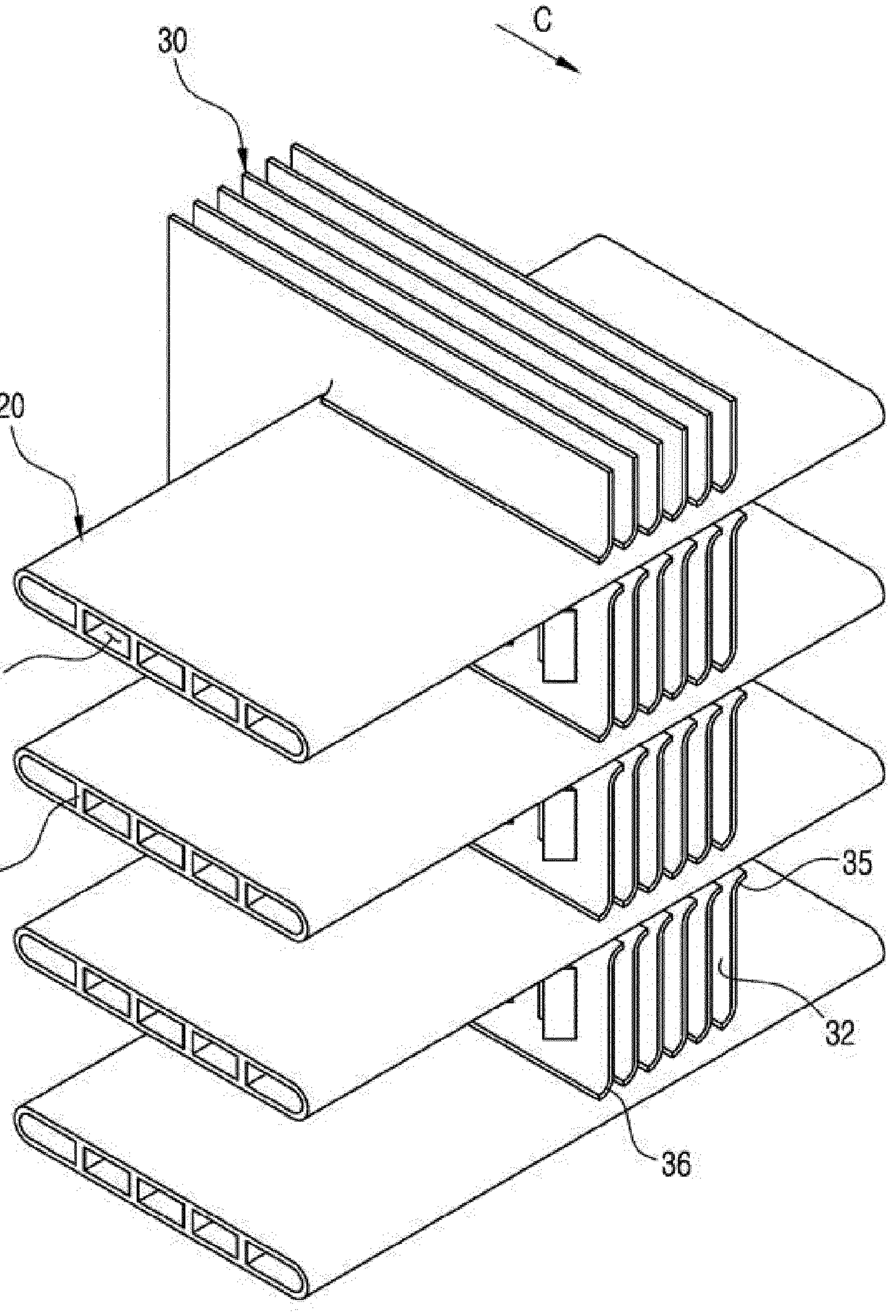


FIG. 5

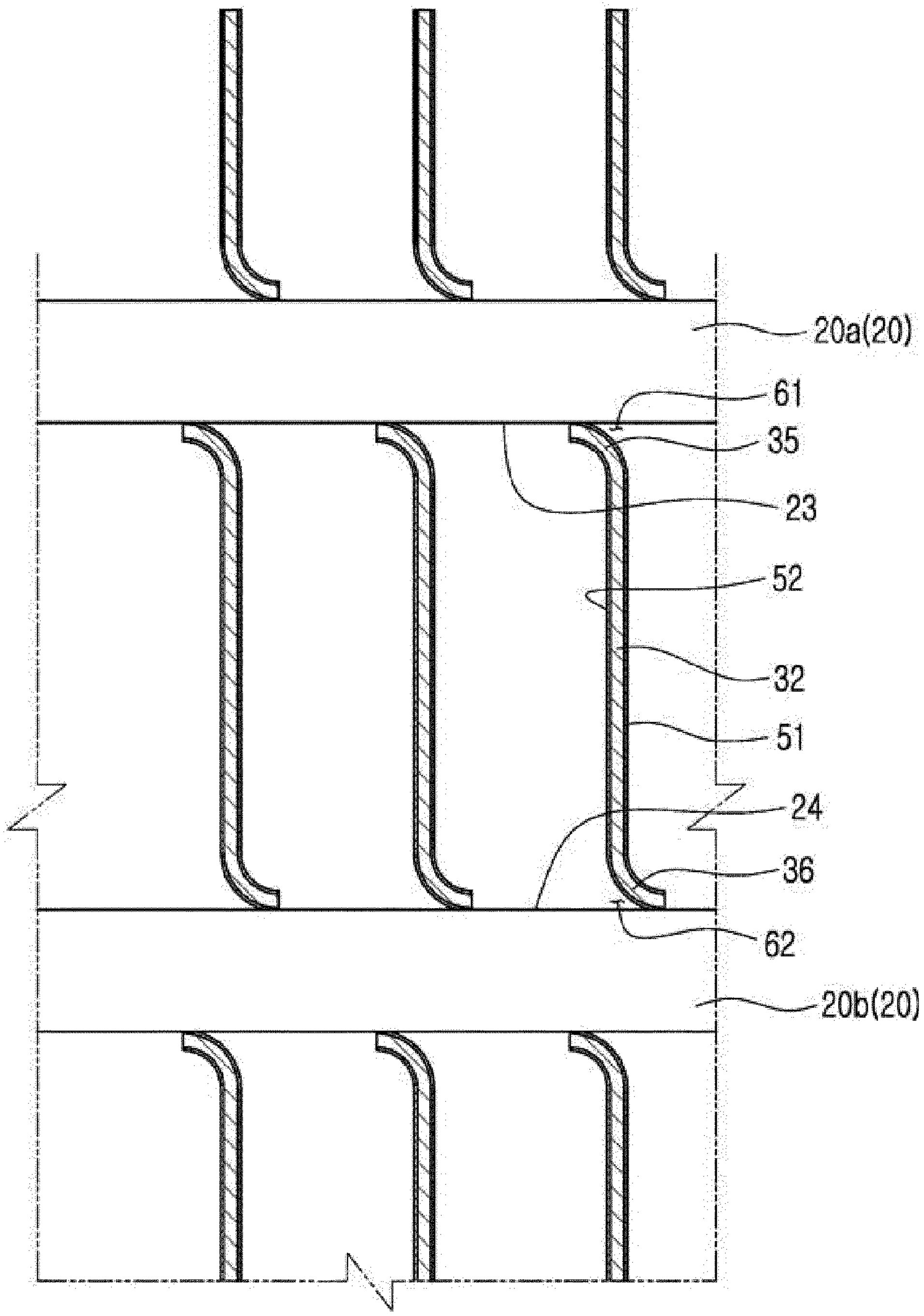
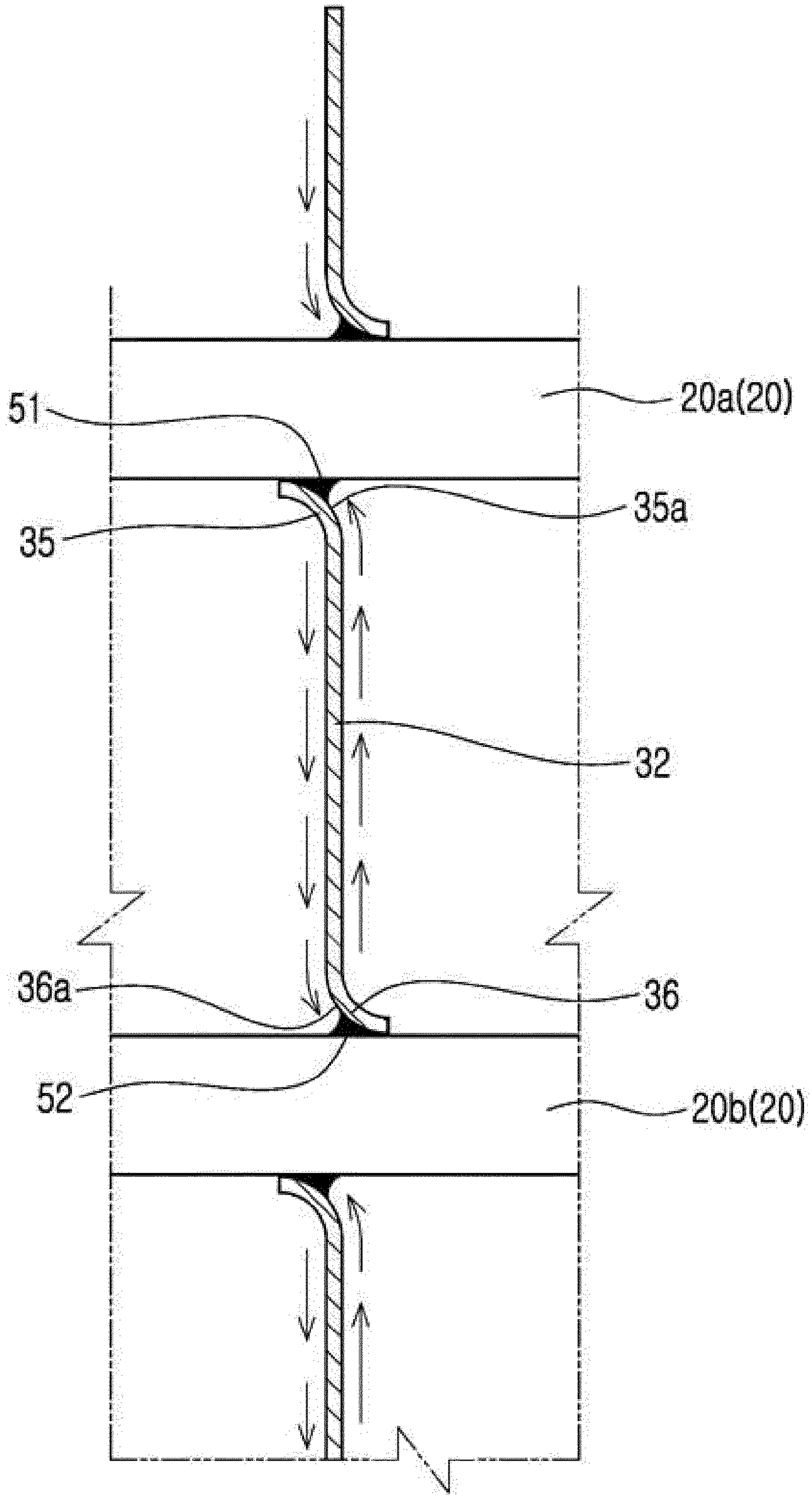


FIG. 6



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Application Number
EP 13 18 6171

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F28F

The present search report has been drawn up for all claims

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CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 18 6171

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